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BENTHIC ASSEMBLAGES FOR ECOLOGICAL EVALUATION OF LAKE MANZALA, MEDITERRANEAN SEA, EGYPT

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ABSTRACT: Lake Manzalah one of the northern Nile Delta in Egypt is the largest lake, which lies between the lakes Borollus and Bardaweel and connects to the Mediterranean Sea. It has an area of current 250 thousand acres. It contains many islands particularly along the south-western region forming of semi-enclosed basins and it is characterized by dense submerged hydrophytes as *Pomatogeton pectinals*; *Ceratophyllum demersum* and floating hyacinth *Eichhornia crassipes.* Seven major drains are loading directly in the south to the west. Lake Manzalah-bottomed shallow (0.5-1m), brackish water (3-18‰ and is suffering from the phenomenon of high nutrition (eutrophication) due to increased rates of nutrients and organic matter. So some sources of wastes discharges such as sewage and industrial waste and agricultural activity pour directly into the lake, especially the southern region (Bahr El Baqar Drain). The study aims to study the distribution of benthic organisms in the lake and knowledge of the relationship between the types and aggregates benthic food ecosystem as the important food sources' for some aquatic organisms, especially economic fish and crustaceans in study stations. Bottom sediment samples were collected from 11 sites by grab sampler covering different environments lake and from 4 drains consists mostly of organic materials (sludge) is made up of waste sewage, industrial, agricultural waste plants, and calcareous shells empty. Results indicate for examining configuration qualitative macro benthic recording the 16 species of aquatic plants and invertebrates where empty calcareous shells were more frequent. The abundance of macrobenthic organisms at different sampling sites along Lake Manzala can be ranked as follows: Ostracoda (45.4%, 1010 ind/m^2) > submerged plants (12.9%, 287 tufts/m^2) > Amphipoda (9.2%, 207 ind/m^2) > Polychaetes (7%, 110 ind/m^2) Bivalves (5.9%, 132 ind/m^2). The biomass of benthic assemblages at different sampling sites can also be ranked as follows: at ST5 (18.1%, 4433 ind/m^2) > St6 (11.3%, 2772 ind/m^2) > ST8 (9.8%, 2405 ind/m^2) > ST3 (9.2%, 2247) > ST7 (8.7%, 2122 ind/m^2). The biomass of benthic assemblages at different sampling sites can also be ranked as follows: echinoderms (52%) > molluscs (27%) > crustaceans (16%) > polychaetes (2%) > other groups (3%). Due to the increase of pollutants extensively loaded into the drains are the possible factors having affecting the constituents' structures of benthos. Sites of sampling study were evenly spread (J' > 0.8) only at sites 6 and 8, moderate diversity (H' > 1.00) was at most sites and show lower value at sites 3 and 11 and 0 at site 1. The abiotic environmental effects in the lake are general to those generally observed in other areas influenced by organic wastes, namely, changes in the physic-chemical properties of the sediments and low oxygen concentrations in the bottom water due to the decomposition of organic materials.

KEYWORDS: Benthic assemblages; environmental evaluation; biodiversity; dominance species; Lake Manzala

INTRODUCTION

The bottom sediments of Lake Manzala consist mainly of (sludge) as silt, mainly mixed with organic matter resulting from sewage, agriculture, and industrial waste, resulting in controlled eutrophication rates. So some sources of wastes discharge such as sewage and industrial waste and agricultural activity pour directly into the lake without any treatment, especially in the southern region-Bahr El Baqar Drain (EL-Bady, 2014; Elkadya *et al.*, 2015; Elshemy and Khadr, 2015; Arnous and Hassan, 2015). The effect on qualities of the community structures will affect the characteristics of the ecosystem is the result of a vulnerability in the processes between individuals traits (Weiher *et al.*, 1998; Grime, 2006). Appropriate adjectives in direct response and may include these traits respond to environmental change, or through compensatory. Previous studies conducted in the lake during the years 1993 (El-Sherif *et al*., 1993 and 1997, El-Komi, 1997) reflect some changes in species diversity of neighbourhoods benthic in numerical density regarding the lack of equal distribution between species and between study areas due to the different environments, depending on the different type bottom and properties aqueous medium physical and chemical which has a direct impact and indirectly on the configuration qualitative revive quantity and quality of benthos. Bernhardt *et al*. (2010) reported the Wetland vegetation in Lake Manzala that massive population growth occurred and the two major vegetation changes occurred less than 10 years after closure upriver of the Low and High dams that markedly altered the Nile regime from Upper Egypt to the coast.

Lake Manzala locates in the northeast of the Nile River Delta and extends administratively across three governorates (Port Said; Damietta; Dakahlia). Sources and outlets of water in the Lake Manzala (EEAA, 2017) included 8 drains sources: Hados; Farskor; El Sarw; and Bahr El Bagar; Direct Sewage Stations; Bioprocessing Plant south of Port Said, and purification El Anania drain station. The lake is considered one of the most important and largest northern lakes, with an estimated area of 125,000 acres in 2014, with a depth of half a meter. By 2001, Lake Manzala had lost approximately 80 percent of its former area through the effects of drainage efforts and about 250,000 fishermen benefit from Lake Manzala, and the number of boats in about 2,680, distribution: 4,349 boats at Al-Matareya, 17,500 boats in Damietta, and 6,830 boats in Port Said (Dinar, 1995*)*.The lake produces different types of fish (Tilapia, Mullet, Whiting grass carp, shrimp, and crab. The presence of the three biogases (El Gamil outlets) leads to the passage of saltwater fishes from the Mediterranean to the lake, which leads to an increase in the types of salty fish, which are the most important economically.

Recently, the government has widely removed illegal infringements from lake fillings for housing or agriculture or the establishment of unlicensed fish farms where it has been completely removed. So the work in the lake is divided into the South Port Said sector with a total area of about 78,000 acres and the East Damietta sector with an area of 62,000 acres. The following have been implemented: 1- Starting to cleanse the lake from plants and weeds; 2- Remove unauthorized buildings, nests, and fish farms; 3- Starting the dredging works to increase the depth of the lake; 4- Improving the water quality of the lake by facilitating the entry of seawater to it by deepening and expanding the Boughases: El Gamel new and old Inlets and El Dibba to the western border of the lake.

This work was carried out at the South Port Said sector, where about 337,000 square meters were cleared; East Damietta sector, 14,000m^2 with a total of 351,000 m^2; drains will be digging and ended with Gibbons filters to filter the water entering the lake and the lake is bordered to prevent future encroachments in Port Said, Dakahlia, and Damietta governorates with a width of 35 meters, and a road of 8 meters with a length of 80 km to connect the lake with the international coastal road. The objective of processes is to eliminate lake pollution and return fish as was the case in the past and to establishing social housing and population gatherings for fishermen. The project costs about 40 Billion Egyptian pounds during the period 2017-2019 without the housing costs within two years, from 2017 to 2019. Accordingly, huge quantities of reeds, jungle, heist, and the Nile have been removed, in an area estimated at 34,000 acres; 4,100 unlicensed buildings and structures were removed; 100,000 m^3 cubic meters have been dredged per day, with a total of 14 million m^3, so far; the presence of large quantities of minerals after analyzing them in the central laboratories, which have a high economic value; the goal is to increase fish stocks and create a nature reserve that receives migratory birds in the lake and the issuance of strict and deterrent laws for the protection of Egypt's lakes. There will be patrols with helicopters to monitor any encroachment on the lakes and chase outlaws.

It has been intensively investigated during the last 50 years. Many scientific publications are reviewed on Hydrodynamic-ecological model analyses of the water quality (Rasmussen *et al.*, 2009**);** on water, nitrogen, and phosphorus budgets (El-Saharty, 2014); on the average of water budged in Lake Manzala (Said and Abd-Abdl-Moati, 1995 and 1997) on the application of remote sensing to site characterization, and environmental change analysis (Ahmed *et al.*, 2009); on hydrodynamic-ecological model analyses of the water quality (Rasmussen *et al.*, 2009) on physicochemical properties (Elmorsi *et al.*, 2017) on the environmental assessment of the spatial distribution of zooplankton and on algal diversity of the Mediterranean lakes (Khairy *et al.*, 2015). Dynamics is due to the consequent changes in the interactions between species functions (Garnier *et al.*, 2004) will affect the community change ecosystem processes through changes in the representation of the ecosystem impact qualities (Diaz *et al.*, 2004; Kremen, 2005). These properties of the ecosystem variables changes are the reliable forecast on qualities of ecosystem functions (Suding *et al.*, 2008).

Estimated average population density annual benthic constituents to revive benthic during 1992-1993 (1371 ind/m^2 followed by a marked the decline during the previous study 2009-2010 by 4162 ind/m^{2}and notes low in density previous study 2010-2011 reached a density of 1973 ind/m^2 during the current study observed a rise in the population density of existing standing crop of reviving macrobenthos live up to 3056 ind/m^2. The distribution of the bottom fauna of Lake Manzala was studied by many researchers e.g. (El-Komi, 1997, 2014, 2015 and 2017; El-Sherif *et al.*, 1993). On the other side, the use of direct macrobenthic functional biodiversity indices of community structure along the environmental gradient to predict responses were recently developed (Grime *et al.*, 1988; Woodward and Diament, 1991; Chapin *et al.*, 1993; Poff, 1997; Purvis and Hector, 2000) including studies on traits related to the probability of extinction e.g. Williams *et al.*, 2005 and invasion (e.g. Grotkopp *et al.*, 2002; Olden *et al.*, 2006). In addition to models which have been suggested for understanding community dynamics, include; environmental stress models, and either nutrient/ productivity models for the food (Hamilton *et al.*, 2005) chain dynamics hypothesis

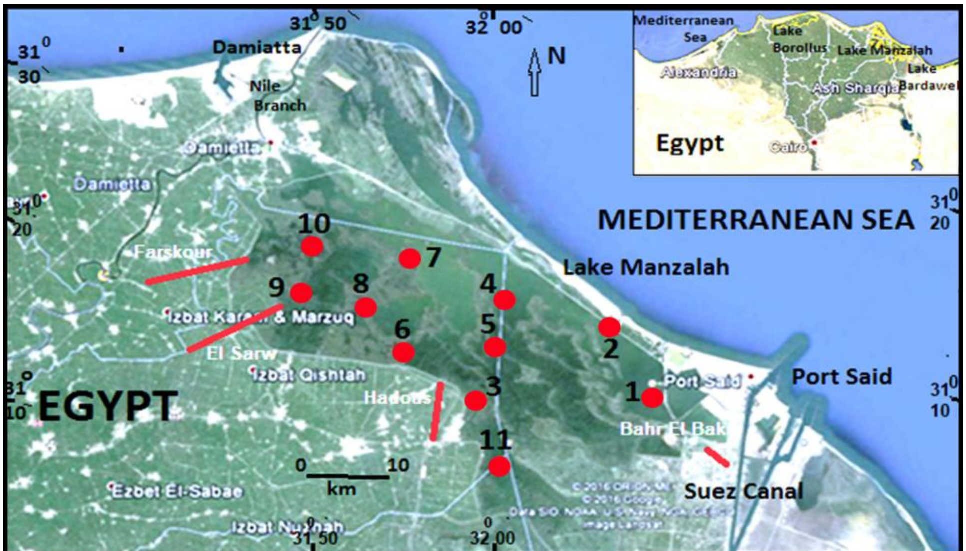
(Connell, 1975; Menge, 2000) the two models postulate that communities can be ordered along an environmental gradient. McGill *et al.* (2006) argued that the general principle in community ecology may not be achieved if research continues to focus on pair-wise species interactions independent of the environment. They suggested four research themes: functional traits, environmental gradients, and interactions milieu and performance currencies to bring general patterns to the community ecology. Relatively few studies have explicitly incorporated structuring abiotic (environmental gradient) and biotic (movement, dispersal) features that are key to species co-existence and vital for the maintenance of species diversity. The number of species in a community is influenced by a variety of factors (e.g., physical stress, nutrient availability, consumer pressure, habitat destruction), which result in a non-random diversity gradient in natural habitats.

Globally, the magnitude of impacts of the activities in the marine environment is increasing over the last 5 decades, and most pollutant wastes on the bottom. Studying benthic assemblages, therefore, are important to emphasize their impacts. This study sought to determine the community structure of the macrobenthic fauna of Lake Manzala. Through the qualitative, biomass, and numerical density configuration assessments of benthic communities in aquatic environments can estimate and determine the biological index of biosafety for the study area. In assessing the ecological impacts of certain known groups were based upon their response to environmental stress and termed initially as opportunistic and equilibrium species groups (El-Komi, 2017; a,b, 2019). This functional assemblage is widely adopted using macrobenthos, particularly in closed and semi-closed aquatic areas. Represent an easily understood depiction of biological data as community biomass, the abundance of individuals, species diversity, and depth distribution of biomass within the sediment. Besides which some of the more mobile species can wander far from their ‘home's ground and so their absence or presence can be the source of ambiguity. Therefore, it is necessary to identify the so-called indicator species the presence or absence of which is a direct reflection of water quality and not due simply to the vagaries of chance (Dauer *et al.*, 1992 and Weisberg *et al.*, 1997).

So the national program for environmental monitoring of Egyptian Lagoons aims to determine environmental contaminants impacting, halt the continuing deterioration, protecting their plans, and sustainable development. Compare the annual averages for some variables present (pH, dissolved Oxygen, nitrogen compounds) to that hydrographical survey of international levels. The primary aims of this study involve unfolding the community structure of the macrobenthic faunal assemblages and assessing their relationship to lagoon bottom habitats. This study aimed at the assumption that the macrobenthos as bioindicator assemblage of the structure of the lake bottom sediments is significantly affected by environmental conditions. The specific objectives of the study were to: determine the state of macro benthic faunal assemblages in the area of study; sediment characteristics; and determine the abundance and species diversity of lagoon bottom habitats macro benthic faunal assemblages.

MATERIAL AND METHODS

a- **Area of Study:** Lake Manzala locates between the coordinates, latitude (31°16′ 0″ N) and longitude (32° 12′ 0″ E) as shown in Fig. 1 and their sites locations in Table 1.



Northern coastline				Middle Region			Southern Region				Southern Drains			
ST10	ST7	ST4	ST2	ST9	ST8	ST5	ST6	ST3	ST1	ST11	Farskour	El Sarw	Hadous	Bahr El Baqar

Fig. 1. Northern part of Egypt map shows the North River Nile Delta Lakes and the sampling sites in Lake Manzala during 2017.

The pattern of the study sampling sites in Lake Manzala can be divided into three main regions namely: the northern coastal region; Middle Region; Southern Region, and the Southern Drains. It is associated with the Mediterranean Sea through the two artificial inlets called the Boughaz (El Gamil I and II). It is subjected to a scope of difficulties including the decrease of its zone achieves a length of 85 km coming about because of the extension of agricultural and fish farm's activities and achieving a most extreme width of 22 km and has an area of around 650 km^2.

b- **Sampling collection:** Sampling was carried out during two periods, the 1stduring February 2017 representing the winter season and the 2nd during September representing the summer season 2017. Benthos and bottom sediment samples were collected from 11 sites representing the different habitats in Lake Manzala. The positions of the selected sites, as well as the nurture of the bottom sediments, are shown in Fig. 1. The location of the sampling sites is detected by using GPS. At each site, the bottom sediment sample was collected by Van Veen grab sampler sized 15cm x 15cm (an equivalent area to 0.02 m^2) which each sample was placed in plastic containers, labelled, and preserved in 8-10 diluted formalin solution. Also, bottom sediments were collected from 4 main drains (Farskour; El Sarw; Hadous, and Bahr El Baqar).

c- **Water depth and transparency as recorded from Final report, EEAA 2017:** The lake water depth was greatly varied among the different sampling sites ranging from a minimum of 25 cm (ST3) to a maximum of 1.5 m (ST1) and an average of one meter in most sites. The degree of transparency of lake water is ranged from 15 cm to one meter with an average of 45 cm therefore the transparency is relatively moderated except in southern sites and the drains.

Table 1. Northern part of Lake Manzala shows the sampling sites and their coordinates during 2017.

Stations	Location	Latitude.	Longitude	Sediment nature	benthos constituent
	Northern Coastal Region				
ST10	El Zarga (in area with heavy submerged aquatic plants near Farskourdrian)	31° 21 37``	31° 55`98``	Sludge	Submerged aquatic plants
ST7	El hamara (north in saline water)	31 ° 20`18``	31 °59` 15``	Sludge, sand	empty shells
ST4	El Tamsah	31 ° 18`11``	32 ° 04`29``	Sand	empty shells
ST2	In front el Gamel out let	32 ° 61`26``	32 °11`19``	Sand	empty shells
	Middle Region				
ST9	El Dadbgo (in area with heavy submerged aquatic plants south to Sarwdrian)	31° 16` 76``	34°53`83``	Sludge	Submerged aquatic plants
ST8	Abou El kabier (north to Sarwdrian)	31° 15`84``	31° 56 `11``	Sludge	plants
ST5	Elkan	31° 13`85``	32 ° 04`38``	Sludge, shells	plant fragments
	Southern Region				
ST. 6	Dashy (in area with heavy submerged aquatic plants)	31 °14`26``	32° 00`15``	Sludge	Shell frag.ments submerged aquatic
ST3	West to El Bashter	31° 11`13``	32 °04`05``	Sludge, shells	plant fragments
ST11	El Ganka in front to Hadousdrian.	31° 07`01``	32°06`13``	Sludge	plant fragments
ST1	In front Bahr el BaqarDrian	31°12`02``	32°12`31``	Sludge	plant fragments
	Southern Drains				
	Farskour	31° 19`	32 °46`	Sludge	plant fragments
	El Sarw	31° 16`	32° 47`	Sludge	plant fragments
	Hadous	31° 11`	32 °57`	Sludge	plant fragments
	Bahr El Baqar	31° 10`	32°09`	Sludge	plant fragments

d- **The nature of the benthic sediment:** Sediments in a few zones are comprised of organic materials (sludge) is made out of waste sewage and agricultural and industrial particularly in the southern region and others of sandy silt, sands, and shells in the northern region (Table 1). Consequently, it can decide a few conditions prevailing in lake environments. The nature of bottom sediment as illustrated in Table 1 is characterized by some deposits of organic material (sludge) and is composed of sewage waste of agricultural, industrial, and others of sandy silt and shells.

e- **Physic-chemical Parameters (after Final report, EEAA, 2017)** (Table 2)

- The annual average water temperature ran a minimum of 26.3°C and high 29°C with an average of 27.4°C.

Table 2. Physic-chemical Parameters (after Final report, EEAA, 2017) of water quality of Lake Manzala

Stations	Depth Cm	Trans Cm	Temp °C	pH	Salinity ppt	DO mg/l	BOD mg/l	DOM mg/l	COD mg/l
Northern Coastal Region									
ST10	100	40	27.2	8.26	12.16	4.88	24.38	24	96.3
ST7	100	50	27.5	8.14	31.47	6.34	29.25	19.2	78.54
ST4	100	45	26.5	8.26	27.24	5.04	14.63	19.2	78.54
ST2	100	45	26.3	8.53	13.45	6.66	87.75	24	96.3
Middle Region									
ST9	100	100	28.2	8.19	8.44	5.85	29.25	22.4	90.38
ST8	100	40	27.2	8.36	16.22	5.36	19.5	20.8	84.46
ST5	100	35	28.5	7.95	3.17	6.83	48.75	12.8	54.86
Southern Region									
ST6	125	30	29	8.39	4.81	9.26	146.25	17.6	72.62
ST3	25	60	26.5	8.1	3.84	0.81	43.88	17.6	72.62
ST11	100	30	27	8.68	3.1	4.23	14.63	24	96.3
ST1	150	15	27	7.6	3.52	0.16	48.75	14.4	60.78
Min.	**25**	**15**	**26.3**	**7.6**	**3.1**	**0.2**	**14.6**	**12.8**	**54.9**
Max.	**150**	**100**	**29**	**8.7**	**31.5**	**9.3**	**146.3**	**24**	**96.3**
Average	**100**	**44.5**	**27.4**	**8.2**	**11.6**	**5**	**46.1**	**19.6**	**80.2**

- Water salinity ranged from relatively high at St10 (El Zarga, near Farskour Drain); at ST7 (El Hamara, in the north), at ST4 (El Tamsah, in the middle); at ST2 (in front of El Gamil outlet); at ST9 (El Dadbgo, in the area with heavy submerged aquatic plants south to Sarw Drain), and at ST8 (Abou El Kabir, north to Sarw Drain) corresponding respectively to 12.16‰, 31.47‰, 27.24 ‰, 13.45‰, 8.44 ‰, and 16.22‰. Whereas it was low at the rest sites (ranged from 3.17 ‰ to 4.81‰).
- Hydrogen ion concentration (pH) situated in the alkaline side, most reduced value 7.6 at ST1 and 7.95 ST9 and values increased to 8.1 at ST8 and 8.68 at ST11.
- Dissolved oxygen in the water is ranged between less worth 0.81 mg/l (at ST3, west to Basheer) and 0.16 mg/l (at ST1, Bahr El Baqar), reaching high value of 9.26 mg/l at the stations ST6, Dashey (is characterized by increasing of submerged plants), and the values were moderate at stations ST7 (6.34 mg/l), ST2 (6.66 mg/l), ST5 (6.83 mg/l), and it was low at rest station varied between 4.23 to 5.85 mg/l.
- Compare the annual averages for some variables present to those hydrographical survey of international levels found as cited in the final Report EEAA (2017): pH levels are found in the allowed limits (9.0-6.0) of average (7.99); dissolved oxygen levels (4.2-12.6 mg/l) average (0.95 mg/l); consumer under biology oxygen levels (0.3-6.0 mg/l); in all stations the lack of nutrient in lake water (average of 0.95 mg/l).

f- **Laboratory Analyses (El-Komi, 2017c and 2019):** Bottom sediment samples were washed through 100 and 300 µm mesh-sized sieves thoroughly with fresh water to remove the formaldehyde and other fine sediments (lesser than 300 µm). During sorting, stained matter or organisms identified were placed into broad taxa, including polychaetes, molluscs, and to the species, level using a binocular stereomicroscope has a power magnification of 20x and 40x. Acceptable taxonomic keys were used from different branches of taxonomical sources.

The following descriptive measurements were computed at each site:

- S is the species number per sample
- A is the abundance of individuals and it is expressed as some ind/m^2
- B is the biomass of individuals and it is expressed as the wet weight of individuals in g/m^2 the ratio
- B/A and A/S were plotted for the samples at the different sites.

g- **Diversity Indices:** Diversity indices that serve as an indication of community health on area scales can be measured using several indices as Magurran (1955), Goodall (1973), Magurran and McGill (2011) El-Komi (2017 and 2019), and Diverse-Univariate diversity indices using PRIMER 5 (Plymouth Routines In Multivariate Ecological Research) including Margalef's species Richness, Pielou's Evenness index, Shannon-Weiner species diversity, and Simpson's diversity index were applied in this study.

-Margalef's species richness (d) (1958): Species richness refers to the total number of different species present (without taking into account the proportion and distribution of each species) within the sample. Margalef index [49] is represented by the equation: $d = (S-1)/lnN$ where S = the total number of species, and N = the total number of individuals in the sample.

- Pielou's Evenness (J`) (1966**):** Evenness with the assumption of all species was accounted for in the sample. This aids in qualifying organism distribution among sampled assemblages. The higher the attained value, the more evenly individuals are spread among the species. Species evenness is dependent on species richness and species diversity. The evenness measure is a ratio of the observed diversity to the maximum possible in a sample having the same number of species. The equation used was:

$J` = H/H`max = H`/\log S$

where H` = the Shannon-Wiener diversity index, S = the total number of species.

- Shannon-Wiener's species diversity index (H`) (1949**):** The Shannon-Wiener diversity index (also referred to as the Shannon diversity), characterizes the state of an assemblage per the species richness and species abundance. It assumes all species are represented in the sample and that individuals are randomly sampled from an independently large population. The community diversity is defined by the obtained value; 0 to 1.5 for poor, 1.5 to 2.5 for moderate, and > 2.5 for highly diverse. The Shannon-Wiener diversity value often falls between 1.5 and 3.5 but can exceed 4. The index increases as the community richness and evenness increase (Shannon and Weaver, 1949).

The equation used is:

$$H' = -\sum_{i=1}^{S} pi \ln pi$$

where *pi* = the proportion of individuals found in species i ln = natural logarithm s = the total number of species.

- Simpson's diversity index (D): Simpson (1951) introduced this measure to determine the degree of concentration when species are classed. The values of Simpson's diversity index range from 0 to 1, where 0 represents no diversity and 1 represents infinite diversity. The index is directly related to species evenness and richness. The Simpson index gives more weight to common or dominant species; therefore, a few rare species with only a few representatives will not affect the diversity.

The equation used to measure it was: $D = \Sigma\,[((n-1)\,/\,(N-1))]$

where n = the total number of organisms of a particular species N = the total number of organisms of all species. D is a measure of dominance, so as D increases, diversity (in the sense of evenness) decreases. Thus, Simpson's index is usually reported as its complement 1-D. This provides an intuitive proportional measure of diversity that is much less sensitive to species richness.

h- **Statistical analyses:** - Statistical tools used in Univariate and Multivariate analyses were Microsoft Excel tool PCA and PRIMER (Plymouth Routines in Multivariate Ecological Research) version 5 respectively. The analysis of variance (ANOVA) using simple linear regression (FAO, 1991) was calculated. This method is based on determining the significant differences at the 95% confidence limits between the variables of sites (abundance, biomass, and groups of benthos) and physic-chemical variables.

- The triangular matrix of similarities between samples leading to hierarchical classification (cluster analysis) (FAO, 1991). This is based on a Bray-Curtis similarity matrix of appropriately transformed species abundance or biomass data.

- Principal component and factor analyses PCA are multivariate techniques, which generate a sequence of varieties known as components of factors in a correlation matrix. These analytical methods have been successfully used in marine ecology. It is based on extracting information on the regional patterns of species from complex correlation matrices. The basic difference between PCA and factor analyses FA is that the PCA is assumed that all the variance is common and its orthogonal components can be extracted, whereas in the FA the variance common in all variables is separated from the specific and error (residual) variances. The analysis is based on the data of the abundance (no. ind/m^2) of the most common species or the main high taxa groups of benthos using the numerical data. (Table 8)

Swartz's dominance index: This measured the number of species whose combined abundance comprised 75 of the total sample abundance (if index value > 5 indicating that the area has no stress community). According to PTI 1993, values less than 5 usually indicate a stressed community (PTI, 1993 as cited by Laetz, 1998). The Swartz's dominance index values ranged from one to six at the sampling sites, where most western sites were significantly less stressed than the previous sites.

RESULTS AND DISCUSSION

Part1- Distribution of Macrobenthic Structure in Lake Manzala:

1. Species composition of benthos structure:

1.1 Species composition: This study reviewed the benthic structure and its distribution in Lake Manzala. Results show for inspecting arrangement subjective macrobenthic communities during the study period were recorded 16 species as listed

Table 3. Abundance annual averages of abundance (no. ind/m^2) and relative abundance (%) of the main groups of benthic species recorded in bottom sediments collected from Lake Manzala during 2017.

Abund 2017	*Species*	St1	St2	St3	St4	St5	St6	St7	St8	St9	St10	St11	Ave	%
Aquatic plants	***Potamogeton pectinatus***	0	0	0	0	0	126	0	756	714	378	189	197	8.8
	Ceratophyllum demersum	0	0	42	0	0	42	0	426	63	315	105	90	4.1
Nematoda	***Enoplos meridionalis***	0	504	630	0	0	0	0	0	0	0	0	103	4.6
Oligochaeta	***Chaetogaster lirnnaei***	42	0	63	0	273	399	0	0	0	0	0	71	3.2
Polychaeta	***Capitella capitata***	0	210	294	0	64	189	0	0	105	0	0	78	3.5
	Nereis irrorata	0	63	0	105	42	0	147	0	0	0	0	32	1.5
Insecta larvae	***Tendipes tentans***	252	357	84	0	840	273	189	273	84	252	252	260	11
Ostracoda	***Sclerochilus contortus***	378	1008	1134	819	1680	945	1176	950	966	630	1428	1010	45.4
Amphipoda	***Corophium volutator***	0	105	0	0	1386	336	63	0	0	0	0	172	7.7
	***Gammarus* sp.**	0	0	0	0	63	63	105	0	0	42	0	25	1.1
	***Elasmpus* sp.**	0	0	0	105	0	0	0	0	0	0	0	10	0.4
Isopoda	***Sphaeroma serratum***	0	0	0	63	0	0	0	0	0	0	0	6	0.3
Barnacles	***Balanus impoivisus***	0	0	0	232	0	0	189	0	0	0	0	38	1.7
Bivalvia	***Cerastoderma edule***	0	0	0	252	0	0	147.5	0	105.5	0	0	46	2.1
	Corbicula consobrina	0	0	0	231	84.5	399	0	0	0	0	0	65	
	Pisidium pirothi	0	0	0	0	0	0	106	0	126	0	0	21	0.9
	Abundance ind./m^2	672	2247	2247	1807	4433	2772	2122	2405	2164	1617	1974	2224	100
	Biomass g/m^2	1.3	7.9	15	428	83	300	299	360	339	210	154		
	S No. of species	3	6	6	7	8	9	8	4	7	5	4		
	d (Margalef's richness	0.307	0.648	0.648	0.800	0.837	1.009	0.914	0.385	0.781	0.541	0.395		
	J' Pielou's evenness	0.787	0.810	0.706	0.826	0.702	0.857	0.736	0.926	0.727	0.876	0.633		
	H' (loge) Shannon	0.865	1.452	1.265	1.608	1.459	1.882	1.531	1.284	1.415	1.410	0.878		
	Simpson	0.540	0.712	0.647	0.735	0.718	0.811	0.662	0.701	0.682	0.731	0.449		
	Salinity (ppt)	12.16	31.47	27.24	13.45	8.44	16.22	3.17	4.81	3.84	3.1	3.52		
	pH	8.26	8.14	8.26	8.53	8.19	8.36	7.95	8.39	8.1	8.68	7.6		

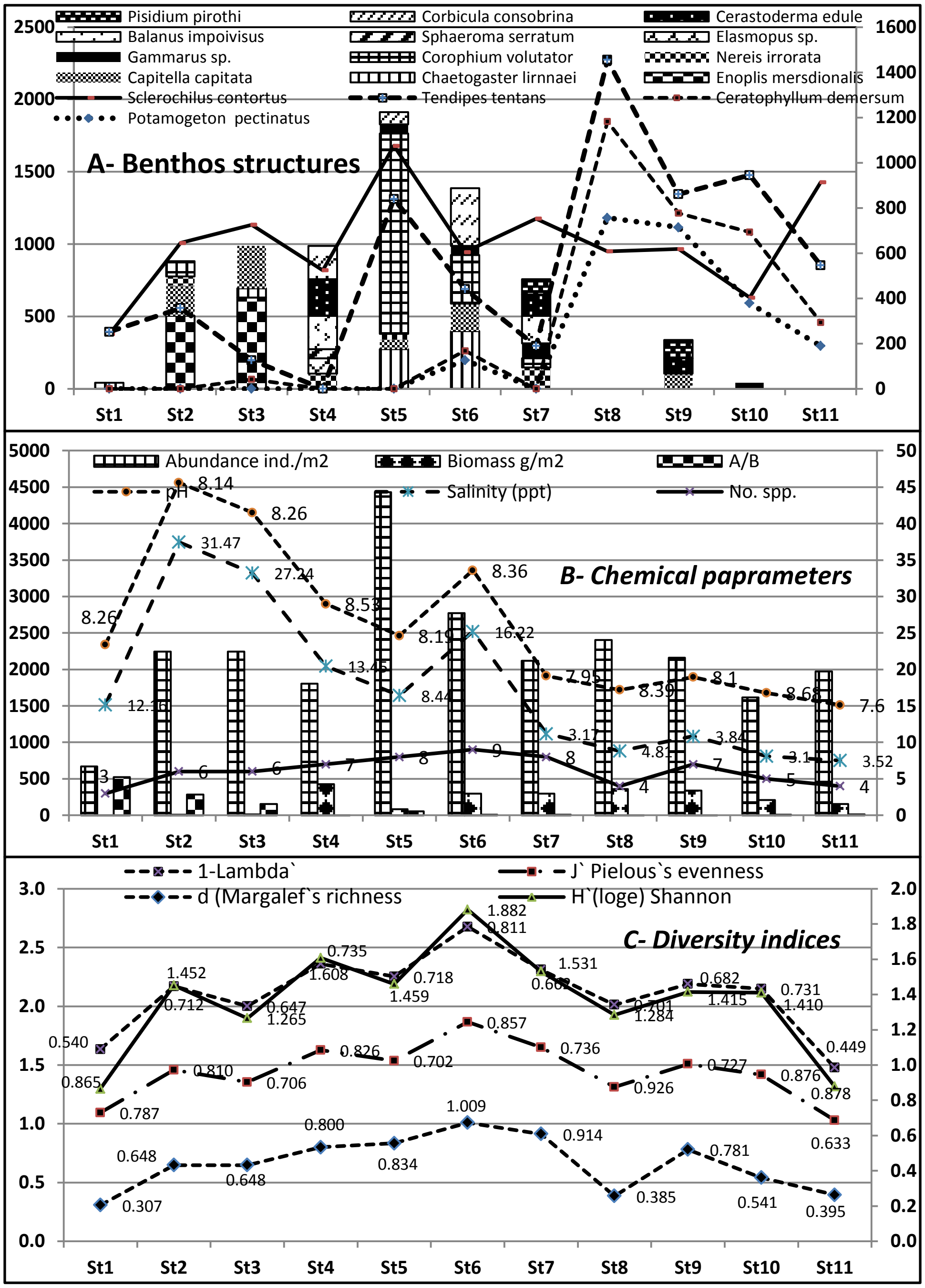


Fig. 2. Regional changes: A, Benthos structure; B, Chemical parameters; C, Diversity indices were calculted for benthic constituents at the study sampling sites in Lake Manzala during 2017.

in Table 3 were identified as benthic living communities in the addition to many un-living composed mainly from empty shells of bivalves, gastropods, barnacles, and fragments of aquatic plants. These include 16 species belong to 10 main higher taxonomic levels namely;

- Submerged aquatic plants included 2 species namely *Potamogeton pectinatus* and *Ceratophyllum demersum*

-Phylum Nematoda (class Enoplea);

Phylum Annelida (class Oligochaeta, class Polychaeta);

-Sub Phylum Crustacea, class Ostracoda, order Myodocopida), (class Malacostraca, Order Amphipoda, Order Isopoda, order Cirripedia);

-Phylum Insecta; insect larvae

-Phylum Mollusca (class Bivalvia), and class Gastropoda

Species number (S): The structure of species number of benthos groups at the different sites (as shown in Table 3 and Fig. 2) emphasized that two groups from a total of 10 were relatively high predominate namely; group Amphipoda (comprised 3 spp.) and Bivalvia (comprised 2 spp.) and each of submerged aquatic plants and Polychaeta each of them included 2 spp and the rest groups were represented by only one species.

2- Abundance of benthic communities (A): Tables 3 and 4 and Fig. 3 emphasized that the data analysis of benthic groups were the highest predominate benthic meiofauna Ostracoda constituent representing 1st highest abundant (1010 ind/ m^2, representing 45.4% of the total annual average of 2224 ind/m^2) which recorded at the most sampling sites in the lake and living among the sand bottom sediments. The 2nd highest abundance rather which was recorded at the most sampling sites in the lake was the submerged vegetation plants (*Potamogeton pectinatus* and *Ceratophyllum demersum)* reached 287 tuft/m^2, representing 12.9%. Insect larvae showed the 3rd highest density of individual numbers in which lived on bottom sediment estimated by an annual average of 260 ind/m^2, representing 11.7%. Class Crustacea, represented by order Amphipoda (*Corophium volutator, Gammarus* sp., and *Elasmopus* sp.) which recorded at the saline and brackish sites reaching 206 and representing 9.3%. Oligochaeta group recorded in relatively high numbers epically in polluted sites and represented an indicator polluted species estimated by an annual average of 174 ind/m^2, representing 7.8%. Errantia Polychaeta *Capitella capitata* and *Nereis irrorata* were relatively abundant rather (5%, 111 ind/m^2) and live inside muddy building tubes and attaching to any submerged objects. They can tolerant the increase of polluted sediment and represent an indicator of pollution species. Bivalves showed the 7th highest density of individual's numbers accounting for 5.9% of the total number of individuals estimated by an annual average abundance 132 ind/m^2 which most species live inside sandy and muddy bottom sediments (*Crastoderma edule, Corbicula consobrina* and *Pisidium pirothi*) were recorded and can tolerate the polluted areas representing 9.6% of the total annual average reaching 132 ind/m^2. The rest groups namely Nematode, barnacle, and Isopoda were recorded in a lower annual average of 4.6%, 1.7%, and 0.3%, respectively.

Table 4. Abundance of the annual averages density in descending order A (no. ind/m^2), biomass (wet weight g/m^2), A/B ratio and the number of species recorded, diversity indices (B) and water quality (C) as cited in final EEAA during 2017.

A – Benthos structure

ST	Abundance ind./m^2	%	ST	Biomass g/m^2	%	ST	B/A	ST	S No. spp.
ST5	4433	18.1	ST4	428	19.5	ST1	0.002	ST6	9
ST6	2772	11.3	ST8	360	16.4	ST2	0.004	ST5	8
ST8	2405	9.8	ST9	339	15.4	ST3	0.007	ST7	8
ST2	2247	9.2	ST6	300	13.6	ST5	0.237	ST4	7
ST3	2247	9.2	ST7	299	13.6	ST11	0.019	ST9	7
ST9	2164	8.8	ST10	210	9.5	ST6	0.108	ST2	6
ST7	2122	8.7	ST11	154	7.0	ST10	0.141	ST3	6
ST11	1974	8.1	ST5	83	3.8	ST7	0.150	ST10	5
ST4	1807	7.4	ST3	15	0.7	ST8	0.157	ST8	4
ST10	1617	6.6	ST2	7.9	0.4	ST9	0.130	ST11	4
ST1	672	2.7	ST1	1.3	0.1	ST4	0.078	ST1	3

B – Diversity indices

Stations	d (Margalef`s richness	Stations	J` Pielou`s evenness	Stations	H`(loge) Shannon Weaver	Stations	Simpson
ST6	1.009	ST8	0.9264	ST4	1.6076	ST6	0.8108
ST7	0.9138	ST6	0.8565	ST6	1.8820	ST4	0.7347
ST5	0.8337	ST10	0.8762	ST2	1.4520	ST10	0.7311
ST4	0.8001	ST4	0.8261	ST7	1.5312	ST2	0.7118
ST9	0.7813	ST2	0.8104	ST5	1.4594	ST5	0.7182
ST2	0.6479	ST1	0.7871	ST9	1.4151	ST8	0.7012
ST3	0.6479	ST7	0.7363	ST10	1.4102	ST9	0.6817
ST10	0.5414	ST9	0.7272	ST8	1.2843	ST7	0.6621
ST11	0.3954	ST3	0.7061	ST3	1.2652	ST3	0.6473
ST8	0.3853	ST5	0.7018	ST11	0.8777	ST1	0.5399
ST1	0.3072	ST11	0.6331	ST1	0.8647	ST11	0.4486

C – Water quality

Stations	Salinity (ppt)	Stations	pH	Stations	DO mg/l	Stations	BOD mg/l
ST2	31.47	ST10	8.68	ST6	9.26	ST6	146.25
ST3	27.24	ST4	8.53	ST5	6.83	ST2	87.75
ST6	16.22	ST8	8.39	ST2	6.66	ST5	48.75
ST4	13.45	ST6	8.36	ST7	6.34	ST1	48.75
ST1	12.16	ST1	8.26	ST9	5.85	ST3	43.88
ST5	8.44	ST3	8.26	ST8	5.36	ST7	29.25
ST8	4.81	ST2	8.14	ST4	5.04	ST9	29.25
ST9	3.84	ST5	8.19	ST10	4.88	ST10	24.38
ST11	3.52	ST9	8.10	ST11	4.23	ST8	19.50
ST7	3.17	ST7	7.95	ST3	0.81	ST4	14.63
ST10	3.10	ST11	7.6	ST1	0.16	ST11	14.63

3- Biomass g/m^2 (B): As shown in Tables 5 & 6 and Fig. 2 submerged aquatic plants (*Potamogeton pectinatus,* and *Ceratophyllum demersum*) have the largest biomass among the bulk of benthos collected at the different sites yielding 95.6 g/m^2 representing 47.9%

Table 5. Abundance density (no. ind/m^2) and annual average biomass of benthos groups (wet weight g/m^2) and number of species (S) estimated at descending order.

Abundance 2017	*Species*	Aver.	%	Biomass 2017	*Species*	Aver.	%
Ostracoda	*Sclerochilus contortus*	1010	45.4	**Vascular plants**	*Potamogeton pectinatus*	54.5	27.3
Aquatic plants	*Potamogeton pectinatus*	197	8.8		*Ceratophyllum demersum*	41.1	20.6
	Ceratophyllum demersum	90	4.1		**Total**	**95.6**	**47.9**
	Total	**287**	**12.9**	**Bivalvia**	*Cerastoderma edule*	32.61	16.3
Insecta larvae	*Tendipes tentans*	260	11.7		*Corbicula consobrina*	36.28	18.2
Amphipoda	*Corophium volutator*	172	7.7		*Pisidium pirothi*	10.05	5.0
	Gammarus sp.	25	1.1			78.9	39.5
	Elasmopus sp.	10	0.4	**Barnacles**	*Balanus impoivisus*	20.6	10.3
	Total	**206**	**9.27**	**Polychaeta**	*Capitella capitata*	0.43	0.21
Polychaeta	*Capitella capitata*	78	3.5		*Nereis irrorata*	1.39	0.70
	Nereis irrorata	32	1.5		**Total**	**1.82**	**0.91**
		111	4.98	**Amphipoda**	*Corophium volutator*	0.93	0.46
Bivalvia	*Cerastoderma edule*	46	2.1		*Gammarus* sp.	0.28	0.14
	Corbicula consobrina	65	2.9		*Elasmopus* sp.	0.06	0.03
	Pisidium pirothi	21	0.9		**Total**	**1.27**	**0.63**
	Total	**132**	**5.93**	**Insecta larvae**	*Tendipes tentans*	1.27	0.64
Nematoda	*Enoplos meridionalis*	103	4.6	**Oligochaeta**	*Chaetogaster linnaei*	0.07	0.03
Oligochaeta	*Chaetogaster linnaei*	71	3.2	**Isopoda**	*Sphaeroma serratum*	0.07	0.04
Barnacles	*Balanus impoivisus*	38	1.7	**Ostracoda**	*Sclerochilus contortus*	0.02	0.01
Isopoda	*Sphaeroma serratum*	6	0.3	**Nematoda**	*Enoplos meridionalis*	0.001	0.001
Total no. ind./m^2		**2224**	**100**	***Total bimass g/m^2***		**200**	**100**

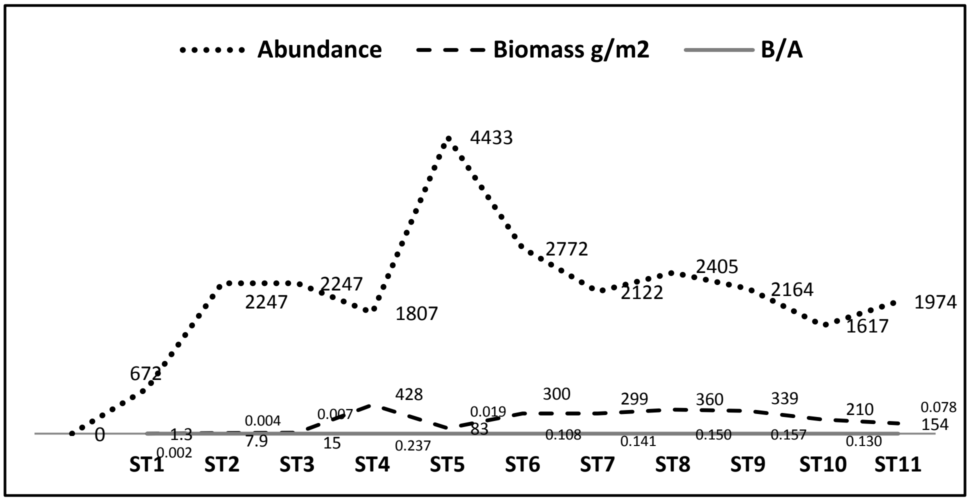


Fig. 3. Regional changes: A- Benthos structure abundance (no. ind/m^2); B- Benthos biomass (wet weight g/m^2); B/A- ratio of abundance and biomass calculted for benthic constituents at the study sampling sites in Lake Manzala during 2017.

of the total biomass 200 g/m^2. The 2nd more weight was bivalves attained 78.9 g/m^2, representing 39.5% of the total annual average). While Cirriped barnacles group have relatively high biomass among the bulk of benthos collected at the different sites yielding 20.6 g/m^2 representing 10.3% of the total biomass. Errantia Polychaetes species were sustained 1.82 g/m^2 and representing 0.91% of the total biomass. Similarly, crustacean amphipods attained 1.72 g/m^2 representing 0.63%. The other benthic groups were less frequent ranging from 0.64% to less than 0.01% of the total annual average biomass of individuals whose biomass was ranged from 1.27 g/m^2 to less than 0.01 g/m^2. On the other side, the percentage of biomass of benthic groups at higher taxonomic levels at the different sampling sites can also be ranked as following: submerged aquatic plants (47.9%) > bivalves (39.5%) >Cirripedia (10.3%) Polychaeta (0.91%) > amphipods (0.63%) > other groups ranged from 0.64% to less than 0.01%.

4- The pattern of benthic assemblages:

4.1 Regional variations of benthic fauna during 2017:

4.*1.1 Species number (S)*: Regional variations in the species number as shown in Table 7, 8 and Fig. 2 the highest number of species was found at the following sites: 8-9 species were recorded at sites ST5 (ElKan mainly bottom sediments off sludge and plant fragments), ST6 (Dashdy, characterized by heavy aquatic plants and sludge bottomed), ST8 (Abu Kabier north Sarw Drain) and ranged from 7-6 spp at sites ST2

ST3 (west ElBashteer, mainly of plant fragments and sludge bottomed); ST9 (ElDabgo heavy submerged aquatic plants); ST7 (El Hamara in the north). And at the rest sites varied from 5 to 3 species.

4.1.2 Abundance of benthic fauna (as shown in Tables 4 & 6 and Fig. 2)**:**

1- **Submerged aquatic plants:** *Potamogeton pectinatus* and *Ceratophyllum demersum* were more frequent at most sites ST6 (Dashdy), ST8 (Abu El kabier,

Table 6. The yearly annual average of biomass (wet weight g/m^2) and relative biomass (%) of the main groups of benthic species recorded in bottom sediments collected from Lake Manzala during 2017.

Biomass 2017	*Species*	St1	St2	St3	St4	St5	St6	St7	St8	St9	St10	St11	Ave	%
Aquatic plants	***Potamogeton pectinatus***	0.00	0.00	0.00	0.00	0.00	81.00	0.00	178.00	171.00	109.50	60.50	54.5	27.3
	Ceratophyllum demersum	0.00	0.00	13.00	0.00	0.00	12.00	0.00	181.00	55.00	98.50	92.50	41.1	20.6
Nematoda	***Enoplos meridionalis***	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.002	0.001
Oligochaeta	***Chaetogaster lirnnaei***	0.00	0.00	0.08	0.00	0.33	0.35	0.00	0.00	0.00	0.00	0.00	0.07	0.03
Polychaeta	***Capitella capitata***	0.00	1.04	1.07	0.00	0.53	1.16	0.00	0.00	0.93	0.00	0.00	0.43	0.21
	Nereis irrorata	0.00	3.03	0.00	3.93	1.90	0.00	6.45	0.00	0.00	0.00	0.00	1.39	0.70
Insecta larvae	***Tendipes tentans***	1.28	2.15	0.41	0.00	4.17	1.32	0.64	0.82	0.41	1.34	1.43	1.27	0.64
Ostracoda	***Sclerochilus contortus***	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01
Amphipoda	***Corophium volutator***	0.00	1.62	0.00	0.00	5.73	2.29	0.56	0.00	0.00	0.00	0.00	0.93	0.46
	***Gammarus* sp.**	0.00	0.00	0.00	0.00	0.73	0.81	0.91	0.00	0.00	0.67	0.00	0.28	0.14
	***Elasmpus* sp.**	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03
Isopoda	***Sphaeroma serratum***	0.00	0.00	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.04
Barnacles	***Balanus impoivisus***	0.00	0.00	0.00	127.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	20.64	10.3
Bivalvia	***Cerastoderma edule***	0.00	0.00	0.00	167.60	0.00	0.00	138.60	0.00	52.50	0.00	0.00	32.61	16.3
	Corbicula consobrina	0.00	0.00	0.00	128.33	69.68	201.05	0.00	0.00	0.00	0.00	0.00	36.28	18.2
	Pisidium pirothi	0.00	0.00	0.00	0.00	0.00	0.00	51.50	0.00	59.00	0.00	0.00	10.05	5.0
Total biomass g/m^2		1.28	7.85	14.58	428.33	83.06	299.99	298.68	359.84	338.86	210.03	154.45	200	100
%		0.1	0.4	0.7	19.5	3.8	13.7	13.6	16.4	15.4	9.6	7.0		

north Sarw drain), ST9 (El Dabgo south Sarw drain), ST10 (El Zarga, near Furskour drain), and ST11 (El kenka, front Hadous drain) reaching an annual average of 287 tufts/m2 corresponding to 12.9%.

2- Nematoda *Enoplismers dionalis* was recorded at TS2 (504 ind/m^2) and ST3 (630 ind/m^2) having a little annual average of 103 ind/m2and 4.6%.

3- Oligochaeta *Chaetogaster lirnnaei* was characterized by inhabiting inside muddy tubes and representing as pollution species indicator. Its annual abundance density was recorded at ST1 (42 ind/m^2), IST3 (63 ind/m^2) ST5 (273 ind/m^2) and ST6 (399 ind/m^2).

4- Polychaeta the dominant species were species of muddy sedentary form namely *Capitella capitata* and *Nereis irrorata* as pollution species indicator were recorded in moderate numbers at different sampling sites which the two species ranged from 63 to 294 individuals (the 1st species was recorded at ST2, front El Gamil outlet; ST3, west El Bashteer; ST5, El Kan; ST6, Dashdy; and ST9, El Dabgo attaining an average of 78 ind and 3.5%), the 2nd species varied from 63 to 147 individuals (ST3, ST4, El Tamsah, ST5, and ST7, El Hamara) ranged from 42 to 168 ind/m^2 corresponding to 1.5%.

5- Phylum Euarthropoda (subphylum Hexapoda, class Insecta) in which the Insecta larvae *Cricotopus mediterranous* and *Nymphon gracile* were more flourished at all sampling sites yielding density varied from 260 ind/m^2 representing 11% of the total benthic abundance at all sites yielding density varied from 84 to 840 ind/m^2.

6- Class Ostracoda is small crustaceans, which inhabit virtually all aquatic environments occur as calcified “shells”. Thus, they have a "seed"-like appearance and therefore are also known by the term "seed shrimps" or "mussel shrimps". They were the highest predominate benthic meiofauna Ostracoda constituent reprinting 1st highest abundant (1010 ind/m^2, representing 45.4% of the total annual average of 2224 ind/m^2) which recorded at the most sampling sites in the lake and living among the sand bottom sediments.

7- Orders (Amphipoda, Isopoda, and Cirripedia) in which were frequently recorded at sampling sites. Amphipoda yielding little an annual average of 203 individuals representing 9.27% of total benthic abundance at all sites and the species abundance at sites ST4, ST5, ST6, and ST8 were varied from 63 to 1386 ind/m^2. Isopoda *Sphaeromas erratum* was recorded by a few number 63 ind/m^2 only at ST4 whereas; Barnacles *Balanus impoivisus* was more frequent at sites ST4 and ST7.

8-Class Bivalvia was represented by 3 species at most sampling sites.

9-Bivalve species *Cerastoder maedule* was recorded at 3 sites ST4 ST7 and ST9 yielding 252 ind/m^2, 148 ind/m^2, and 106 ind/m^2. The second species *Corbicula consobrina* was recorded at ST4, ST5, and ST6 sustaining 231 ind/m^2, 85 ind/m^2, and 399 ind/m^2. The third species *Pisidium pirothi* has the occurrence of 106 ind/m^2 at ST7 and 126 ind/m^2 at ST9.

4.1.3 Biomass of benthic fauna (as shown in Tables 4 & 6, Fig. 2):

1- Submerged aquatic plants ranked the 1st benthic group has maximum occurrence and biomass of 208 g/m^2 and 153 g/m^2, sustaining annual average biomass of 95.6 g/m^2 and the annual average percentage of 47.9%. *Potamogeton pectinatus* and *Ceratophyllum demersum* were more frequent at most sites at ST3 (west of Bashteer) yielded 13 g/m^2, at ST6 reached 93 g/m^2. They were recorded in high weight at sites ST8 – ST11 attained respectively 395 g/m^2, 266 g/m^2.

2-Bivalve species ranked the 2nd benthic groups have maximum occurrence and biomass yielding an annual average 78.9 g/m^2 (corresponding to 39.5% of annual average biomass. *Ceratoderma edule* were more frequent at sites ST4 (El Tamsah), ST7 (El Hamara), and ST9 (El Dabgo); *Corbicula consobrina* was more frequent at sites ST4, ST5 (El Kan), and ST6 (Dashdy), and *Pisidium pirothi* was recorded at sites ST7 and ST9. It sustained annual average biomass of 20.6 g/m^2 and an annual average percentage of 10.3%.

3- Barnacles *Balanus impoivisus was* recorded only at ST4 (El Tamsah) and ST7 (El Hamara) attained respectively 127 g/m^2, and 100 g/m^2.

4- Polychaeta: *Capitella capitata* and *Nereis irrorata* were relatively less frequent at most sites and characterized by low weight at different sampling sites which the species biomass yielded an annual average biomass 1.82 g/m^2 representing only 0.9% of the total annual average biomass.

5- Amphipoda, *Corophium volutator, Gammarus* sp. and *Elasmopus* sp. were a less frequent occurrence at sites ST2, ST4, ST5, ST6, ST7, and ST10 which characterized by low weight at different sampling sites and biomass yielded an annual average biomass 1.27 g/m^2 representing only 0.63% of the total annual average biomass.

6- Ostracoda, *Sclerochilus contortus* was recorded at most sites in little biomass yielded an annual average biomass of 1.27 g/m^2 representing only 0.64% of the total annual average biomass.

7- The rest groups Oligochaeta, Isopoda, and Nematoda yielded little an annual average biomass 0.7- less 0.01g/m2 representing 0.3%-0.01% of the total benthic biomass.

4.1.4 B/A Ratio for the samples at the different sites**:** B/A Ratio was plotted for the samples at the different sites as listed in Table 4 and illustrated graphically in Fig. 2. The ratio indices which serve as an indication of community health on spatial and temporal scales can be measured using several indices. However, A/B ratio indicating increases when the value of benthic abundance increase concerning the increase in biomass yield, and consensually it decreased when the value of biomass increased. It is also clear from the table and shape showed how the appropriate medium is for the growth of the bottom organisms as the increase in the ratio B/A indicates that the medium is not suitable for the growth of benthic organisms.

5**- Diversity Indices** (as shown in Table 7 and Fig. 2)**:** Diversity indices served as an indication of community health on area scales. It can be measured using several indices as Magurran (1955), Goodall (1973), Magurran and McGill (2011) El-Komi (2017b). Also, DIVERSE-Univariate diversity indices can use PRIMER 5 (Plymouth Routines In Multivariate Ecological Research). Margalef's species Richness, Pielou's Evenness index, Shannon-Weiner species diversity, and Simpson's diversity index will apply in this study.

5.1 Swartz Dominance index**:** Swartz's dominance index measured the number of species whose combined abundance comprised 75 of the total sample abundance (if index value > 5 indicating that the area has no stress community). The dominance index values ranged from one to 2 species at the sampling sites ST1, ST2, ST3, ST8, ST9, and ST11, but it ranged between 3 to 4 species at the rest sampling sites ST4, ST5, ST6, ST7, and ST10, therefore, the area of study has stress community.

Table 7. Yearly annual averages of abundance (no.ind/m^2), biomass (wet weight in g/m^2) and the numberof species recorded in benthos groups in bottom sediments collected from Lake Manzala during 2017.

Abund ind/m^2	No. spp.	Abundanc e ind/m^2	d (Margalef`s richness	J` Pielou`s evenness	H`(loge)	Simpson's diversity
St1	3	672	0.3072	0.7871	0.8647	0.5399
St2	6	2247	0.6479	0.8104	1.4520	0.7118
St3	6	2247	0.6479	0.7061	1.2652	0.6473
St4	7	1807	0.8001	0.8261	1.6076	0.7347
St5	8	4433	0.8337	0.7018	1.4594	0.7182
St6	9	2772	1.0092	0.8565	1.8820	0.8108
St7	8	2123	0.9138	0.7363	1.5312	0.6621
St8	4	2405	0.3853	0.9264	1.2843	0.7012
St9	7	2164	0.7813	0.7272	1.4151	0.6817
St10	5	1617	0.5414	0.8762	1.4102	0.7311
St11	4	1974	0.3954	0.6331	0.8777	0.4486

5.2 Margalef's species richness (d)**:** Species richness refers to the total number of different species present (without taking into account) the proportion and distribution of each species) within the sample. The calculated values species richness (d) were low of species richness of values more than one at ST1 (1.0092), were less than one at the most sites mainly 0.9138 at ST7, 0.7813-0.8337 at ST4, ST5, and ST9, and the rest sites ranged from 0.3072-0.6479.

5.3 Pielou's evenness (J')**:** Pielou's evenness is used as the ratio of the expected number of species against the recorded number of species as an index of evenness. According to the assumption indicated that all species accounted for in the sample. The higher value attained 0.9264 at ST8. The evenness values were 0.8104, 0.8216, 0.8565, and 0.8762 at ST2, ST4, ST6, and ST10. At species, evenness is dependent on species richness and species diversity. The evenness measure is a ratio of the observed diversity to the maximum possible in a sample having the same number of species meaning the more evenly individuals spread among the species.

5.4 Shannon-Wiener's diversity index (H`)**:** The Shannon-Wiener diversity index refers to the state of an assemblage per the species richness and species abundance. The estimated values 1.0092 were moderate diverse at ST6 and 0.9138 at ST7, ranged from 0.7813 to 0.8337 at ST4, ST5, and ST9. At the rest sites, low diversity ranged from 0.3072 to 0.6479.

5.5 Simpson's diversity index (D)**:** Simpson's diversity indexes aimed to measure and determine the degree of concentration of species classes. Simpson's diversity values as the index at the different sites ranging from the low value of 0.5399 at ST1 to a high value of 0.8108 at ST6. That provides an intuitive proportional measure of diversity that is much less sensitive to species richness.

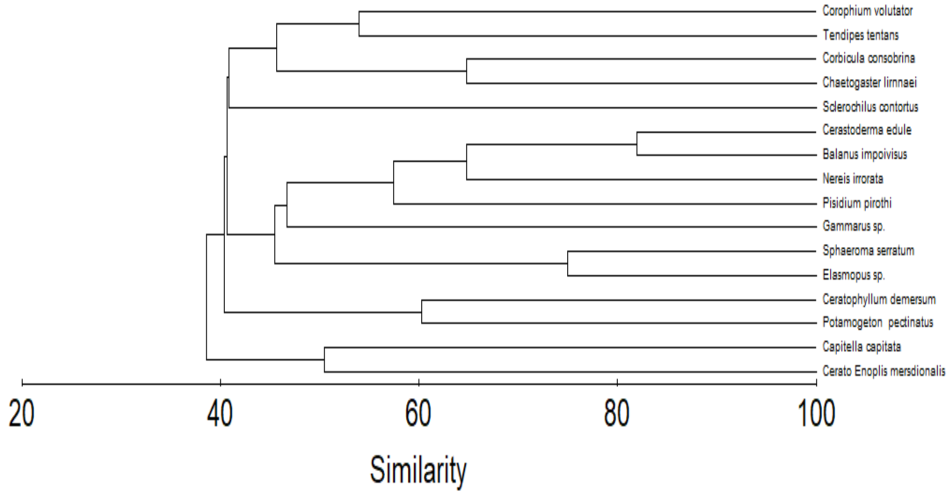


Fig. 4. Bray-Curtis similarity (%) dendrogram within benthic groups and diversity indices at different studied sites.

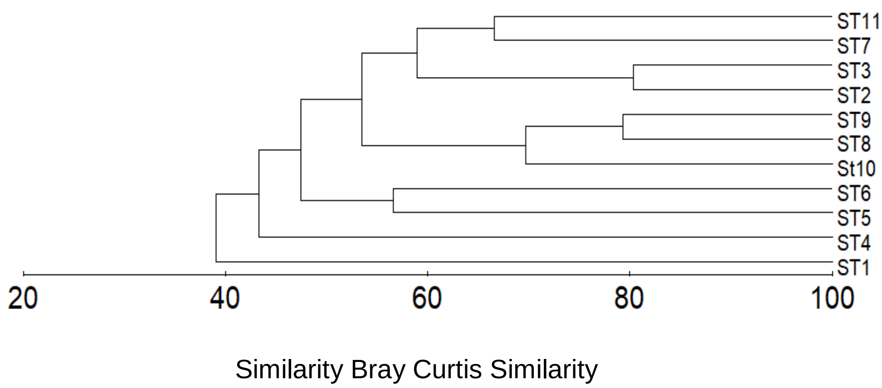


Fig. 5. Bray-Curtis similarity (%) dendrogram within benthic sites and diversity indices at the different studied areas.

***5.6 Cumulative species count over samples*:** Cumulative species count over samples are shown in Fig. 4, A indicating the 1st rank is ST1, ST2, and ST3 their species count 3 to 8, the 2nd involved each of ST4, ST5, and ST6 have species count 13-15, and 3rd rank included the rest site ST7 - ST11 reached species count of 16.

***5.7 Cluster Analysis Similarity*:** A Bray-Curtis similarity cluster assessment between species (Fig. 4 and Table 9) are displayed as dendrograms. Between-species similarity showed 4 groups were average at 85% to 60% namely: *Ceratoderma* and *Balanus (*85%*);*

Spheroma and *Elasmopus (75%); Corbicula* and *Chaetogaster (65%),* and *Ceratophyllum* and *Potamogeton*. The rest species have approximately 17% to 70% similarity was observed within-species. The combining of 8 groups is illustrated as their parentage of similarity.

On the other side, the Bray-Curtis similarity cluster assessment between-site (Table 10 and Fig. 5**)** shows five classes show high similarity at sites; class 1 (ST3, ST2, 85%); class 2 (ST8, ST9, 80%); class 3 (ST10, 70%); class 4 (ST11, ST7, 65%), class 5 (ST6, ST5, 57%) and class 6 (ST1, 39%). The detail of Combining between the 12 sites illustrated as their parentage of similarity.

Table 8. PCA Principal Component Analysis within different studied sites of benthic species.

Eigenvectors

1-	4.86	30.4	30.4	2-	3.63	22.7	53.1
3-	2.37	14.8	67.9	4-	1.95	12.2	80.1
5-	1.27	7.9	88.1	6-	0.88	5.5	93.6
7-	0.61	3.8	97.4	8-	0.30	1.9	99.2
9-	0.10	0.6	99.9	10-	0.02	0.1	100

(Coefficients in the linear combinations of variables making up PC's)

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
Potamogeton pectinatus	-0.100	0.339	0.307	0.124	-0.191	0.478	0.114	-0.261	-0.226	0.058
Ceratophyllum demersum	-0.131	0.312	0.257	0.255	0.102	0.060	0.650	-0.125	0.131	0.069
Enoplos meridionalis	-0.105	0.028	-0.530	-0.305	0.104	0.075	0.312	-0.234	0.070	0.067
Chaetogaster linnaei	-0.162	-0.391	-0.028	0.278	-0.351	0.029	0.006	0.000	0.060	0.521
Capitella capitata	-0.165	-0.097	-0.489	-0.171	-0.301	0.251	0.190	-0.232	0.026	-0.117
Nereis irrorata	0.328	-0.208	0.083	-0.304	0.128	-0.127	0.265	-0.203	-0.592	0.072
Tendipes tentans	-0.252	-0.326	0.191	0.048	0.356	0.003	-0.091	-0.360	-0.313	-0.180
Sclerochilus contortus	-0.104	-0.296	0.097	-0.216	0.241	0.579	0.205	0.634	-0.023	-0.066
Corophium volutator	-0.149	-0.427	0.143	0.077	0.210	0.226	-0.141	-0.392	0.320	0.166
Gammarus sp.	0.015	-0.334	0.325	-0.169	-0.258	-0.320	0.395	-0.032	0.379	-0.415
Elasmopus sp.	0.391	-0.035	-0.137	0.266	0.160	0.188	-0.007	-0.106	0.152	-0.215
Sphaeroma serratum	0.391	-0.035	-0.137	0.266	0.160	0.188	-0.007	-0.106	0.152	-0.215
Balanus impoivisus	0.429	-0.101	0.066	-0.091	0.030	-0.066	0.218	0.050	0.067	-0.215

Continued……...

Cerastoderma edule	0.435	-0.025	0.066	-0.069	-0.081	0.219	-0.058	-0.125	0.140	0.008
Corbicula consobrina	0.111	-0.277	-0.111	0.431	-0.431	0.056	0.126	0.119	-0.393	-0.230
Pisidium pirothi	0.116	0.063	0.285	-0.452	-0.415	0.260	-0.261	-0.159	0.050	-0.064

Principal Component Scores

Sample	SCORE1	SCORE2	SCORE3	SCORE4	SCORE5	SCORE6	SCORE7	SCORE8	SCORE9	SCORE10
St1	-0.376	0.976	-0.328	0.521	0.207	-1.763	-1.501	-0.159	0.021	0.168
St2	-0.824	-0.078	-2.037	-1.276	0.759	-0.182	0.158	-0.516	-0.623	-0.151
St3	-1.209	0.431	-2.990	-1.160	-0.120	0.387	0.569	0.157	0.524	0.126
St4	5.726	-0.386	-0.980	1.566	0.614	0.500	-0.014	-0.095	0.045	-0.014
St5	-1.941	-4.045	1.222	0.231	1.362	0.718	-0.380	-0.381	0.190	0.022
St6	-1.125	-2.240	-0.560	1.821	-2.453	-0.280	0.341	0.253	-0.195	-0.013
St7	2.423	-1.195	1.915	-2.727	-0.581	-0.878	0.618	0.185	-0.026	0.074
St8	-1.162	2.382	1.408	1.163	0.545	0.577	1.026	-0.216	-0.265	0.237
St9	0.080	1.862	0.922	-1.007	-1.485	1.595	-1.115	-0.333	0.040	-0.068
St10	-0.797	1.682	1.073	0.807	0.172	-0.971	0.648	-0.355	0.404	-0.282
St11	-0.794	0.664	0.354	0.061	0.981	0.295	-0.351	1.460	-0.116	-0.100

Table 9. Similarity Create triangular similarity/distance matrix, Analyze between Samples Similarity measuring: Bray Curtis Standardize: No, Transform: Square root. CLUSTER Hierarchical - Cluster analysis Hierarchical, Cluster analysis Similarity Matrix, and Data type: Similarities, Cluster mode: Group average, Use data ranks: No.

Variables	**Combining**
1 *Potamogeton pectinatus*	13+14 -> 17 at 81.98
2 *Ceratophyllum demersum*	11+12 -> 18 at 75.
3 *Enoplos meridionalis*	4+15 -> 19at 64.83
4 *Chaetogaster linnaei*	6+17 -> 20 at 61.59
5 *Capitella capitata*	1+2 -> 21 at 60.27
6 *Nereis irrorata*	7+9 -> 22 at 53.98
7 *Tendipes tentans*	3+5 -> 23 at 50.5
8 *Sclerochilus contortus*	16+20 -> 24 at 41.97
9 *Corophium volutator*	10+24 -> 25 at 36.37
10 *Gammarus* sp.	8+22 -> 26at 34.98
11 *Elasmopus* sp.	19+26 -> 27 at 26.5
12 *Sphaeroma serratum*	23+27 -> 28 at 19.92
13 *Balanus impoivisus*	18+25 -> 29 at 19.79
14 *Cerastoderma edule*	21+28 -> 30 at 14.44
15 *Corbicula consobrina*	29+30 -> 31 at 7.94
16 *Pisidium pirothi*	

Table 10. Similarity Create triangular similarity/distance matrix, Analyze between Samples Similarity measuring: Bray Curtis Standardize: No, Transform: Square root. CLUSTER Hierarchical - Cluster analysis Hierarchical, Cluster analysis Similarity Matrix, and Data type: Similarities, Cluster mode: sites average, Use data ranks: No.

	Samples	*Combining*		*Samples*	*Combining*
1	ST1	2+3 -> 12 at 80.37	6	ST6	5+6 -> 17 at 56.59
2	ST2	8+9 -> 13 at 79.27	7	ST7	14+16 -> 18 at 53.52
3	ST3	10+13 -> 14 at 69.71	8	ST8	17+18 -> 19 at 47.49
4	ST4	7+11 -> 15 at 66.63	9	ST9	4+19 -> 20 at 43.32
5	ST5	12+15 -> 16 at 58.92	10	ST10	1+20 -> 21 at 39.03

Part 2- Distribution of Macrobenthic Structure in the Lake Manzal Drains:

1-Nature of bottom sediments**:** The nature of sediments, as noted, is mainly composed of organic sediments and remnants of water plants and pollutants from sanitation, agricultural and industrial, and limestone. The sediments consist mostly of organic matter, sludge. It is composed of sewage, agricultural and industrial waste. It was composed mainly of sludge at sites Bahr El Bagar and HadousDrians and composed of sludge and plant fragments at sites El Sarw Drain and FaraskourDrian.

2- Benthic constituents**:**

2.1 Annual abundance (no. ind/m^2)**:** The results indicate, as is evident in Table 11 and Fig. 6, that the density is the least possible in the drains due to the increase of pollutants that are directly from different sources and have a high impact on the constituents of the benthic communities and the abundance is estimated by an annual average of density 1019 ind/m^2 where the numerical density was relatively higher in the Hadous and Bahr El Bagar drains reaching a density of 1215 ind /m^2 and 1135 ind/m^{2}at a rate of 29.9 % and 27.8% respectively. It was less density at Faraskour and El Sarw attaining a density of 1051 ind/m^2 and 672 ind/m^2 and representing an average of 25.8% and 16.5%.

The data analysis of benthic groups at lake drains were constituents mainly from meiofauna Ostracoda constituent representing the 1st highest abundant (1010 ind/m^2, representing 59.8% of the total annual average of 609 ind/m^2) which recorded at the most sampling sites in the lake and living among the sand bottom sediments. The 2nddominated group was the Mollusca (Gastropoda *Melanoides tunculata*, *Bellamya unicolor* and Bivalvia *Corbicula consobrina*) reaching 138 ind/m^2 corresponding 13.5%. The 3rddominated group was insect larvae were estimated by 13.4% reaching a density of 137 ind/m^2. The benthic groups mainly Oligochaeta and polychaeta *Capitellides* and *Nereis irrorata* were recorded in a few individuals (of 3.1 to 5.2 on average) and the percentage ranged from 3.1% to 5.2%. High occurrence of Oligochaeta group and Errantia Polychaeta *Capitella capitata* and *Nereis,* whereas, *Melanoides* and *Bellamya unicolor* were recorded in polluted sites and represented as an indicator polluted species. On the other side, species of Mollusca *Melanoides tunculata*, *Bellamya unicolor*, and *Corbicula consobrina* were recorded in high numbers and can tolerate the pollution and considered as polluted indicator species.

Table 11. Average annual abundance (no. ind/m^2) of the benthic species estimated at Lake Manzala Drains during Feb-Sep 2017.

Abundance	Farascore	ElSaro	Hadous	Bahr el Bager	Average	%
Oligochaeta	0	126	0	0	32	3.1
Capitellides	0	210	0	0	53	5.2
Ostracoda	798	0	882	756	609	59.8
Nereis irrorata	0	84	126	0	53	5.2
Insecta larvae	168	126	126	126	137	13.4
Melanoides tunculata	85	0	85	42	53	5.2
Bellamya unicolor	0	126	0	85	53	5.2
Corbicula consobrina	0	0	0	126	32	3.1
Total no. ind./m^2	1051	672	1219	1135	1019	100
%	25.8	16.5	29.9	27.8		

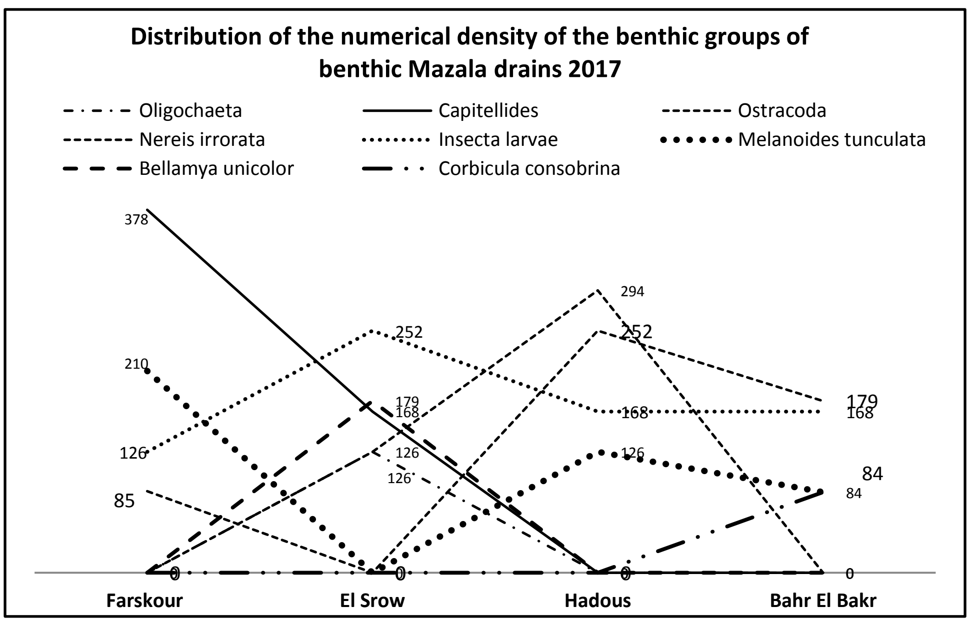


Fig. 6. Average annual abundance (no. ind/m^2) of the benthic species estimated at Manzala Drains during Feb-Sep 2017.

Table 12. Average annual of the benthic biomass (wet weight g/m^2 species estimated at Manzala drains during Feb-Sep 2017.

Biomass	Farskour	El Srow	Hadous	Bahr El Bakr	Average	%
Oligochaeta	0	0.14	0	0	0.04	0.1
Capitellides	3.1	1.4	0	0	1.1	1.6
Ostracoda	0.01	0	0.01	0.01	0.01	0.01
Nereis irrorata	0	6	14	0	5.0	7.1
Insecta larvae	0.6	1.3	0.84	0	0.68	1.0
Melanoides tunculata	7.6	0	4.6	3.0	3.8	5.4
Bellamya unicolor	0	161	0	0	40	57.5
Corbicula consobrina	0	0	0	76	19	27.3
Total no. ind./m2	11	170	19	79	70	100
%	4.1%	60.6%	6.9%	28.4%		

***2.2 Annual biomass of benthos (wet weight g/*m^2*)*:** As shown in Table 12 and in Fig. 7 the distribution of the average of the recorded species from the benthos groups in the study areas show registration of only Mullica group was attaining the maximal biomass of 63 g/m^2 which corresponding to 87% of the total annual average percentage of benthos, The rest benthic groups on the other side reaching low percentage (0.1%-7.1%) and biomass (0.04 – 5.0 g/m^2).

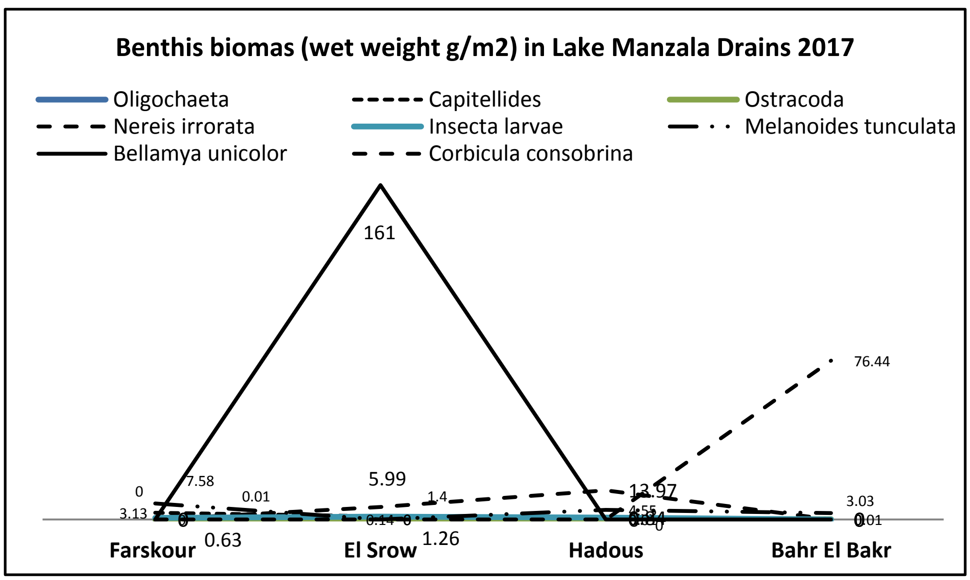


Fig. 7. Average annual of the benthic biomass (wet weight g/m^2) species estimated at Manzala Drains during Feb-Sep 2017.

The annual benthic biomass at the different drains was estimated at an average weight of 70 g/m^2 El Sarw Drain was the densest with 61% and highly biomass of 170 g/m^2 and was followed by relatively high density with wet weight of 28.4% and biomass of 79g/m^2 at Bahr El Bagar Drain. But low biomass was recorded at both sites (Hadous and Faraskour) reaching 19 and 11 g/me and corresponding to 6.9% and 4.1% respectively.

DISCUSSION

Lake Manzala is known as a brackish lake, and it is the largest of the northern deltaic lakes having two outlets (El Gamil) as a source of saline seawater from the Mediterranean Sea. Owing to low water depth from 0.5 to 1.5 m and due the lake are received from nine drains at the southern part. It is one of three natural lakes, Manzala, Timsal, and Great Bitter Lake) intersected by the Suez Canal. Lake Manzala served as a significant source of fish production in Egypt, but pollution and lake drainage have reduced the lake's productivity. Data analysis carried out during this statistical study indicated that the water depth of the lake and the water quality was the one factoring leading to decreasing in structures of benthic constituents and accordingly reflects in the fish production in the lake. On the other side, some Physic-chemical parameters are affected by the increase in nitrogen concentrations of mineral salts and generally on the benthic flora and fauna in particular fisheries. For seasonal variation in temperature in a clear factor is not considered aquatic distribution in terms of qualitative difference to the number of dominant species and numerical density and quantity and seasonally in the study areas of the lagoon for its location in the moderate tropical region. It is well known the water temperature of the most important factors affecting the whole aquatic environment in water surveys of fish, phytoplankton, zooplankton, aquatic plants, and benthic faunas in addition to its impacts on all physic-chemical properties. The concentration of pH ion is the most important factor affecting the aquatic environment where participation in all dynamic processes within aquatic surveys focus also it has an important role in precipitation or melting metals in-water surveys. The results showed the lagoon located on the alkaline side where the average concentration values ranged between 8.02-8.42. The nature of sediments indicated that the occurrences of mud (silt and clay) represented the highest percentage of about 98% in the addition to the percentage of organic matter in sediment reflecting that lake is exposed to the entrance of freshwater or drainage untreated water from different polluted drainage from the human sewage, agriculture drainage, fish farming, and industrial waste material. From a public health point of view with the result especially when applying international mentions of water quality found that at all stations located within the limits of contaminated except.

On the other side, another factor as natural and anthropogenic may be disturbance and influence on the disruption of the system‘s stability in an enclosed environment in lagoons and reflecting the variable of the benthic organisms distributions. Raffaelli and Hawkins (1996) mentioned that anthropogenic stresses are superimposed on stresses caused by natural environmental factors. Generally, marine biodiversity changes may be directly resulted from habitat structure, pollution, exploitation, or indirectly through climate change and related bio-geochemistry changes. Stress can be any factor that negatively affects the physiology, growth, reproduction, and survival of an organism or that has consequences affecting populations or communities (Shiel, 2009). Stress at one level of organization (e.g. individual, population) may also have an impact on other levels, for example, causing alterations in community structure. However, it is sometimes difficult to detect the effects of anthropogenic stress at the level of individual organisms, and impacts are more often investigated at a population or community level (Crowe *et al.*, 2000). There is little doubt that anthropogenic disturbance has extensively altered the global environment, leading to a decrease in biodiversity.

Previous studies conducted in the Lake during the previous year's El-Komi, 1997 and 2017 which the current study for reflecting some changes in the qualitative diversity of benthic and numerical density of equal distribution between species and between study areas due to different environments, depending on the type and physical and chemical properties of aqueous than the direct and indirect impact on the qualitative composition of benthic. The challenges facing the development of the lake according to EEAA (2017) final Report: Cavitation and erosion of soil, which reduced the area of the lake from 750,000 to 100,000 acres; Continuous pollution is a condition in which the lake receives huge amounts of sewage water and industrial waste, which is received annually without any treatment, mainly from Bahr El Bagar Drain about 650 million cubic meters of sewage water is dumped in the lake, and subsequently by Hados Drain 1.7 million cubic meters. 3- The spread of the hydrophytic vegetation according to Mashaly and El-Ameir, 2007; Ramadan, 2002*;* Bernhard *et al*., 2010 including *Phragmites australis*, *Eichhornia crassipes*, *Typha domingensis*, *Arthrocnemum macrostachyum* and *Echinochloa stagnina*, affected the quality of both the water and the fish. Muramoto and Oki (1983) studied on the removal of some heavy metals from polluted water by water hyacinth *(Eichhornia crassipes)* that grows abundantly throughout the tropical and subtropical regions of the world, and is also widely distributed in the southwest regions in Japan.

The results indicate an average annual stocking 1968 ind/m^2 density is in terms of numerical density and the number of species is relatively small compared with previous studies of the Lagoon during the successive monitoring yearly studies from 2010 to 2017 (El-Komi 2017). Numerical density estimated the highest density of stations numbers 2, 5, 6, 8 and 9 with annual average respectively 2310, 4284, 2310, 2073 and 2121 ind/m^2 and the corresponding percentage 10.7%, 19.8%, 10.7%, 9.6%, and 9.8% of average annual stocking 1968 ind/m^2 and lower density estimated at other stations where the annual average numerical density ranged between 525 to1827 ind/m^2 and a percentage between 2.4%-8.4% of average annual stocking. And also for the number of species varied number of 7-9 species at the station numbers 4-7 and less diverse with the rest of the stations where the number of species ranged between 3-6 species, on the other hand, the results indicated that there is a clear variation between numerical density during the average numerical density semesters during summer and winter 2016 and 2017 estimated respectively 1786 and 2150 ind/m^2. The statistical analysis shows the quantitative and qualitative appreciation of the numerical density of benthic species living macrobenthos lack a certain style explains the degree of increase or decrease in numerical density during sampling periods. And the presence of high numerical density from the previous year as is evident with the previous report on monthly changes to numerical benthic density. The average annual density in Lake Manzalah attained 1371 ind/m^2 and the biomass amounted 40.6 g/m^2. But it is lower than the average annual biomass of benthos in Lake Maruit that reached 76.6 g/m^2 (Samaan and Aleem, 1972). The standing crop of bottom living organisms in Lake Manzalah was relatively low as it embraced mainly Insect larvae, Oligochaeta, Amphipoda, Polychaeta and barnacles. These may be resulting from the amount of organic matter in the sludge that accumulated on the bottom from the different pollutant resources discharged into the lake leading to change in nature of the bottom. Meanwhile, the chemical and physical characters are greatly changes becoming unsuitable for the living and growth of most benthic organisms (El-Komi, 1997).

The abiotic environmental effects in Lake Manzala are general to those generally observed in other areas influenced by organic wastes, namely, changes in the Physic-chemical properties of the sediments and low oxygen concentrations in the bottom water due to the decomposition of the organic matter (El-Komi, 2019). According to Pearson and Rosenberg (1978) the effects are most pronounced in the vicinity of the outlets and decreased progressively with increasing the distance from the discharged points. As mentioned in many lectures, Snelgrove (2001) indicated that abiotic variables such as temperature, salinity, oxygen concentration, light availability, and sediment composition mainly have been historically ascribed the greatest direct influence over benthic organisms distributions. In the present work, the environmental variables in lake Manzala such as sediment structure, organic matter content, temperature, salinity, dissolved oxygen, nutrient concentrations, pH, turbidity, water transparency, and depth may be more correlated with abundance, density, and diversity of macrobenthic assemblages but some of these variables may vary seasonally (El-Komi, 2019; Nicolaidou *et al.*, 1988; Arvanitidis *et al.*, 1999; Hagberg and Tunberg, 2000; Mistri *et al.*, 2000 and 2001).

The contamination of natural environment components such as soil, sediment, water, and biota by heavy metals is a major worldwide concern (Ramadan, 2002; Mashaly and El-Ameir, 2007; Ali 2008; EL-Bady, 2014; Elkadya *et al.*, 2015; Elshemy and Khadr, 2015; Arnous and Hassan, 2015). The concentrations of Zn, Cd, Cu, Mn, and Pb in water and bottom sediments of the Eastern Lake Manzala indicated that the sediments and water the ultimate sink for heavy metals in the aquatic system. The contaminated water body with heavy metals greatly affected the lake's food, organisms, and, hence, humans. The lake receives about 7,500 million cubic meters annually from industrial drainage, agriculture, and health treatment from the drains of the Bahr El Bagar (human and industrial wastes polluted materials) and the drains of Hados; Ramses; Hados and Farskor (agricultural drains and this amount has been reduced to 4000 million cubic meters after the construction of El-Salam Canal (EEAA, 2017). According to Said and AbdMooati (1995 and 1997) reporting the average changes in the freshwater content (dF) of the lake was 547.0 x 106 m^3 with the maximum i.e. 72.4 x $l0^6$ m^3 in July. Using the quantity of inflowing and outflowing water through Boughaz El-Gamil (Lake-Sea connection), the change in water volume relative to sea level change was 549 x $l0^6$ m^3/y. The sea level height (dh) induced an average monthly change of 6.5 cm. Using the amount of freshwater discharge as well as the lake volume, the lake water is replaced every 48 days. The lake receives industrial and agricultural sewage water in addition to the remnants of the villages surrounding the drain Bahr El Baqar having a color black with an unpleasant smell as a result of silting the opening of the Boghazs any increased rates of silt deposition in addition to contaminate materials, and the absence of the phenomenon of tides, which led to the change of the productive composition of the lake as a result of increasing the proportion of freshwater and sanitation, which leads to reduce the degree of salinity of the water, and the lack of salt fish species in the lake the most economically valuable and the reproduction of freshwater fish from Tilapia and Clarias (catfishes) in the lake the least economically valuable in addition to the encroachments of the people and lake water and blockage of the lake waterway and the use of electricity in the water to kill fishes and then collect them or use explosives from illegal methods to kill fishes, and also planktonic organisms as zooplankton and phytoplankton, and benthic communities as annelids, mollscans, the hydrophytes vegetation.

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