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Ecological studies on macrobenthic invertebrates in four northern Khors of Lake Nasser (Egypt); Community Structure, Relative Abundance and Diversity.

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ABSTRACT

The community structure, abundance and diversity of macrobenthic invertebrates were studied in relation to major physical and chemical characteristics of water and sediment during 2015 in the four northern khors of Lake Nasser (EL-Ramla, Kalabsha, Rahma and Wadi-Abyad). Twenty six macrobenthic invertebrates species belonging to Insecta (15 species), Annelida (5 species), Mollusca (5 species) and Decapoda (1 species) were recorded. The study indicated that the western khors sectors (El-Ramla and Kalabsha) or lying nearby the main stream were higher in species richness and abundance than that of the eastern khors (Rahma and Wadi-Abyad).This may be attributed to their sandy loamy bottom nature that provided with patches of aquatic plants. At the littoral stations, the magnitude of the standing crop of macrobenthic invertebrates showed the highest counts and biomass during winter with an average of 3016 orgs./m^2, weighting 9.9 g. fresh wt./m^2. In autumn, the standing crop was with an average of 2662 orgs./m^2, weighting 19.5 g. fresh wt./m^2, when the water temperature fluctuated between18.9 & 25.2°C. On the other hand, the macrobenthic invertebrates at the offshore stations remained low throughout most of the year due to the shortage of suitable substrate. Pearson correlation coefficient showed that the aquatic insects, annelids and molluscs were categorized in relation to water temperature, organic matter and dissolved oxygen, respectively.

INTRODUCTION

The macrobenthic invertebrates are those organisms, which survive on the bottom of different aquatic habitats, either attached or limited in their mobility. They are usually adapted to different environmental conditions prevailing at the bottom. Freshwater macrobenthic invertebrates include representatives of many aquatic insects, molluscs (gastropods and bivalves), annelids (oligochaetes and hirudineas) and crustaceans (Merritt *et al*., 2008). They contribute in many important ecological functions, such as decomposition, nutrient recycling as well as serve an important role in aquatic food webs as both consumers and prey (Vanni, 2002 and Moore, 2006). Most benthic organisms feed on debris that settle on the bottom of the water and in turn serve as food for a wide range of fishes (Idown and Ugwumba, 2005). In Lake Nasser, the different groups of benthos serve as an important food for various fish species (Latif, 1974 and Iskaros, 1993).

These authors found that chironomid larvae form the major food items for *Mormyrus kannume, M. caschive* and *Chrysichthys auratus* throughout the different seasons. *Synodontis schall* and *S. serratus* feed mainly on gastropods, *Bulinus truncatus* and *Physa acuta*. Furthermore, they reported that nymphs of Odonata and Ephemeroptera, larvae of Trichoptera, Corixidae are also infrequently appeared in the guts contents of the above 5 fish species. *Hydrocynus* spp., particularly *H. forskalii,* subsists mainly on insect larvae (Iskaros, 1993; Mola, 2009).

The study of macrobenthic invertebrates in Lake Nasser has received little interest. Entz (1978) and Latif (1974) regarded gradual change in the components of benthos with the development of the lake, particularly molluscs and oligochaetes. Detailed investigations were carried out by Iskaros (1988 & 1993) on the distribution and seasonal variations of benthic organisms in Lake Nasser and adjacent water (Aswan Reservoir and the River Nile) in relation to the prevailing environmental conditions and identified 40 species related to the Aquatic Insecta, Mollusca, Annelida and Platyhelminthes. Fishar (1995) recorded 39 species of zoobenthos, 14 species previously recorded by Iskaros (1993) were not included in Fishar (1995) list, but added 9 species for the first time. In the recent years, Iskaros and El-Dardir (2010) identified 10 species from the offshore stations of ten sectors at depths exceed 50 m. Mola and Abdel-Gawad (2014) carried out a review on macrobenthic organisms and recorded 24 species which were previously known by other investigators.

The aim of the present study.

1. Survey of macrobenthic invertebrates groups inhabiting the four northern khors of Lake Nasser.
2. Studying the distribution, abundance and diversity of macrobenthic invertebrates in relation to different environmental parameters and seasonal changing in the study areas
3. Studying some of physico-chemical characteristics in the investigated sites such as temperature, transparency, dissolved oxygen, hydrogen ion concentration (pH), conductivity and organic matter.

MATERIALS AND METHODS

The study area:

An important feature of Lake Nasser is the presence of side extensions, locally referred to as “khors” and these constitute about 76% of its total area. The number of the important khors is about 85 of which 48 are located on the eastern side and 37 on the western shore. Some of these khors have considerable area, and consequently are converted to auxiliary semi-isolated lakes. The two largest khors, namely; Allaqi and Kalabsha constitute collectively about 53% of the total area of the khors. The present investigation includes selection for the important northern khors i.e El-Ramla, Kalabsha, Rahma and Wadi-Abyad (Figs. 1, 2 & Table 1). On the basis of quantitative and qualitative analysis, the macrobenthic invertebrates were sampled. Thus, at each khor, two sectors were selected to represent the different habitat. The first one lies nearby the main stream, while the situation of the other one is at the middle of the khor. At each sector, two stations were taken for sampling from the different khors, namely; the littoral shallow area that extends down to six meters depth and at the offshore deep stations which are usually located about the middle of the khor (about 20m depth).

Table 1: Morphometric data for the studied khors

Khor Name	El-Ramla	Kalabsha	Rahma	Wadi-Abyad
Length (km)	25.72	47.20	23.58	18.30
Surface area (km^2)	101.20	620.0	95.20	48.70
Perimeter (km)	284.0	517.0	232.0	184.0
Volume (km^3)	0.96	7.16	2.15	1.11
Distance from the High Dam (km)	10.0	50.0	55.0	70.0
Latitude	23° 54`N	23° 54`N	23° 31`N	23° 21`N
Longitude	32° 50` E	32° 50` E	32° 54` E	32° 57` E
Nature of the bottom	Sandy loamy	Sandy loamy	Gravels & rocks	Gravels & rocks

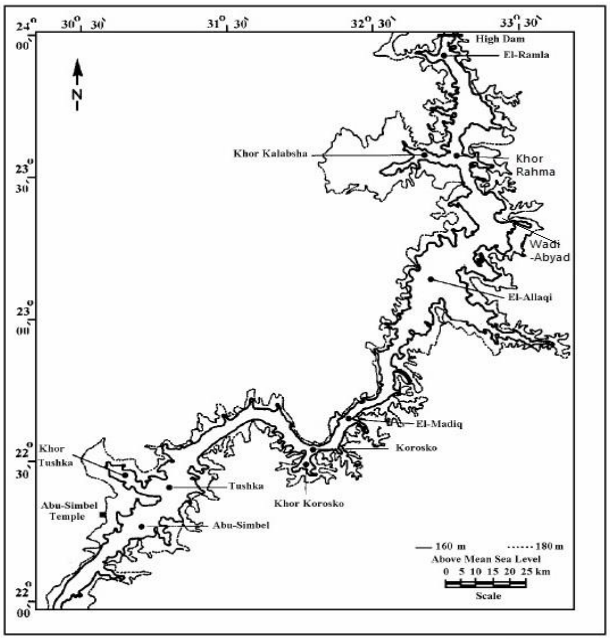

Fig 1: Lake Nasser and its main khors in both east and west banks.

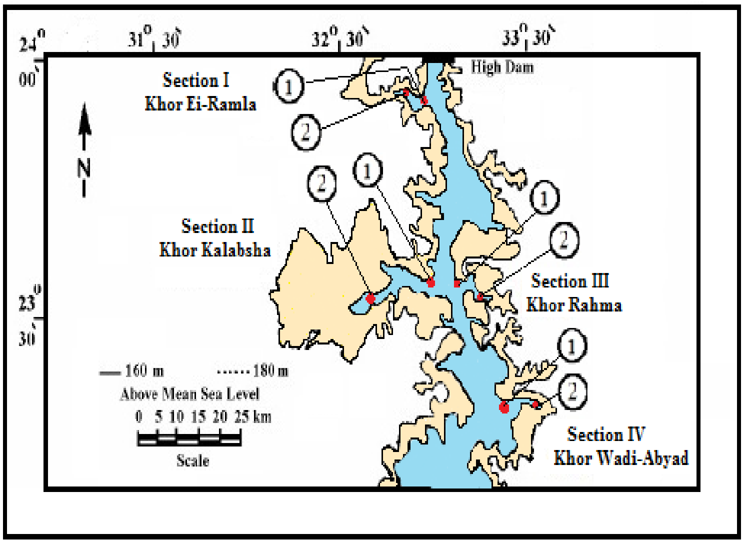

Fig. 2: Sampling sites at the northern khors of Lake Nasser

Both khors El-Ramla and Kalabsha are located at the western bank of Lake Nasser, where as khors Rahma and Wadi-Abyad are on the eastern bank of the lake.

Sampling of macrobenthic invertebrates was performed seasonally during winter (January), spring (June), summer (July) and autumn (October) of 2015.

Measurements of Physico-chemical parameters:

Some ecological factors including water temperature, pH, dissolved oxygen, conductivity, transparency, organic matter were measured during collecting period. Water temperature, pH values and electrical conductivity were measured by using CRISON Multimeter MM40+(APHA, 1992). Water transparency was determined by means of a white enameled standard Secchi disc, with a diameter of 20 cm. Dissolved oxygen was determined by using an oxygen electrode (Jenway Oxygen Meter, Model 1070; Jenway, UK). Determination of organic matter in sediment was carried out according to the method described by Hanna (1965).

Collection and treatment of macrobenthic invertebrates:

At each station, two random samples were collected at both the littoral and offshore stations; using an Ekman grab with opening of 234 cm^2 (1/43 m^2). The collected samples were then thoroughly washed from the muds in metallic sieve with mesh size of 0.4 mm. Organisms with smaller size (ex. early instars of chironomid larvae) were picked by hand from the surface water after stirring the sample. The bottom organisms were sorted directly in the field and then preserved in 5% formalin solution. In the laboratory, the numbers of different species or genera were determined. The fresh weights of the different groups were also estimated by retaining the organisms on a filter paper for five minutes before weighing to get rid of water adhering to their bodies. The shells of molluscs were removed for determining their flesh weights. A total of 132samples were examined. Fresh weight of organisms in square meter were refered as GFW/m^2.

For the identification of aquatic insects, the following references were used: Wirth and Stone (1968); Smith and Mancy (1978); Mason (1973) and Hilsenhoff (1975). The main references used for Mollusca included that of Demian (1959); Brown (1980); Brown *et al*. (1984) and Ibrahim *et al*. (1999). For the identification of Oligochaetae, Brinkhurst and Jamieson (1971) and Pennak (1978) were used and were further checked by Dr. E.G. Easton from British Museum. Hirudinea werealso identified with the kind help of Prof. N. El-Shemy and Prof. A.H. Obuid-Allah (Departement of Zoology, Assiut University).

Statistical analysis:

Analysis of variance on SPSS software package (version 23) (SYSTAT statistical program) was used to test the present data. Pearson correlation coefficient and Stepwise multiple regressions were used to select the affected variable.Probability value ≤ 0.05 were defined as significant throughout the present study; however the value ≥ 0.05 were defined as non-significant.

RESULTS

Physico-chemical Characteristics

Table (2) displays the data of physical and chemical analysis, which were reported for the khors water throughout the study period. Temporal water temperature differences were relatively high and fluctuated between a minimum value of 18.5°C at the bottom water layer in sector 1 of khor El-Ramla during winter to a maximum one of 34.5°C at the surface water layer of the same sector of the same khor in spring. Conductivity values varied between a minimum level of 230 µs/cm at the surface water layer of sector I of khor Kalabsha during autumn with the incoming flood to a maximum one of 280 µs/cm at the surface water layer of sector II of khor Kalabsha accompanied with the falling water temperature in winter. Also, the decrease of water temperature during winter leads to a considerable elevation in oxygen concentrations that attained the highest values (range: 7.29 – 10.4 mgO_2/l) compared with summer (range: 2.02 – 7.61 mgO_2/l).

Table 2: Physico-chemical Characteristics of Khors water of Lake Nasser

Khors / Season & depth		Temperature °C								Dissolved oxygen							
		W.		Sp.		Su.		A.		W.		Sp.		Su.		A.	
		S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B
El-Ramla	Sec. I	21.2	18.5	34.5	26.0	28.2	25.4	25.1	24.8	9.7	7.29	7.52	5.01	7.03	2.51	8.92	7.32
	Sec. II	23.2	19.2	33.7	25.9	28.0	24.9	25.1	24.7	10	7.65	7.8	6.18	7.32	2.22	7.52	7.78
Kalabsha	Sec. I	21.1	18.5	32.0	24.8	30.0	29.5	25.9	25.7	10.4	8.36	8.8	5.0	7.04	2.86	7.33	7.35
	Sec. II	21.1	18.9	28.5	27.5	29.7	29.2	24.6	24.4	9.72	8.54	8.3	8.5	7.61	6.96	7.96	7.70
Rahma	Sec. I	22.9	19.2	29.5	26.0	28.8	27.6	25.8	25.5	10.0	8.08	8.5	8.7	7.02	2.76	6.82	6.6
	Sec. II	20.2	18.9	33.0	26.5	29.2	29.1	24.8	24.7	9.83	8.65	7.08	8.51	7.14	6.93	6.89	6.69
Wadi-Abyad	Sec. I	21.5	19.7	28.5	26.5	29.8	27.7	25.5	25.1	9.61	8.8	8.61	7.71	6.9	2.02	7.8	6.5
	Sec. II	23.2	19.0	29.0	27.3	29.4	29.1	25.4	25.1	9.37	7.9	8.45	8.55	7.31	6.03	6.85	6.18

Khors / Season & depth		Conductivity								pH							
		W.		Sp.		Su.		A.		W.		Sp.		Su.		A.	
		S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B
El-Ramla	Sec. I	276	275	271	241	247	254	237	233	8.22	8.24	8.36	7.80	8.19	7.83	8.01	8.22
	Sec. II	269	282	252	243	247	255	234	233	8.53	8.28	8.55	8.26	8.33	7.85	8.20	8.31
Kalabsha	Sec. I	274	272	230	246	243	245	230	231	8.40	8.38	8.76	8.28	8.25	8.41	8.17	8.33
	Sec. II	280	272	232	223	242	244	234	233	8.13	8.37	8.50	8.70	8.46	8.49	8.21	8.39
Rahma	Sec. I	275	267	236	226	243	245	233	233	8.58	8.36	8.97	9.14	8.19	7.89	8.03	8.2
	Sec. II	270	274	235	250	244	243	235	235	8.20	8.33	8.95	9.2	8.34	8.42	8.04	8.19
Wadi-Abyad	Sec. I	267	263	234	241	240	243	231	231	8.56	8.31	8.68	8.30	9.37	7.95	8.0	8.13
	Sec. II	271	268	237	230	241	242	235	232	8.44	8.23	8.60	8.96	8.42	8.22	8.01	8.11

Where: S = Surface & B = Bottom &W. = Winter; Sp. = Spring; Su. = Summer & A. = autumn

The pH values in the different khors waters were always on the alkaline side at narrow range. It varied between a minimum value of 7.80 at the bottom water layer in sector I of khor El-Ramla during spring to a maximum one of 9.37 at the surface water layer in sector I of khor Wadi-Abyad during summer. The relative alkaline pH values recorded in the different khors were the result of photosynthetic uptake of CO_2 by phytoplankton (Zaghloul, 1985).The Secchi disc readings (Transparency) throughout the different sectors (Table 3) fluctuated between 2.5 m. at sector I of khor Rahma during spring and 5.8 m. at sector II of khor Wadi-Abyad in autumn.

The highest readings were found during spring, summer, particularly at the littoral and offshore sediments of sector II of khor Wadi-Abyad (avg. 10.47 % and 10.88 %, respectively) .The values of organic matter content (Table 4) were generally higher in the sediments of the offshore stations than those of littorals. This is attributed to the nature of bottom deposits at littoral stations, which consisted mainly of sand as mentioned previously, while at the offshores was silt, clay.

Table 3: Seasonal variations of transparency (m.) of water at the northern khors of Lake Nasser

Khors / Season		Winter	Spring	Summer	Autumn	Average
El-Ramla	Sec. I	4.5	2.9	4.2	4	3.9
	Sec. II	3.7	2.8	4.2	3.5	3.55
Kalabsha	Sec. I	3.5	3.2	3.4	3.7	3.45
	Sec. II	4.2	3.2	3.5	4.5	3.85
Rahma	Sec. I	4.5	2.5	3.8	4.9	3.925
	Sec. II	4.4	2.6	3.8	4.6	3.85
Wadi-Abyad	Sec. I	3.8	2.6	4.5	5.2	4.025
	Sec. II	3.6	2.9	3.8	5.8	4.025
Average		4.0	2.8	3.9	4.5	3.82
SD		0.42	0.27	0.37	0.78	0.21

Table 4: Percentage of organic matter at littoral and offshore sediments at the northern khors of Lake Nasser.

Khors \ Season		Winter		Spring		Summer		Autumn		Average	
		littoral	Offshore	littoral	Offshore	littoral	Offshore	littoral	Offshore	littoral	Offshore
El-Ramla	Sec. I	2.51	11.73	2.55	4.78	2.11	3.99	1.56	6.35	2.18	6.71
	Sec. II	5.08	6.96	7.76	8.77	6.65	8.11	4.02	5.06	5.87	7.22
Kalabsha	Sec. I	3.21	4.52	2.48	8.23	3.84	7.33	4.79	5.53	3.58	6.40
	Sec. II	2.61	4.15	4.49	5.87	4.15	5.23	3.94	4.41	3.79	4.91
Rahma	Sec. I	6.20	5.78	4.31	6.51	3.15	6.72	3.78	4.44	4.36	5.86
	Sec. II	5.77	7.29	4.20	6.99	5.30	8.22	4.46	5.36	4.18	6.97
Wadi-Abyad	Sec. I	6.35	6.55	7.73	8.11	7.37	7.99	2.75	2.79	6.05	6.36
	Sec. II	7.40	8.11	10.47	10.88	9.81	11.43	3.66	4.71	7.83	8.78
Average		4.80	6.80	5.50	7.50	5.30	7.40	3.60	4.80	4.73	6.65
SD		1.88	2.38	2.85	1.90	2.53	2.22	1.03	1.04	1.76	1.12

Macrobenthic invertebrates

Community composition, distribution and seasonal variations:

A total of 26 macrobenthic invertebrates species were recorded during the study belonging to aquatic insects (15 species), oligochaets (3 species) and molluscs (5 species). According to their relative abundance, they contributed respectively about 55.1, 24.9, 17.8 % of the total benthos. In addition, there were another two groups including Crustacea and Hirudinea recorded as rare forms, constituted collectively about 2.2 % of total benthos (Table 5). The highest density and biomass of macrobenthic invertebrates at the littoral stations (Fig. 3) in the northern khors were recorded at El-Ramla and Kalabsha with an annual average of 3399 org./m^2 with 16.5 GFW/m^2 and 3124 org./m^2 with 14.2 GFW/m^2, respectively (Fig. 3).

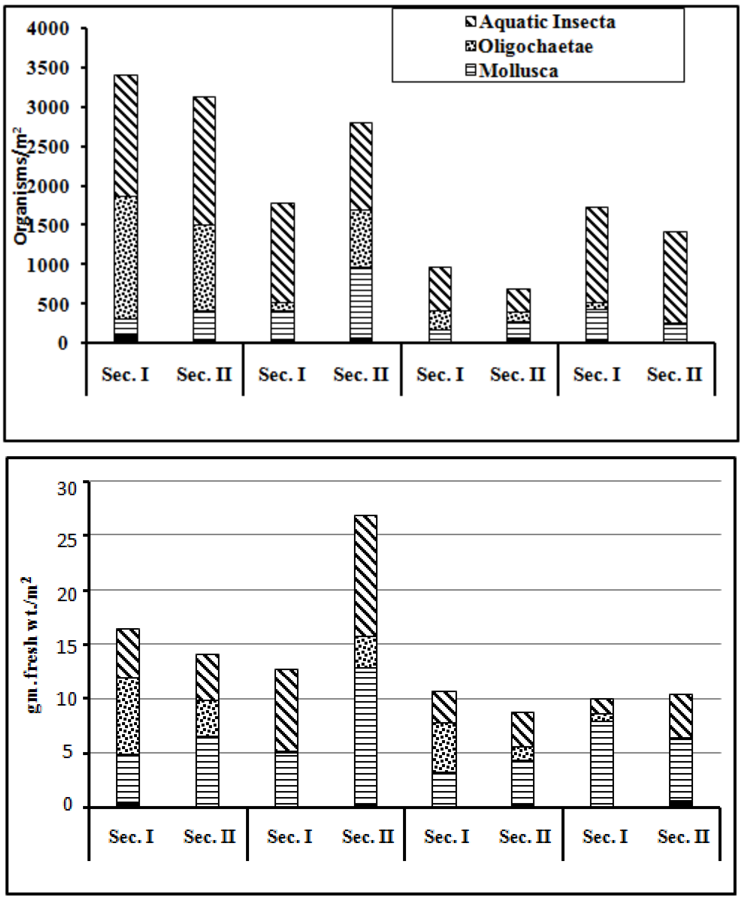

Fig.3: Annual average density and biomass of the macrobenthic invertebrates (organisms/m^2 and gm. fresh wt./m^2) recorded at the littoral stations of the northern khors of Lake Nasser.

Table 5: Average relative contribution (%) descriptive taxa to the total density of macrobenthic invertebrates recorded in four northern Khors of Lake Nasser.

Species	**littoral**		**Offshore**	
	No./m²	**%**	**No./m²**	**%**
Dicrotiendipes modestus	186	9.3	0	0
Procladius sp.	120	6.1	18	4.3
Microtendipes sp.	103	5.2	12	2.9
Ablabemyia sp.	40	2.0	0	0
Cryptochironomus sp.	39	1.9	0	0
Tanytarsus sp.	21	1.1	2	0.5
Clinotanypus sp.	15	0.7	2	0.5
Polypedilum sp.	4	0.2	1	0.2
Chironomus sp.	6	0.3	3	0.7
Cricotopus sp.	6	0.3	0	0
Pupae of Chironomidae	16	0.8	0	0
Nymph of Anisoptera (2 species)	44	2.2	0	0
Nymph of Zygoptera (1species)	83	4.2	0	0
Larvae of Trichoptera	42	2.1	12	2.9
Hemiptera (1 species)	216	10.9	65	15.7
Nymph of Ephemeroptera	156	7.9	61	14.7
Limnodrilus udekemianus Clap	314	15.8	115	27.7
Limnodrilus hoffmeisteri Clap	158	8.0	51	12.3
Branchiura swerbyi Bedd	22	1.1	47	11.3
Melanoides tuberculata Muller	111	5.5	0	0
Bulinus truncatus Muller	98	4.9	0	0
Valvata nilotica Jickeli	83	4.2	26	6.3
Physa acuta Draparnaud	63	3.2	0	0
Sphearium hartmanni Jickeli	1	0.1	0	0
Cardina nilotica Roux	22	1.2	0	0
Helobdella conifera Moore	15	0.7	0	0
Barboronia assiuti nov. sp.	2	0.1	0	0
Total	1987	100	415	100

On the other hand, the density of the community sharply declined at the other two khors, particularly khor Rahma (annual average 957org./m^2& 11.5 GFW/m^2). The annual average density and biomass of the total benthos for all the littoral stations reached to 1987org./m^2& 14.1 g.freshwt/m^2. The numerical density of macrobenthic invertebrates remained low at the most offshore stations (Fig. 4). Their annual average values fluctuated between 231 org./m^2 with 3.9 g.freshwt/m^2 to 682org./m^2 with 9.2 g.freshwt/m^2. Generally, the different stations of the four khors which are lying nearby the main stream were richer in macrobenthic fauna than those at the inside ones.

Regarding their seasonal variations, the macrobenthic invertebrates inhabiting the littoral stations (Table 6) showed a rapid increase during winter and autumn, particularly at sectors I and II of khor El-Ramla that harbored 6908 and 7480 org./m^2, respectively, when the water temperature varied between 18.5 and 24.4°C. This was followed by a sharp drop throughout spring and summer. Generally, aquatic insects prevailed during the different seasons followed by oligochaetes and molluscs. The total count of the macrobenthic fauna at the offshore stations remained relatively low during winter and spring but showing tendency of a pronounced increase in summer and less so in autumn. Aquatic insects were common during winter, summer and autumn while, they completely disappeared at most stations during spring.

The total biomass of the macrobenthic invertebrates at the littoral stations (Table 6) was nearly proportional to their numerical values during spring and autumn.

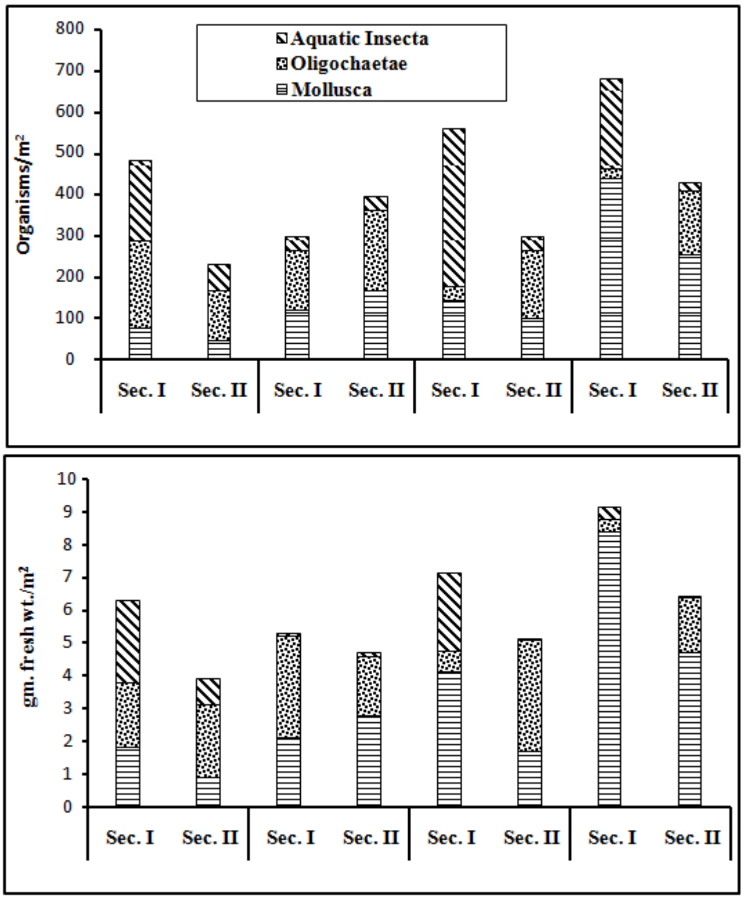

Fig. 4: Annual average density and biomass of the macrobenthic invertebrates (org./m^2 and gm fresh wt./m^2) recorded at the offshore stations of the northern khors of Lake Nasser.

Table 6: Seasonal variation of macrobenthic invertebrates (organisms/m^2 and gm fresh wt./m^2) recorded at the littoral and offshore stations of the northern khors of Lake Nasser

Khors \ Season		Winter				Spring				Summer				Autumn			
		littoral		offshore		littoral		offshore		littoral		offshore		littoral		offshore	
		no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2
El-Ramla	Sec. I	2904	7.12	352	2.2	2156	11.7	88	2.2	1056	17.1	660	12.3	7480	30.12	836	8.6
	Sec. II	6908	17.9	88	1.8	1144	8.48	132	2.1	1760	18.7	352	5.2	2684	11.34	352	6.7
Kalabsha	Sec. I	1496	10.6	264	1.8	1540	9.72	44	1.4	1056	10.77	572	9.9	2992	20.1	308	8.1
	Sec. II	2596	18.8	220	1.5	3344	27.2	264	3.1	1012	20.1	440	8.4	4224	41.6	660	5.8
Rahma	Sec. I	1584	6.13	176	0.4	528	15.68	0	0	572	12.1	572	15.3	1144	12.07	1496	12.8
	Sec. II	484	9.83	44	0.12	440	1.45	44	0.12	924	15.89	396	5.7	924	10.35	704	14.4
Wadi-Abyad	Sec. I	4109	4.9	748	2.2	484	6.9	0	0	1100	16.2	1760	28.8	1232	12.55	220	5.9
	Sec. II	4048	3.59	88	1.7	264	3.3	88	0.09	748	16.6	792	14.4	616	18.1	748	9.6
Average		3016	9.9	248	1.5	1238	10.6	83	1.1	1029	15.9	693	12.5	2662	19.5	666	9.0

During winter and summer, the community showed a certain deviation where the first peak concerning numbers during winter with low biomass (avg. 9.9 GFW/m^2) was compensated with a peak of high biomass (avg. 15.9 GFW/m^2) during the second season, due to the increased number of molluscs whose their flesh is heavier than the weight of insects. At the offshore stations, the total biomass sharply declined during winter (avg. 1.5 GFW/m^2) and spring (avg. 1.1 GFW/m^2), but showed a rapid increase during summer (avg. 12.5 GFW/m^2) and less so in autumn (avg. 9.0 GFW/m^2).

Aquatic Insecta

Aquatic insects constituted respectively about 55.1 % by number (Table 7) (avg. 1095 insects/m^2) and 34.7% by weight (4.8 GFW/m^2) of the total benthos. Chironomid larvae represented the most important organisms among the benthic community inhabiting Lake Nasser, where they constituted about 27.1% by number (avg. 538 larvae/m^2) of total benthos at the littoral stations. Their maximum distribution at the littoral stations was recorded at Khor El-Ramla while the lowest value was at Khor Rahma (Fig. 3). Their peaks were recorded during winter and autumn. At the offshore stations, chironomid larvae appeared rarely with an annual average of 22 larvae/m^2 with 0.1 g. Fresh wt./m^2. The chironomid larvae were mainly represented by 10 species, namely; *Dicrotiendipes modestus, Procladius* sp., *Microtendipes* sp., *Ablabemyia* sp., *Cryptochironomus* sp., *Tanytarsus* sp., *Clinotanypu*s sp. *Crictopus* sp., *Chironomus* sp. and *Polypedilum* sp.

Table 7: Annual average density and biomass of the macrobenthic invertebrates (organisms/m^2& gm fresh wt./m^2) at the littoral and offshore stations of the northern khors of Lake Nasser.

Khors \ Groups		Aquatic Insecta				Oligochaetae				Mollusca				Rare forms				Total			
		littoral		offshore		littoral		offshore		littoral		offshore		littoral		offshore		littoral		offshore	
		no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2	no./m^2	gm/m^2
El-Ramla	Sec. I	1540	4.6	198	2.5	1551	6.9	209	2.0	187	4.4	77	1. 8	121	0.62	0	0	3399	16.5	484	6.3
	Sec. II	1617	4.3	66	0.8	1100	3.3	121	2.2	385	6.45	44	0.9	22	0.14	0	0	3124	14.2	231	3.9
Kalabsha	Sec. I	1265	7.5	33	0.1	99	0.2	143	3.1	363	5.0	121	2.1	44	0.08	0	0	1771	12.8	297	5.3
	Sec. II	1112	11.1	33	0.1	726	2.97	198	1.8	902	12.4	165	2.8	55	0.47	0	0	2795	26.9	396	4.7
Rahma	Sec. I	550	2.97	385	2.4	242	4.4	33	0.65	165	4.2	143	4.1	0	0	0	0	957	11.5	561	7.1
	Sec. II	297	3.2	33	0.04	121	1.17	165	3.4	220	4.77	99	1.7	55	0.3	0	0	693	9.4	297	5.1
Wadi-Abyad	Sec. I	1214	1.4	220	0.4	99	0.67	22	0.35	385	7.9	440	8.4	33	0.1	0	0	1731	10.1	682	9.2
	Sec. II	1166	3.9	22	0.02	11	0.12	154	1.7	231	5.7	253	4.7	11	0.7	0	0	1419	10.4	429	6.4
Average		1095	4.8	124	0.79	494	2.5	130	1.9	355	6.4	168	3.3	42	0.30	0	0	1986	14.1	422	6.0

In addition, pupae of Chironomidae, nymphs of Odonata and Ephemeroptera, larvae of Trichoptera and Hemiptera appeared less abundant at the littoral stations and constituted about (0.8, 6.4, 7.8, 2.1, 10.8%) respectively. They showed their maximum persistence in winter and autumn.

Oligochaeta:

Oligochaets contributed numerically about 24.2% by number and 17.7% by weight (Table 7) (avg. 494 orgs./m with 2.5 GFW/m^2) of the total benthos. They represented the second component of benthic fauna at the littoral stations. At the offshore stations, oligochaetes appeared less abundant with an annual average 130 orgs./m^2 with 1.9 g. fresh wt./m^2.Oligochaetae reached their maximum distribution at the littoral stations at Khor El- Ramla followed by a gradual decrease till reached the lowest values at Khor Wadi- Abyad (Fig. 3). Oligochaetes were represented mainly by *Limnodrilus udekemianus* Clap**.** L. *hoffmeisteri* Clap, and *Branchiura sowerbyi* bed. Their peaks appeared during winter and autumn.

Mollusca

Molluscs constituted respectively about 17.9% by number and 45.4 % by weight (Table 7) (avg. 355 gastropods/m^2 with 6.4 GFW/m^2) of the total benthos. At the offshore stations, molluscs were only represented by species; namely *Valvata nilotica* Jickeli, with an annual avg. 26 gastropods/m^2 with 0.3 GFW/m^2. The maximum distribution of molluscs at the littoral stations was recorded at Khor Kalabsha while the lowest values were at Khor Rahma (Fig. 3). The molluscs recorded included 4 gastropods belonging to four families, namely; *Valvata nilotica* Jickeli, *Physa acuta* Draparnaud, *Bulinus truncatus* Aud. and *Melanoides tuberculata* Mullerand, and one bivalve belongs to one family, namely; *Sphearium* (*Musculium*) *hartmanni* Jickeli. Their peaks appeared during summer and spring.

Rare fauna

The fourth rare group includes Crustacea (represented by *Cardina nilotica*) and Hirudinea (represented by *Helobdella conifera & Barboronia assiuti*) and they represented collectively about 2.2% by number of total macrobenthic invertebrates (Table 7), with an annual avg. 42 orgs./m with 0.30 GFW/m^2.

Table 8: Correlation coefficient matrix between physico-chemical parameters and bottom fauna during the present study.

	A.Ins	mol	Oli	T	O_2	pH	Cond.	O.M
mol	0.206							
Oli	0.591	0.116						
T	-0.611	0.032	-0.512					
O_2	0.058	0.664	0.154	-0.139				
pH	-0.781	0.135	-0.883	0.524	-0.147			
Cond	0.592	-0.175	0.879	-0.240	0.305	-0.895		
O.M	-0.121	-0.023	-0.490	0.356	-0.404	0.349	-0.364	

DISCUSSION

The macrobenthic invertberates qualities and quantities are largely influenced by the surrounding environmental conditions, including biotic and abiotic factors and are affected by a complex inter-relationship between these different factors (Hawkes, 1975, Angradi *et al*., 2006). Difonzo and Campbell (1988) found that the relative abundance and composition of invertebrates vary depending on the type of microhabitat (aquatic plants, bottom sediments or water column).Similarly, in the present study, the aquatic plant belt of the different khors from a suitable substrate for the growth of Chironomini such as *Dicrotendipes* sp. The gastropods *Bulinus truncatus, Physa acuta* and nymphs of Odonata were found also more abundant amongst the aquatic vegetation.

The organic matter in the sediments provides an indication of the amount and type of food setting on the bottom from the water column and it is used as an index of those available for benthic animals (Byers *et al*., 1978). In the present investigation, organic matter in the sediments of the northern khors of Lake Nasser generally increased during spring and summer at both the littoral and offshore stations, may be due to the gradual accumulation of phytoplankton on the khors bed and its decomposition in the previous seasons. The present results also clarified a negative correlation betweenorganic matter and Oligochaetae and Hirudinea. According to Payne (1986), died phyto- and zooplankton deposited on the bottom constitute the major food items for the macrobenthic invertebrates.

Transparency was measured with the highest values in winter and autumn (avg. 4.0 & 4.5 m, respectively), while it decreased during spring and summer (avg. 2.8 & 3:9 m , respectively). The decrease in the water transparency in Lake Nasser is caused by two main factors, namely; allochtonic inorganic silt and mud of rivene origin and autochtonic suspended organic matter (plankton and detritus) (Entz, 1974). Iskaros (1993) mentioned that the increases density of zooplankton in khor Kalabsha during winter and autumn parallel with the increased transparency enables good nourishment of chironomid larvae which thus appeared more abundant during this period in the present investigation. This also coincides with the observations of Lewis (1957) in the Blue Nile at Khartoum.

The pH values in the four investigated khors lie on the alkaline side and fluctuated between 7.80 at the bottom water layer of sector I of khor El-Ramla during spring to 9.37 at the surface water layer of sector I of khor Wadi-Abyad in summer. Train (1979) and Delince (1992) mentioned that pH range between 6.5 and 9.0 is more suitable for the aquatic fresh water life.Iskaros and El-Otify (2013) recorded the pH values in Aswan Reservoir between a minimum of 7.34 during winter and maximum of 7.95 in spring and found the increased density of macrobenthic invertebrates was usually accompanied with the increased pH values.

Lake Nasser belongs to the 1st class with low conductivity, less than 600 us/cm. El-Shahawy (1975) and Mageed & Heikel (2006) explained that the low conductivity of the lake water during the flood period is due to the low water conductivity of the flooded Blue Nile which contributes about 84% of the Nile flood. Entz (1978) illustrated that electrical conductivity is an important factor affecting on the emergency of chironomid larvae. In the present study, there was a positive correlation between electrical conductivity and aquatic insects and oligochaetes.

The aquatic insects and oligochaetes reacted negatively to water temperature (Table 8). This is rather in agreement with Iskaros *et al*. (2011) observations on the seasonal variations of chironomid larvae and oligochaetes in Aswan Reservoir, where their peaks were observed during autumn and winter. Thus, the rise of water temperature during spring and summer is expected to accelerate the developmental rate of chironomid leading soon to the adult stage through pupation as previously mentioned by Konstantinov (1958). This mayexplain the scarcity of the larval stages in these two seasons. Pennak (1953) suggested that although temperature is not usually a limiting factor, it often determines the relative abundance of oligochaetes.

Dissolved oxygen is one of the key factors of aquatic ecosystem; oxygen is needed for all oxidation, nitrification and decomposition. The concentration of dissolved oxygen is influenced by several factors such as temperature, salinity and photosynthetic activity of plankton and submerged plants. In the present investigation, molluscs in the northern Khors were significantly dependent on the amount of dissolved oxygen (Table 8). In this respect, it was reported that the snail distribution in Africa revealed that oxygen is probably the principle limiting factor (Brown, 1980).

The present study revealed that the littoral shallow areas sustained a higher standing crop of macrobenthic fauna as compared with that of the offshore localities. The annual average density at the littoral stations amounted to 1986 orgs./m^2 forming 14.1 g. fresh wt./m . The highest record was reached at the sectors nearby the main Nile channel, decreasing towards the inner sectors of the different khors. The magnitude of the standingcrop of benthos at the offshores exhibited more or less lower values with an annual average of 422 orgs./m^2 forming 6.0 g. fresh wt./m^2. Similar observations were also recorded in the while Nile and adjoining waters

(Mankov, 1969), Lake Victoria (Rzoska, 1976) and in Lake Nasser (Iskaros,1988 and 1993). The fact that the shallow waters favourite habitats is probably correlated with the greater abundance of food (Pennak, 1953).

The Physico-chemical features of Lake Nasser are in favour of producing high standing crop of phytoplankton, zooplankton and macrobenthic invertebrates which in turn, provide the main food items for most fish inhabiting the lake as mentioned previously. The ability of different trophic levels in the food cycle is in favour of increasing the available food resources for fish and consequently increasing the annual fish yield. This also creates a certain biological balance in the food chain and furnishes an ideal recycling and interaction between the different biota (Iskaros et al, 2008). Also, the selection of certain khors sush as khors El-Ramla and Kalabsha for construction of fish farms could be an important mean for increasing fish production.

CONCLUSION

According to the results, abundance of groups was as follows: Aquatic Insecta was the first group (avg. 1095 insects/m^2) at the littoral stations and (avg. 124 insects/m^2) at the offshore stations. Oligochaetae was second group (avg. 494 organisms/m^2) at the littoral stations and (avg. 130 organisms/m^2) at the offshore stations. Mollusca was third group (avg. 355 gastropods/m^2) at the littoral stations and (avg. 168 gastropods/m^2) at the offshore stations. Rare forms was fourth group included Hirudinea (avg. 15 organisms/m^2) and Crustacea (avg. 28 organisms/m^2).

REFERENCES

American Public Health Association "APHA"(1992). Water Environment Federation. Standard methods for the examination of water and wastewater, 18th edit. New York.

Angradi, T. R.;Schweiger, E. W. and Bolgrien, D. W. (2006). Inter-habitat variation in the benthos of the Upper Missouri River (North Dakota, USA): implications for Great River bioassessment. *River Research and Applications*,22(7), 755-773.

Brinkhurst,R.O.andJamieson,B.G.M.(1971).AquaticOligochaetae of the world. Univ. TorontoPress, Ont., 860 pp.

Brown, D. S. (1980). Freshwater snails of Africa and their medical importance. Lond., Taylor & Francis Ltd, 478pp.

Brown, D. S.; Fison, T.; Southgate, V. R. and Wright, C. A. (1984). Aquatic snails of the Jonglei region, southern Sudan, and transmission of trematode parassites. Hydrobiol., 110:247-271.

Byres, C.; Mills, E. L. and Stewart, P. L. (1978). Acomparison of methods of determining organic carbon in marine sediments with suggestions for a standard method, Hydrobiologia, 58:43-47.

Delince, G. (1992). The ecology of the fish pond ecosystem with special references to Africa. Kluwer Acdemic Poblishers Dordercht, Boston and London, 223pp.

Demian. E. S. (1959). On the freshwater gastropods of Dakhla and kharga Oases. Bull. Zool. Soc. Egypt, 14:17-21.

DiFonzo, C. D. and Campbell, J. M. (1988). Spatial partitioning of microhabitats in littoral cladoceran communities. Journal of freshwater ecology, 4(3): 303-313.

El-Shahawy, M. (1975). Studies on the physical properties of Lake Nasser. M.Sc. Thesis, Fac. Sci, Cairo Univ., Cairo. 128pp.

Entz, B. A. G. (1974). Limnology. In. B. A. G. Entz and A. F. A. Latif (Eds.), Report on survey to Lake Nasser and Lake Nubia (1972-1973). Lake Nasser Development Centre, working paper. No 6, Aswan; 4-63.

Entz, B. A. G. (1978). Sedimentation processes in the Reservoir Lake Nasser-Nubia during 1965-1974 and future aspects. Symposium of Ecological Studies on the River Nile. Egyptian Society of Environment, Cairo,(April;1978)

Fishar, M. R. A. (1995). Studies on bottom fauna in Lake Nasser, Egypt. Ph.D. Thesis. Fac. Sci, Suez Canal Univ, Egypt. 267pp.

Hann, B. J. (1995). Invertebrates as sociations with submersed aquatic plants in a prairie wetland. USF (Delta Marsh) Annual report, Vol. 30.

Hawkes, J. G. (1975). Practical problems in exploration. Vegatatively propagated Crops. In: O.H. Frankel and J.G. Cambridge Univ, press, Cambridg, pp. 117-121.

Hilsenhoff, W. L. (1975). Aquatic Insecta of Wisconsin.With generic keys and notes on biology, ecology and distribution. Tech. Bull. no. 89. Dept. Nat. Res., Mdison, Wisconsin, 55pp.

Ibrahim, A. M.; Bishai, H. M. andKhalil, M. T. (1999). Freshwater molluscs of Egypt. Publication of National Biodiversity Unit, EEAA, No.10.

Idown,E.O.andUgwumba, A. A.(2005).Physical, Chemical and Benthic faunal characteristics of a Southern Nigerian Reservoir . Zoologist 3:15-25.

Iskaros, J. A. (1988). Biological studies on bottom fauna in Lake Nasser and adjacent waters. M.Sc. Thesis, Fac. Sci, Alexandria Univ., 184 pp.

Iskaros, I. A. (1993): Ecological studies on the distribution of zooplankton and bottom fauna in Khor Kalabsha in lake Nasser. Ph.D. Thesis, Fac. Sci, Mansoura Uni., 304 pp.

Iskaros, I. A. and El-Dardir, M. (2010). Factors affecting the distribution and abundance of bottom fauna in Lake Nasser, Egypt. Nature and Science. 8:95-108.

Iskaros, I. A.; Gindy, N. N. and El. Dardir, M.(2011). Long-term fluctuations of macrobenthic invertebrates in Aswan Reservoir, Egypt. International Journal of Environmental Science and Engineering (IJESE). 1:37-48.

Iskaros, I. A. and El-Otify, A. M. (2013). Seasonal periodicity of plankton and benthic fauna community structure and diversity in a small North African reservoir. Water and Environmental Journal. 27:561-574.

Konstantinov, A. S. (1958). The effect of temperature on growth rate and development of chironomide. Dockl. Akad. Nauk. SSSR, 120: 1362-1365.

Latif, A. F. A. (1974). Fisheries of Lake Nasser. Aswan Regional. Planning, Lake Nasser. Development. Center, Aswan, 235pp.

Lewis, D. J. (1957). Observations on chironomid Khartoum. Bull. Ent. Res., 48:155-184.

Mageed, A. A. andHeikal, M. T. (2006). Factors affecting seasonal patterns in epilimnoion zooplankton community in one of the largest man-made lakes in Africa (Lake Nasser, Egypt). Limnologica, 36:91-97 .

Mason, W. T. (1973). An introduction of chironomid larvae. Analytical quality control Laboratory. Nat. Environ. Res. Center. U.S. Environmental protection Agency. Cincinanti, Ohio, 90pp.

Merritt, R.W.;Cummins, K.W.and Berg, M.B.(2008). An Introduction to the Aquatic Insects of North America, fourth ed. Kendall Hunt Publishing, Dubuque, Iowa, USA.

Mola, H.R.A. (2009). Ecological Studies on Planktonic and Epiphytic Microinvertebrates in Lake Nasser, Egypt (Ph.D. thesis). Facultyof Science, Banha University, Egypt.

Mola, H. R. A. and Abdel Gawad, S. S. A. (2014). Spatio- temporal variations of macrobenthic fauna in Lake Nasser khors, Egypt J. Aquat.Res, 40(4): 415-423.

Monakov, A. V. (1969). The zooplankton and zoobenthos of the White Nile and adjoining waters in the Republic of the Sudan. Acta. Hyd. 33(2): 161-185.

Moore, J.W. (2006). Animal ecosystem engineers in streams. Bioscience56, 237–246.

Payne, A. I. (1986). The ecology of tropical lakes and rivers. John Wiley and Sons. Chichester, New York. Toronto, Brisbane and Singapore, 300pp.

Pennak, R. R. W. (1953). Fresh water invertebrates of the United State. University of Colorado. The Ronald press company, New York, 769pp.

Pennak, R. R .W. (1978). Freshwater invertebrates of the United State. 2nd edition. John Wiley and sons. New York, 803pp.

Rzoska, J. (1976). Notes on the benthos of the Nile system. In: J. Rzoska (Ed.), The Nile Biology of an Ancient River. w. Junk, The Hague, 345-351.

Smith, S. E. andMancy, K. H. (1978). The assessment of surface, siltation and plant production of Lake Nasser Reservoir using Landsats Digital Imagery. In: Int. Symp. Environmental effects of Hydroulic Engineering works. Tennsse Valley Authority, Knoxville, Tenn., pp. 422-434.

Train, R. E. (1979). Quality criteria for water. Costal House publication LTD., London, 256pp.

Vanni, M.J. (2002). Nutrient cycling by animals in freshwater ecosystems.

Ann. Rev. Ecol. Syst. 33: 341–370.

Wirth, W. W. andStone, A. (1968). Aquatic Diptera,2nd edition. pp. 372-482. In: R.L. Usinger (Ed.), Aquatic Insecta of California. Univ. Calif. pr. Los Angeles.

Zaghloul, F. A. (1985). Seasonal variations of plankton in Lake Nasser. Ph.D. Thesis, Fac. Sci., Suze Canal Univ., 364pp.

ARABIC SUMMARY

دراسات بيئية على اللافقاريات الكبيرة فى قاع أربعة من الأخوار الشمالية لبحيره ناصر (مصر) من حيث التركيب النوعى والوفره و التنوع .

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تم دراسة التركيب النوع والوفرة والتنوع البيولوجى لعشائراللافقاريات القاعيه الكبيره والمتغيرات الفيزيائية والكيميائية الرئيسية للمياه والرواسب في اربعه من الاخوار الشماليه لبحيرة ناصر (الرملة، كلابشة، رحمة ووادي أبيض) لتقييم وضعها البيئي خلال عام 2015. سجلت الدراسه ستة وعشرون نوعًا من اللافقاريات القاعيه الكبيره التي تنتمي إلى كل من : الحشرات (15 نوعًا) ، والديدان قليله الاشواك (5 أنواع) ، والرخويات (5أنواع) و القشريات (نوع واحد) ، وكانت مجموعة الحشرات هي الأكثر شيوعًا. اكدت الدراسة أن القطاعات الواقعة في الاخوار الغربية (الرملة وكلابشة) أو الواقعة بالقرب من المجرى الرئيسي كانت اكثر وفره وغزاره فى عدد الانواع من اللافقاريات الكبيره عن تلك الموجودة في المنطقه الشرقية (رحمه ووادى ابيض) وهذا يرجع إلى طبيعة القاع من الرمال الطميية والمزودة ببقع من النباتات المائية. اظهرت الدراسه ان الكثافه العددية والكتله الحيويه من اللافقاريات الكبيره في المحطات الشاطئيه كان عالى خلال كل من فصل الشتاء (بمتوسط 3016 كائن / م^2,9.9.جم / م 2) و فصل الخريف (بمتوسط 2662 كائن / م 2 وكتله حيويه 19.5 جم / م ^{2}) وذلك عندما تتقلب درجة حرارة الماء بين 18.9 و 25.2 درجة مئوية . من ناحية أخرى وجد ان اللافقاريات الكبيره في المحطات البعيده عن الشاطىء سجلت انخفاضا عدديا طوال معظم أيام السنة بسبب عدم وجود البيئة المناسبة. كما وجد من خلال تطبيق معامل الارتباط ان الحشرات المائية والديدان قليله الاشواك والرخويات لها علاقه بدرجة حرارة الماء ، والمواد العضوية والأكسجين الذائب على التوالي.