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Microphytobenthos, Meiobenthos and Sediment Quality of Qarun Lake, Egypt

[1]Abd-Ellatif M. Hussian, [2]Hanaa H. Morsi and [3]Mohamed E. Goher

[1]National Institute of Oceanography and Fisheries (NIOF), Inland Water and Aquaculture Branch, 101 Kasr El Aini St., Cairo, Egypt.
[2]Faculty of Science, Menoufia University, Egypt.
[3]National Institute of Oceanography and Fisheries (NIOF), Inland Water and Aquaculture Branch, 101 Kasr El Aini St., Cairo, Egypt.

ABSTRACT

As part of an integrated qualitative and quantitative investigation of several components of the benthic system of Qarun Lake, the microphytobenthose, meiofauna and several environmental characteristics of the sediment were studied during hot and cold seasons (summer 2011 and winter 2012). The sediment is rich with carbonate content in the middle area of the Lake, especially in hot season. Contrarily, the sediment nutrient salts were low in the middle region of the Lake. A total of 92 microphytobenthic species related to 6 classes were identified. The Bacillariophyceae were most diverse with 63 species, then Chlorophyceae and Cyanophyceae with 9 for both, Dinophyceae with 6, Chrysophyceae and Euglenophyceae with 3 and 2 species, respectively. The highest density of microphytobenthos (5150 x 10^4 cell/cm^2) was recorded at the eastern part of the Lake in winter, while the least abundance of 275 x 10^4 cell/cm^2 was detected at the middle Lake during summer. Bacillariophyceae was the abundant group, comprised 71.4% of all recorded taxa. Harpacticoida, free living nematoda, polychaeta and bivalvia larvae were present in miobenthic invertebrates at the sampling sites. Harpacticoida (*Canuella sp*) was always dominant representing more than 72.1% of the individuals per sample, followed free living nematode. Scattered individuals of Polychaete larvae were recorded. Statistical analysis shows a significant positive correlation ($r=0.55$, $P<0.05$) between total microphytobenthos and total meiofauna. The Lake appears to be ecologically unstable and careful limnological monitoring is recommended.

Key words: Microphytobenthos, Meiobenthos, Some physico-chemical variables and Qarun Lake.

Introduction

Microphytobenthos (MPB) describe the group of photoautotrophic microorganisms inhabiting surface sediments of shallow aquatic ecosystems (Pinckney *et al.*, 2003). They are mainly composed of diatoms and chlorophytes and are important primary producers in those sublittoral areas where the euphotic zone extends to the sediment–water interface (Cahoon, 1999). In these environments MPB play an important role in the benthic trophic web, constituting a substantial food source for sediment feeders (Nozais *et al.*, 2005)., among those benthic meiofauna are particularly important consumers of MPB (Carman *et al.*, 1997) since they are attracted to MPB patches (Pinckney *et al.*, 2003). MPB biomass is regulated by both bottom-up and top-down controls. Light and nutrients may regulate biomass and productivity (Sundbäck *et al.*, 2004), while grazers can potentially limit MPB biomass standing stock via high consumption rates (Carman *et al.*, 1997). Changes in the abundance and diversity of benthic diatoms are commonly used to survey water quality and estimates of autotrophic productivity (Foster, 1982). In resent years there has been an increasing interest in the benthic algae as primary producers and contributors to the total lake production. Hargrave (1969) declared that the production of these algae was five times larger than that of the phytoplankton.

The importance of meiobenthos has been emphasized in many studies: it can stimulate the microbial activity in sediment. Meiobenthos can be used as food the macrofauna, its production may be even greater than that of the macrofauna and it can be a potential bioindicator of environmental impacts (Somerfield *et al*., 1995). Wilhm and Dorris (1968) proposed that diversity of benthic invertebrate communities could be used directly to indicate levels of water pollution. Previous investigations have suggested that meiofauna and macrofauna may show similar responses to human disturbances of aquatic environments (Schratzberger *et al.,* 2001). Contrarily, Peterson *et al.* (1996) argue that macrofaunal and meiofaunal communities exhibit repeatable patterns of response to environmental stressors, which are generally detectable at high taxonomic levels.

Previous studies on sediment quality in Lake Qarun were scarce (Goher, 2002 and Abdel Satar & Sayed 2009). Studies on microphytobenthos and miobenthos in Lake Qarun are needed because no prior information exists. Knowledge of the abundance and assembles of these organisms are crucial for The Lake productivity and/ or as an indicator of the environmental conditions. Thus, the aims of our study are as follows: (1) to investigate the distribution, composition and quantitative importance of microphytobenthos and meiofauna in

Corresponding Author: Abd-Ellatif M. Hussian, National Institute of Oceanography and Fisheries (NIOF), Inland Water and Aquaculture Branch, 101 Kasr El Aini St., Cairo, Egypt.
E-mail: abdellatif_elgoaabar@yahoo.com

Qarun Lake, (2) to identify the possible factors that determine the distribution of meiofauna communities. Our work is to provide the first most detailed data on these microbenthos multi-groups in The Lake sediments.

Materials and Methods

Study Site:

Lake Qarun is one of the largest inland closed saline lakes in the North African Great Sahara. The Lake is the deepest area in the River Nile flood plain, making it the final destination of both natural (subsurface flow) and artificial (agricultural) drainage in the Fayum province (Fig. 1). Since The Lake has no natural outlet (Wolters *et al.,* 1989), the drainage water impounded is subject to concentration by evaporation. An average of about 385x10^6 kg of salts are washed out annually from cultivated land and conveyed to The Lake (Meshal, 1977). A volume of fresh water nearly equal to that of the inflowing water is lost annually from The Lake through evaporation while the dissolved salts are left in The Lake (Meshal, 1977). Lake Qarun is currently saline and turbid (Secchi disc transparency usually <40 cm) and has no surface outflow. The Lake comprises two main basins (Fig.1). The main (western) basin has a maximum depth of 8.4 m (in May 1998) and the shallower (eastern) basin has a maximum depth of not more than 3 m. The Lake supports a moderate fishery and is frequented by water birds, however, water quality is declining and bird numbers are diminishing (Meininger and Atta, 1994). Water level varies usually by less than 1 m annually and temperature changes seasonally between about 33 and 15 ºC (El Sayed and Guindy, 1999).

Sampling stations:

Sediment samples were collected from nine sites in The Lake Qarun during hot and cold seasons' (summer 2011 and winter 2012). Sites 1, 2 and 3 represent the eastern area, while sites 4, 5 and 6 represent the middle area and sites 7, 8 and 9 represent the western area of the Lake (Fig. 1).

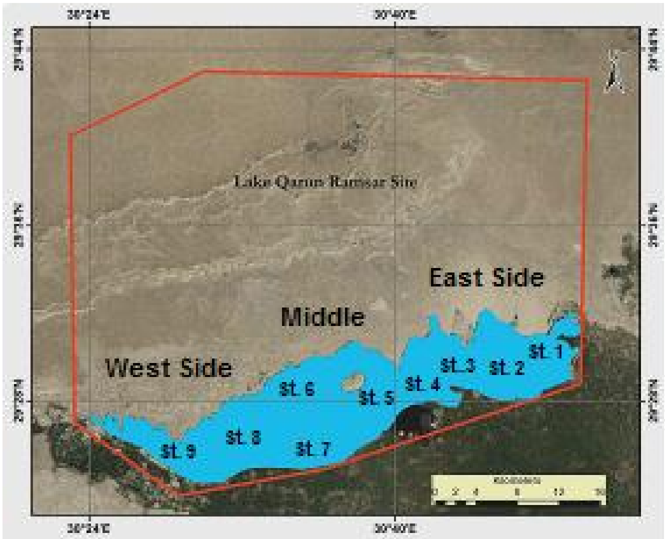

Fig 1: Map showing sampling sites in Qarun Lake

Chemical analysis:

Collection and preparation of the sediment samples:

Recent superficial sediment samples were collected using Ekman grab from 9 stations (Fig 1). For chemical analysis, sediments samples were dried at constant temperature (60 0C) in electric oven for 48 hrs, and then stored in dry clean plastic bags after well grinding to fine grade for various chemical analyses.

A- Field Measurements In Water:

The electrical conductivity (EC) was measured using a conductivity meter (S.C.T.33 YSI) and the data was expressed as (mS/cm), salinity by using portable Hydro Lab. equipment, mod. Multi 340 I / SET WTW, transparency by Secchi disc and water temperature by an ordinary thermometer.

B- Chemical analysis of the sediment:

Sediment pH was measured in 1: 2.5 sediment suspension using Hydrolab Multiset 340i WTW according to methods described in American Society of Agronomy (1982). Fine grained sediment were extracted in 2M KCl for two hours on electric shaker, the sediments extracted were filtered using GF/C microfiber filter paper and used a definite aliquots to determine exchangeable NH_4-N, NO_3-N and NO_2-N. Ammonia (NH_4-N) was determined by indophenol's colorimetric methods according to Bremner and Shaw, (1955). NO_3-N was determined by hydrazine reduction method according to Kampshake *et al.,* (1967). NO_2-N was determined using colorimetric coupled method according to Barnes and Folkard (1951). Available phosphorus was determined after extraction in hot 0.5 M Ca CO_3. Carbonate and Organic matter contents were determined by back titration with diluted HCl and potassium dichromate oxidation under acidic conditions, respectively (Jackson *et al.,* 1984).

2- Biological analysis:

A- Benthic algae

One surface sediment sample (about 1 cm depth) with known surface area was collected by plastic cubic from the Ekman grab samples. Sample was transferred into plastic bottle and fixed with 4% formalin then identified and enumerated using inverted microscope ZEISS 1M4738, magnification power 40 and 100x was used. The drop method was applied (APHA, 1992). The results were presented as number of cells per cm^2 ($cell/cm^2$). The main references used in benthic algal identification were: Compere (1991), Krammer and lang Bertalot (1991), Popovsky and Pfiester (1990), Tikkanen (1986), Starmach (1974), Prescott (1982) and Bourrelly (1968).

B- Meiofauna sampling:

Meiofauna samples were collected by Ekman grab. An area of 0.0033 m^2 from the upper sediment's surface of each locality was investigated.

Treatment of samples:

Samples were stained with Rose Bengal (l gm/L) and were preserved in 4% formalin solution. In laboratory, samples were washed with water and passed through two sieves, the upper one with 500 µm mesh size (captured the macrofauna) and the lower one with a mesh opening of 55µm. Sediments retained on the lower sieve were diluted with water to 100 ml and few drops of Rose Bengal and formalin were added to them. From each sample, three subsamples (1ml each) were examined separately under a dissecting microscope. Sorted animals were identified as much as possible to species level. Individuals of species were counted and the average total density was expressed in number of organisms / m^2.

Statistical analysis:

Pearson's Correlation Analysis was performed to evaluate the relationships between physico-chemical variables and microphytobenthos, meiobenthos densities. The data recorded in this study were examined with principal component analysis (PCA) in order to relate the distribution of microphytobenthos, meiobenthos taxa to the abiotic variables under study, using XL Stat (2001) program.

Results and Discussion

The MPB and meiobenthos are intimately associated with surface sediments and is thus exposed to large environmental fluctuations. Temperature, salinity, light intensity and grain size composition, directly affecting many species by limiting vertical distribution and burrowing performance (Asmus, 1982). On sandy and muddy substrates, edaphic microalgae living on a variety of benthic surfaces are often dominated by diatoms (Agatz *et al.,* 1999). The abiotic sediment qualities measured at each station are presented in Fig (2). Differences within each parameter were related mainly to the season and also with biochemical reactions occurring in the surface sediment. Water temperature showed a seasonal variation related to atmospheric temperature values. Temperature at the sediment-water interface ranged from 16.9 to 30.8 °C (mean 23.9 °C) during the sampling period (Fig. 2). Temperature is known to have a direct effect on aquatic organisms and indirect effect through its influence on other environmental factors such as solubility of gases including oxygen (Abdel Gawad, 1993). EC values varied between 16.5 and 48.5 mS/cm (mean 41 mS/cm). EC highly positive correlated (r=0.73) with transparency. Water transparency was greatest during winter and reached a maximum value of 150 cm at station 6, while a minimum value of 30 cm was recorded at station 1 (Fig. 2). Transparency has a positive effect on growth of microphytobenthos. Salinity of Lake Qarun showed an obvious fluctuation, the minimum values (11.9 and 18.8 g L–1) were recorded at station 1 and 7 during winter and summer, respectively. While the maximum value (37.8 g L–1) was recorded at stations 8 and 9 in winter. Difference in salinity among sites can effect on distribution of some species. This agrees with Ahmed (1991) who stated that the salinity can determine species distribution and Khalil (1985) who stated the diversity and distribution of organisms in Manzalah Lake are largely determined by salinity. A significant negative correlation ($r=-0.53$, $P<0.05$) was observed between salinity and total microphytobenthos density. Sediments of Qarun Lake commonly lie in the alkaline side except in some stations during two seasons. it lie in acidic side. This could be attributed to fermentation processes of organic matter (Lenz, 1977). pH values varied between a minimum value of 6.71 which recorded during summer at station 1 and a maximum of 7.54 which recorded during winter at station 4, with an average of 7.19 (Fig, 2). The distribution of organic matter content in the sediments of Qarun Lake has almost a uniform distribution, except at the station 1 and 7. Which affected by drains water input from El-Bats and El-Wadi Drains, So, they maintain the lowest organic matter contents and the relative high contents of organic matter in the sediments mostly accompanied with high clay contents (Lotfy, 2003). It fluctuated between a minimum value of (1.09 %) at station. 5 during summer and a maximum one (13.01 %) at station 1 during winter, with an average of 6.05 % (Fig. 2).

Carbonate contents were fluctuated between a minimum value of (2.96%) recorded at station. 9 during winter and a maximum value (16.29 %) recorded at station 5 during summer, with an average of 7.11 % (Fig, 2). It is notable from the obtained results that, the middle area of Qarun Lake is rich with carbonate content than the other area, especially during summer. The exchangeable nutrients in the sediment of Lake Qarun showed irregular distribution pattern with low concentrations levels in the middle region of the Lake. This may be due to the sediment type. Clayey sediments are rich in nitrogenous compounds, while the sandy sediments are nutrient poor (Boey, 1997). Nitrite values increased during summer, this may be attributed mainly to decomposition of organic matter under elevation of temperature and dissolved oxygen reduction (Boynton *et al.*, 1997). The exchangeable NO_3-N contents showed altering values ranged from a minimum value of (0.72 µg/g) at station 5 during summer to a maximum value (3.46 µg/g) at station 1 during winter. Nitrate values showed an opposite distribution pattern in comparison to nitrite. This indicates the oxidized conditions of the Lake sediment, where NO_2 is oxidized to nitrate as a result of nitrification process which enhanced by high nitrifying bacteria as reported by Sabae and Ali (2004). Ammonia represents the dominant nitrogenous forms. Its results fluctuated between the minimum value of (49.2 µg/g) at station 5 in winter and the maximum one of 316.8 µg/g at station 1 in winter. Ammonia contents in the Qarun sediment may deserve more priority attention than other nitrogenous forms, but it is not a serious concern because of higher dissolved oxygen contents and normal pH values control the toxicity of ammonia (Johnston and Minnaard, 2003). The orthophosphate values showed irregular variations during study period. In the same time, their values showed a maximum regional value at station 1 during winter and decreased at station 5 during summer. It may attributed to release of reactive forms of phosphate are very limited especially in shallow lakes (Kurata and Kira, 1990). This observation indicated that orthophosphates are transported from agriculture drainage water into The Lake and consequently precipitated as a result of salinity.

Orthophosphate fluctuated between a minimum value of (1.1 µg/g) at station 5 in summer and a maximum one of 9.2 µg/g at station 1 in winter, with an average of 4.2 µg/g (Table, 2). Phosphorus forms chemically tight compounds with major cations, these tight forms especially noted with magnesium in the form of $MgPO_4$., $MgHPO_4$ and MgH_2PO_4 and calcium in the form of $CaPO_4$., $CaHPO_4$ and CaH_2PO_4 (Pulmmer *et al.*, 1984).

The supply of P and N is considered to be one of the main factors determining the magnitude of the primary production (Fathi *et al.*, 2001). It was clear that the inflow drains, carrying silt, nutrients, salts and plankton as well as freshwater from the River Nile, have major influences on Lake Qarun water quality. The Benthic algal of Qarun Lake consisted of 92 taxa. of these, 63 Bacillariophyta, 9 Cyanobacteria, 9 Chlorophyta, 6 Dinophyta, 3 Chrysophyta and 2 Euglenophyta. The identified species are listed in Table (3). Species composition of microphytobenthos communities varied along the study period in winter compared to summer. It may be realized to change of environmental factors which can affect the structure of algal communities. In the present study, the microphytobenthos (MPB) community in the surface sediment layer (0-1cm) was composed mainly of Bacillariaceae forming 88.6 and 63.3% of all recorded taxa during summer and winter, respectively.

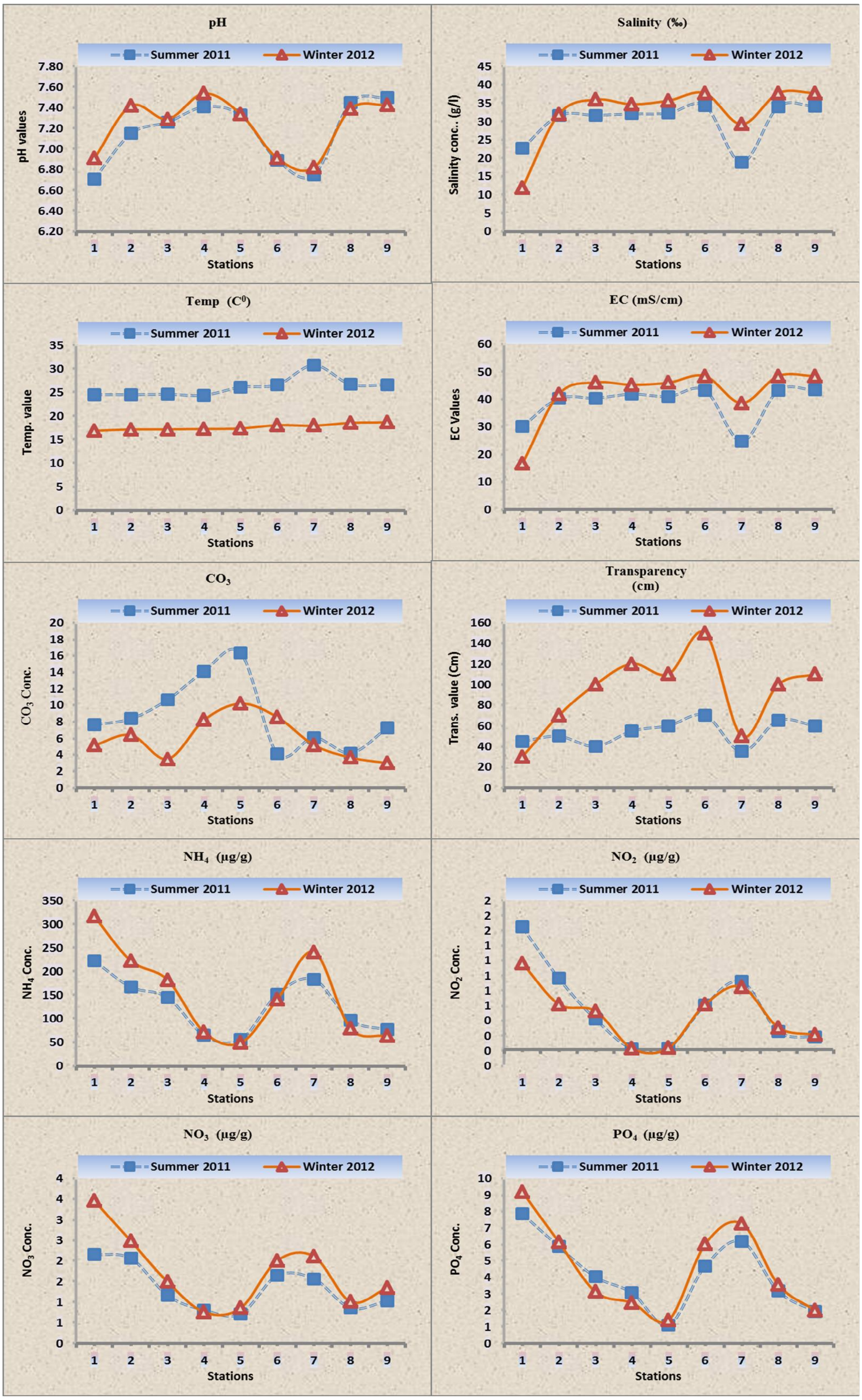

Fig. 2: Some physicochemical parameters of Qarun Lake sediment during summer 2011 and winter 2012.

Medvedeva (2001) pointed out that diverse families are of great diagnostic importance in floristic analyses and the microphytobenthos assemblages were dominated by diatoms, particularly in mesotrophic and meso-eutrophic fishponds. Bacillariophyta was the dominant group in terms of species number and density, and comprised 71.4% of all recorded taxa. The same result was observed in many lakes in the East Black Sea region of Turkey (Sahin, 2008. and Sahin & Akar, 2005). Round (1984) pointed out that diatoms are usually the most common elements of microphytobenthos communities. It is well known that the members of the Bacillariophyta are sensitive to a wide range of limnological and environmental variables, and that their community structure may quickly respond to changing physical, chemical, and biological conditions in the environment (Mooser *et al.,* 1996). Increasing of diatoms can be considered an ecological benefit supplying energy for the planktonic food web (Gorczyca and London, 2003).

Table 3: A list of microphytobenthos species that recorded in Qarun Lake

Bacillariophyceae	*Nitizschia longissima var.reversa*
Achnanthis minutissma (W.Smith)	*Nitzschia acicularis (Rabb.)Grun.*
Amphora ovalis Kutz.	*Nitzschia angularis (Rabb.)Grun.*
Amphora rostrata Kutz.	*Nitzschia denticula (EHr.)*
Biddulphia antediluviana	*Nitzschia frustulum (Kutz.)W. Smith*
Campylodiscus decorus	*Nitzschia lanceolata (EHr.)*
Campylodiscus hibernicus	*Nitzschia liungarica (EHr.)*
Cocconeis placentula (Grun)	*Nitzschia lorenzina (EHr.)*
Cocconeis scutellum	*Nitzschia obtusa (Kutz.)W. Smith*
Coscinodiscus himentum	*Nitzschia palea (Kutz.)W. Smith*
Coscinodiscus lineatus	*Nitzschia palea (Kutz.)W. Smith*
Coscinodiscus ridatus	*Raphoneis amphiceros*
Cyclotella comta Pant.	*Rhoicosphenia curvata*
Cyclotella kutzingiana Kutz.	*Surirella biseriata*
Cyclotella meneghiniana Kutz.	*Surirella ovalis*
Cyclotella ocellata Pant.	*Surirella ovalis var. salina*
Cyclotella operculata Kutz.	*Surirella robusta*
Cyclotella stelligera Pant.	*Syndra acus (EHr.)*
Cymbella holevetica Grun.	*Syndra affineis (EHr.)*
Cymbella microcephala Grun.	*Syndra ulna (EHr.)*
Diatoma hiemale	*Syndra ulna var. lanceotata (EHr.)*
Diatoma vulgare	*Syndra ulna var. spathulifera (EHr.)*
Dimeregramma minor	*Syndra ulna var. subtaequalis (EHr.)*
Epithemia sorex (Dujardin)	*Thalassiosira frarenfeldii*
Eunotia arcus	***Chlorophyceae***
Eunotia faba	*Ankistrodesmus fusiformis (Corda.)*
Fragilaria construens ver.venete Grun	*Chlorococcum humicola*
Gomphonema geminatum (Kutz.)	*Cosmarium galenitum*
Grammatophora angulosa	*Cosmarium grantum*
Liemophora communis	*Cosmarium sp.*
Melosira granulata (Her.) Ralfs	*Elakatothrix gelatinosa (Wille)*
Melosira roeseana (Her.)	*Scenedesmus ecornis (Ehrenberg).*
Melosira varians (Her.) Ralfs	*Scenedesmus quadricuda G.M Smith*
Navicula bulnheimii (Dujardin)	*Tetraedron minimum (Braun)*
Navicula cancellata (Donk)	***Dinophyceae***
Navicula creptocephala Grun.	*Gymnodinum aeruginosum (Stein)*
Navicula lanceulata var. arenaria (Donk)	*Massartia vorticella (Stein)*
Navicula lata (EHr.)	*Peridinium pusillum Stein.*
Navicula opima Grun.	*Peridinium umbonatum*
Navicula rhynchocephala (Dujardin)	*Peridinium umbonatum var. umbonatum*
	Peridinium willei
Euglenophyceae	***Chrysophyceae***
Trechlomonas volvocina var. deyephora	*Dinobryon sp.*
Trechlomonas pulcherrima (Dujardin)	*Dinobryon tabellariae*
Cyanophyceae	*Ochromonas mutabilis (Klebs.)*
Chroococcus cohren	
Lyngbya limnetica Lemmer.	
Lyngbya versicolor Lemmer.	
Merismopedia punctata (Meyen)	
Oscillatoria subuliformis (Meneghini)	
Phormidium interruptum Kutz.	
Phormidium laminosa Kutz.	
Schizothrix friesii (Meneghini)	
Symploca muscorum	

When the highest total microphytobenthos abundance (5150 x 10^4 cell/cm^2) was found at station 1 in winter, the least total microphytobenthos abundance of 275 x 10^4 cell/cm^2 was obtained at station 5 in summer (Fig. 3). Light limitation by suspended solids as well as hydrological related factors is believed responsible for the relatively low microphytobenthos abundance in summer (Brodie, *et al.,* 2013). Our results showed that, the highest total microphytobenthos abundance was recorded in winter. Statistical analysis showed a significant positive correlation (r=0.55, P<0.05) between total microphytobenthos and total meiofauna. Distribution of microphytobenthos communities in Qarun Lake were high rich in the eastern side of the Lake comparing with western side. The considerable variation in the composition and distribution of the microphytobenthos assemblages among the different stations of the Lake was mainly related to differences in the concentration of nutrients in the sediment and climatic changes (Zalat, A and Vildary S., 2005). Regional distribution of the total Bacillariophyceae indicated that the highest density of (1175 x 10^4 and 2075 x 10^4 cells/cm^2) were recorded in the eastern side of the Lake at station 2 during Summer, while the lowest of (425 x 10^4 cells/cm^2) were recorded in the middle of the Lake at station 6 during winter. Most of diatom species in the microphytobenthos community exhibited variations during the study. *Melosira varians* was the most common diatom observed in winter., reached its peak (2250 x 10^4 cell/cm^2) and represented 24.7%. *Cocconeis placentula*, *Cyclotella meneghiniana* and *Cyclotella operculata* were represented (7.1, 9.6 and 7.7%) of the total taxa in winter, respectively. The same pattern was observed in summer, *Melosira granulate* recorded the highest density of 785 x10^4 cell/cm^2 and represented 13.1%, *Coscinodiscus lineatus*, *Coscinodiscus ridatus*, *Cyclotella meneghiniana* and *Syndra ulna* were represented (9.6, 11.2, 12.5 and 6.2%) of the total taxa, respectively, as shown in the Fig. (4). Round (1984) reported that Cyclotella species are considered planktonic. However, *Cyclotella meneghiniana* was found in the microphytobenthos community of Balık Lake. Our results explained that the species of *Melosira granulate* and *Melosira varians* were common and abundant in summer and winter season, respectively. In winter, the second dominant group was Cyanophyta, while in summer was Chlorophyta. Cyanophyta and Chlorophyta were comprised 31.7 and 7% of all recorded taxa, respectively. Regional distribution of cyanophyceae indicated that, its highest density was (725 x 10^4 cell/cm^2) recorded in the eastern side of the Lake at station 1.while it disappeared in the western side at station 8 and 9. Cyanophyceae community was generally dominated by two *Lyngbya limnetica* represented (48.7%) and *Schizothrix friesii* (17.9%) from the total of this group (Fig. 4). Regional distribution of chlorophyceae indicated that, its highest density was recorded in the east side but more abundant in the western side of the Lake, while disappeared in the middle of the Lake. Most common green algae species was *Cosmarium grantum* represented (26.3%) of the total of this group. The other common species are shown in Fig. (4). Other classes were lightly dispersed in The Lake and hence contributed little to the total benthic density. Meiobenthic invertebrates' community plays an important role in The Lakes food web.

It serves as food for a variety of higher trophic levels and its high sensitivity to anthropogenic inputs making them excellent monitors for the study of pollution (Coull, 1999). *Canuella sp.* and free living Nematoda were the main groups of meiofauna in the Lake. Numerically, they were represented by 72.1% and 21.3% of the total number of meiofauna in the different stations, respectively. Very few individuals of Polychaete larvae appeared in the area (only on four times during two seasons). The total population density of meiofauna in the sampled localities is given in Fig (5). Seasonal averages of the total population density were 20000 and 33778 organisms /m^2 during summer and winter, respectively. Three peaks were recorded in the Lake, the highest one (74000 organisms /m^2) was observed in station 1, the second and third ones (70000 and 64000 organisms /m^2) were observed in station 8 and 7, respectively (Fig. 4). In the other stations, average of the total population density were fluctuated between 9500 organisms /m^2 at station 3 and 47500 organisms /m^2 at station 8.

Concerning temporal distribution of meiofauna, winter was the most productive seasons, showing peak at station 1. The minimum values was 4000 organisms /m^2 recorded at station 1 during summer. This disagrees with the results of Rudnick *et al.* (1985) who recorded high meiofaunal densities in some coastal marine ecosystem during summer. Fishar (2000) recorded the highest densities of meiofauna during June and July., Abdel Gawad (2007) recorded the highest number of meiofauna in the Nile River and El Serw Fish Farm respectively during summer. In this study, the lowest of chlorophyceae was recorded when the meiofauna was high. There are a negative correlation (r = - 0.34, P > 0.05) between chlorophyceae and meiofauna in the investigated area. Chlorophyceae have a reverse effect on meiofauna. *Canuella sp.* occupied the first position contributing 83.6 and 52.8% of the total density of meiofauna in the Lake during winter and summer, respectively. It fluctuated between a minimum value of 1000 organisms /m^2 at station 1, 9 during summer and a maximum value of 64000 organisms /m^2 at station 1 during winter (Fig. 5). Numerically, free living Nematoda was the seconed dominant group contributing 12.5 and 36.1% of the total density in The Lake during winter and summer, respectively. It was irregular in their distribution and its density was absent in some stations. Free living Nematodes were few or absent in some stations. This may be due to high dissolved oxygen and low contamination. This agrees with Bouwman *et al.* (1984) who stated that abundance of nematodes occurs in contaminated environment and they are more tolerant to low oxygen content than other taxa. Fishar and Abdel Gawad (2004) confirmed this result in Wadi El Rayan Lakes. Few numbers of Polychaete larvae ranked the third position of the total population density, constituting 2.5%. The distribution of this group showed weak abundance in all stations. It appeared only in stations 1, 5, 8 and 9 during the whole period of study (Fig. 5).

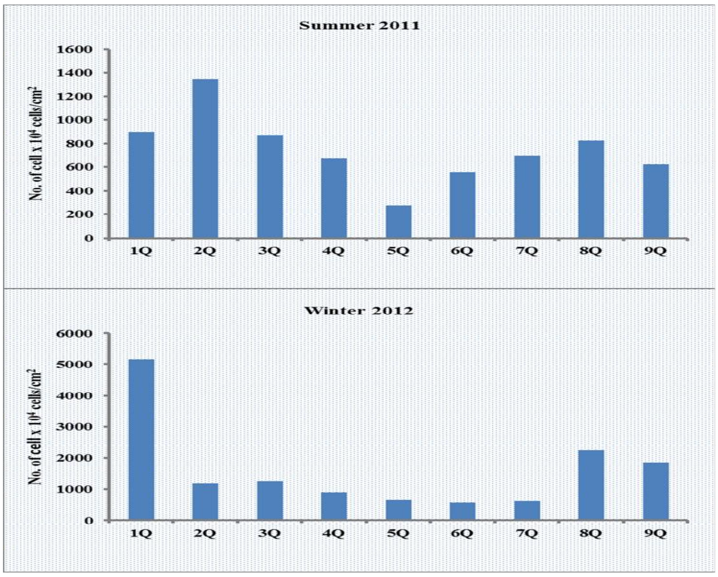

Fig. 3: Total of microphytobenthos at the different stations of Qarun Lake

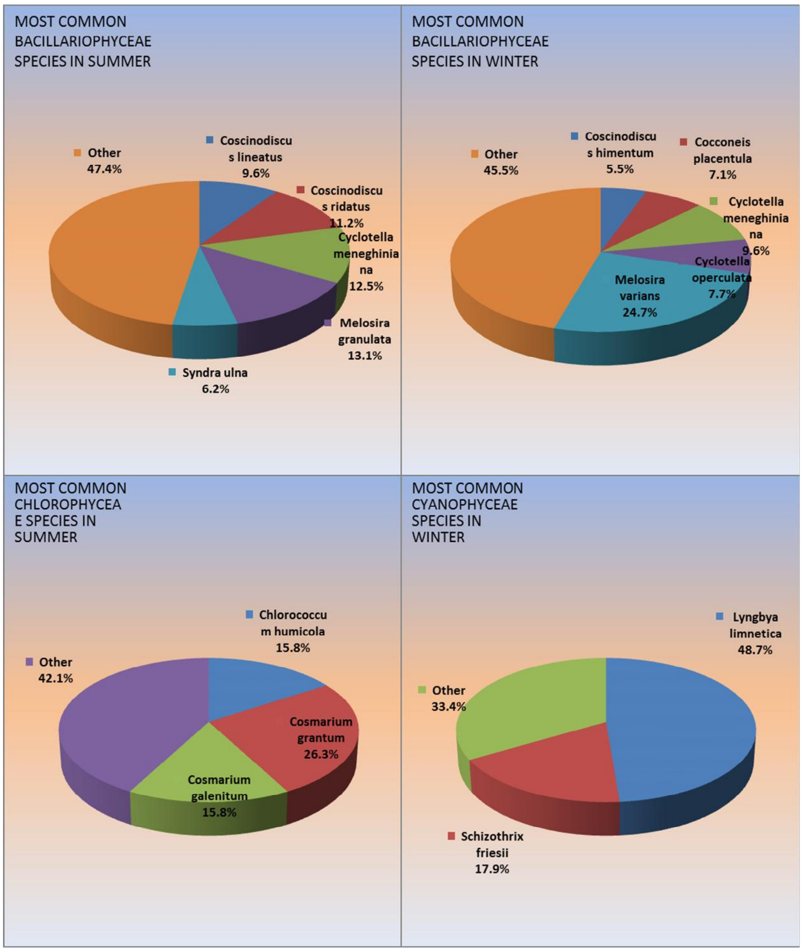

Fig. 4: Percentage abundance of the abundant microphytobenthos species

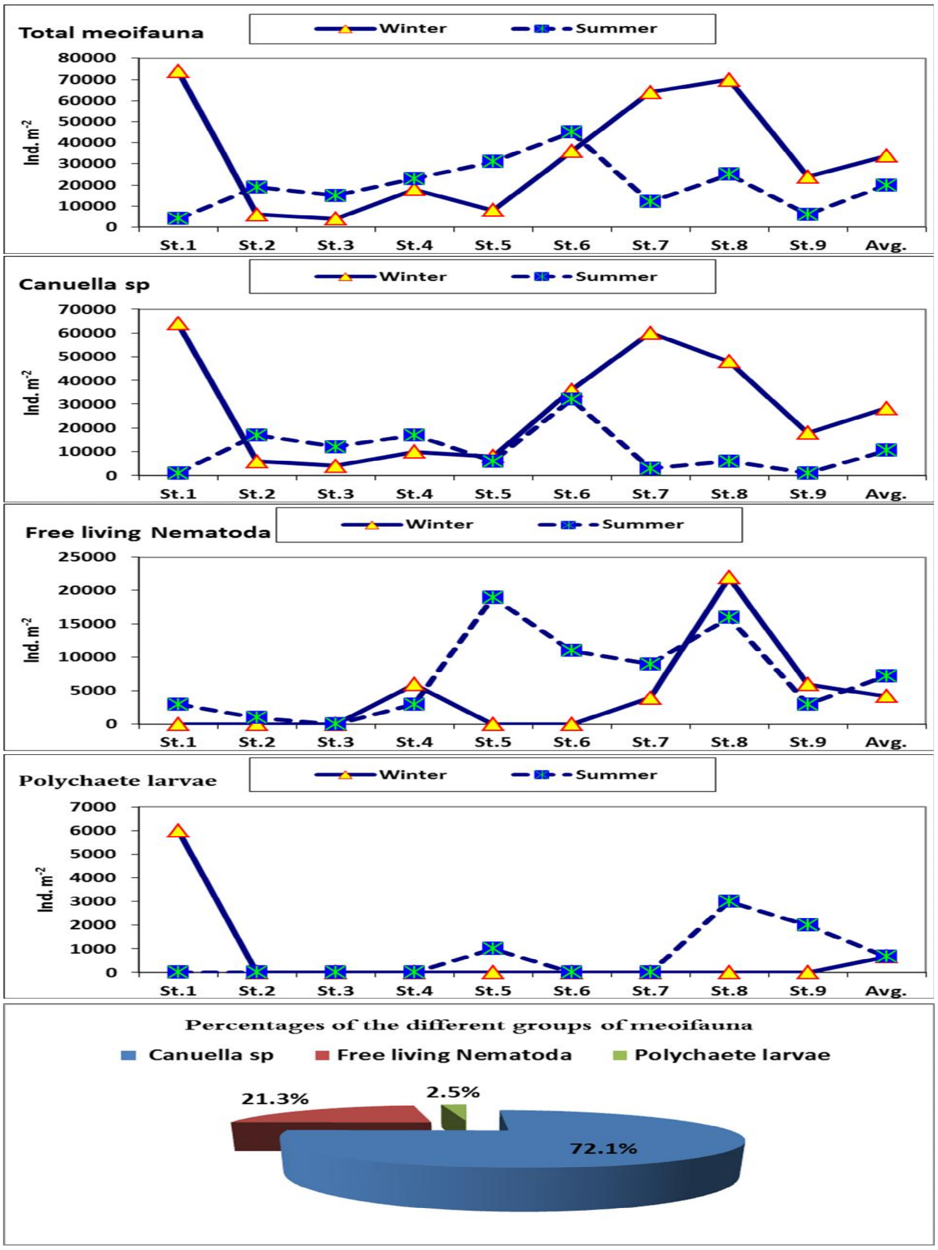

Fig. 5: Total Meiofuna and regional distribution of the different groups, with its percentage in Qarun Lake

Relationship between environmental parameters and Microphytobenthos and meiofauna species composition:

The correlation analysis displayed significant relationships among the tested groups and the sediment nutrient content, being strongest for Cyanophyceae (r= 0.7 and 0.5 for nitrate and available Phosphorus, respectively). Beyond that, most of the groups were negatively correlated with salinity. Close correlations were found for *Cosmarium galenitum* with transparency (r=0.5), *Lyngbya limnetica* with nitrate content and salinity (r=0.6 and -0.7, respectively) and *Canuella* sp with nutrient content (r=0.5). Furthermore, Polychaete larvae were positively associated with organic content (r=.0.5), and negatively correlated with salinity (r=-0.7). In contrast, pH and water temperature were weakly correlated with or did not show any significant relation to, species or groups abundance. Finally, there were significant positive correlations between Polychaete larvae and both Cyanophyceae and total microphytobenthos (r= 0.8 and 0.7).

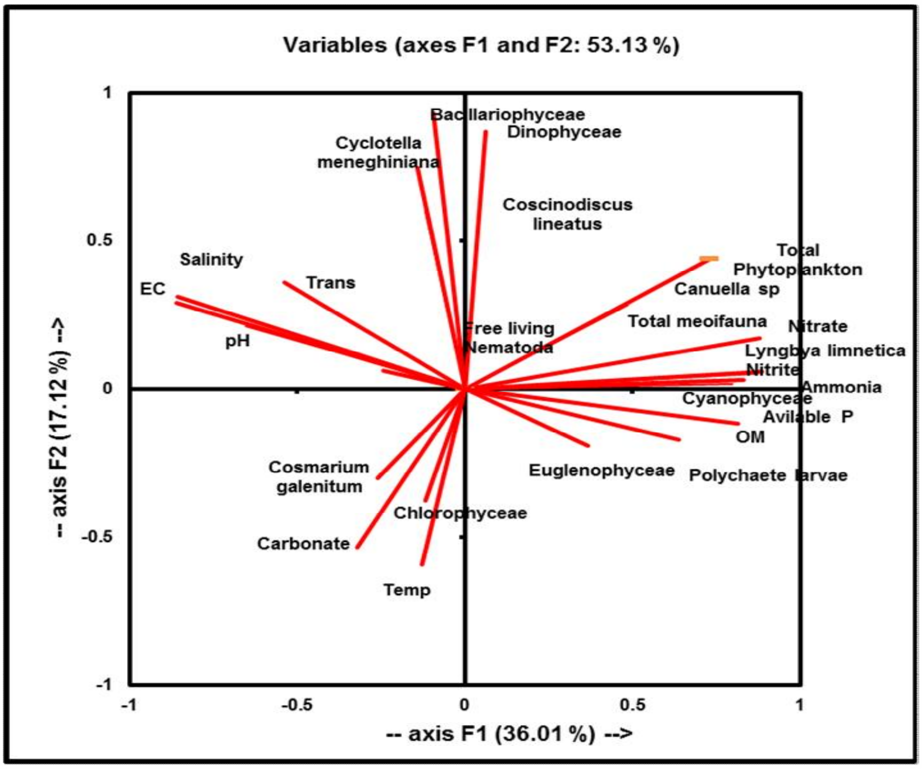

Fig. 6: Principal component analysis (PCA) (Axis I and II) performed on total, dominant species of microphytobenthos, meiofana and some physico-chemical variables

The principal correspondence analysis (PCA) of the MPB and meiofauna community composition suggested that several environmental variables were closely correlated with species abundances (Fig. 6). The first axis explaining 36.01 % of the variance and was primarily associated with the organic mater and nutrient content of the surface sediment, while axis 2 was explaining 17.1 % of the variance and dominated by the salinity, carbonate and temperature. According to the results of PCA analysis, free living nematode has strong adaptation to the environment, and the distribution of some species is affected by the main habitat factors. Sediment of high nutrient content has *Canuella* sp, *Lyngbya limnetica*, *Coscinodiscus lineatus* and Polychaete larvae as the dominant species., waters enriched with carbonate and with high temperature are characterized by *Cosmarium galenitum*. Sediment with high salinity and transparency are characterized by *Cyclotella meneghiniana*.

Conclusion:

From the above result it has been concluded that the sediment of Qarun Lake shows high dominance of microphytobenthos and miofauna which indicates that this lakes posse's high amount of organic waste and therefore the water of the Lake is organically polluted. These present data strongly suggest that both grazer presence and nutrient enrichment induced microphytobenthic community shifts and on the long run nutrients took over a governing role in restructuring the microphytobenthos.

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