Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN: 1110 - 6131 Vol. 21(1): 49- 62 (2017)
www.ejabf.js.iknito.com

Impact of physico-chemical parameters on composition and diversity of zooplankton community in Nozha hydrodrome, Alexandria, Egypt

Mona Hamed Ahmed[1]; Nadia N. B. Abd El-Hamed[2] and Naglaa I. Shalby[1]
1 - Central Lab for Aquaculture Research, Agricultural Research Center, Egypt.
2 - Labor University, Kafr El-Sheikh, Egypt.

ARTICLE INFO

Article History:
Received: Jan. 2017
Accepted: Feb. 2017
Available online: May. 2017

Keywords:
Nozha hydrodrome
Zooplankton
physico-chemical parameters
Shannon diversity index

ABSTRACT

This study was carried out in Nozha hydrodrome, Alexandria, to assess the impact of physico-chemical parameters upon zooplankton community structure and diversity during the period from December 2015 to November. 2016. The results indicated that there were significant monthly variations in physical and chemical characteristics, such as water temperature, pH, dissolved oxygen, total alkalinity, total hardness, nitrite, nitrate, total nitrogen,orthophosphate and total phosphorus. Zooplankton were represented by fifteen genera belong to four groups. Rotifera constituted the main dominant group contributing 82.59% of the total zooplankton, followed by Copepoda (12.33%), Cladocera (3.886%) and Ostracoda (1.22%). The highest density of zooplankton was recorded during January (mean 2504.5 org/ l), while the lowest was found in July (mean 44.25 org/l).The data pointed out that the most effective water variables on composition and distribution of zooplankton were water temperature, total alkalinity, total hardness, ammonia, nitrite, nitrate and total nitrogen. The low value of Shannon diversity index, high value of some water parameters and dominance of pollution tolerant forms of zooplankton revealed that the hydrodrome is suffering from organic pollution.

INTRODUCTION

Water is one of the most important available resources on the earth. It is vital to all forms of life. Water exist in lotic (rivers and streams) and lentic (ponds, marshes and lakes) habitats (Bhat *et al*., 2014; Raut and Shembekar, 2015). Nozha hydrodrome is an isolated part of Lake Mariut. It is enclosed nearly circular freshwater body. Since 1960, it is exploited as fish pond. It receives its fresh water from the Mahmoudia canal through a small feeder canal. In the last two decades, the hydrodrome received its water through several drains that discharge untreated domestic and agricultureal effluents into it (Moustafa *et al*., 2009; Rifaat and Ahdy, 2011).

On the other hand, zooplankton plays a vital role in food web of aquatic ecosystems by linking the primary producers and high trophic levels (Gupta *et al*., 2016).It is one of the most important biotic components influencing all the functional aspects of an aquatic ecosystem, such as food chains, energy flow and cycling of matters (Trivedi *et al*., 2015). Zooplankton is very sensitive and responds more quickly to environment alteration, nutrient enrichment and different levels of pollution, which lead to change in plankton communities in terms of tolerance, abundance, diversity and dominance in the habitat (Madhusudhana *et al*., 2014).

The distribution of zooplankton community depends on a complex of factors, such as change of climatic conditions, physical, chemical parameters of water, vegetation cover and biological interactions (Abdulwahab and Rabee, 2015). It is also useful for general monitoring of certain aspects of the environment as eutrophication, pollution, warming trends and long-term changes, which are sign of environmental disturbance (Al-Ghanim, 2012).

The abundance and species diversity of zooplankton are used to determine and evaluate the conditions of aquatic environment (Goswami and Mankodi, 2012). Hence, zooplankton serves as bioindicator and it is well tool for assessment the health of water bodies (Xiao *et al*., 2012).So, studies on zooplankton composition, physical and chemical characteristics of water are necessary to obtain complete knowledge on the quality of water (Rajagopal *et al*., 2010).

The present work aimed to study the impact of physical and chemical parameters on zooplankton population, composition and diversity in Nozha hydrodrome.

MATERIALS AND METHODS

Study area:

Nozha hydrodrome lies in the southern side of Alexandria city (latitude 31.193^o N, longitude 29.977^o E) and in the northeastern side of Lake Mariut (latitude 31.1^{o}E, longitude 30^o N) with a surface area of about 5.5 Km^2 and an average water depth 2.1m. It is a natural shallow freshwater wetland and it was used as fish culture with an average production of 200-250 t.y^{-1} (Fig.1).

Fig. 1: Location of Nozha hydrodrome with respect to the Mediterranean Sea and Lake Mariut.

Sampling:

Samples of water and zooplankton were collected monthly for one year from six sampling sites in Nozha hydrodrome, during the period from December 2015 to November 2016.

Physical and chemical parameters:

Water temperature (T) and dissolved oxygen (DO) were measured by oxygen meter (model YSI 55).Hydrogen ion concentration (pH) was detected using pH meter (model 301). All chemical parameters were determined according to APHA (2000).

Zooplankton:

Samples of zooplankton were collected from the selected sites by filtering 30 liters of surface water through a zooplankton net 55µm mesh diameter. The sediment samples were kept in plastic bottles with some water, and preserved in 7% formalin (APHA, 2000). The counts of zooplankton were performed using Sedgwick-Rafter cell under a binocular microscope and specimens were identified to genera levels. The main taxonomic references used for identification of zooplankton were Pennak (1953) and Edmondson (1966). Zooplankton density was expressed as number of organisms per litter. Shannon diversity index was calculated for analysis of species diversity.

Statistical analysis:

The variation in the water parameters and zooplankton in different months were assessed using one way analysis of variance (ANOVA). The correlation coefficient(r) was calculated for determining the type of relation between physico-chemical parameters and the dominant zooplankton, according to SPSS software (version 16)

RESULTS AND DISCUSSION

The data of physico-chemical parameters of different water samples from Nozha hydrodrome are presented in Table (1). The surface water temperature ranged between 18.32-31.01^{o}Cin January and June respectively, with a total mean of 25.23C^{o}. There was highly significant variations of its values during different months ($p<0.001$). The decrease or increase in water temperature depends mainly on the climatic conditions, sampling times, sun shine hours and it is also affected by specific characteristics of water environment such as turbidity, wind force, plant cover and humidity (Khalifa and Sabae, 2012).

Hydrogen ion concentration (pH) is the master control parameter in aquatic environment for the chemical and biological transformation of water. The pH values of water were in alkaline side at all sites, with significant monthly differences ($P<0.01$). However, the maximum value was recorded during December and January with mean values of 9.07 and 8.99 respectively, but the minimum one was in April with mean value of 7.64. High pH value appeared concomitantly with the reduction of available free CO_2, indicating active photosynthesis of freshwater phytoplankton (Wu *et al*., 2014).Whereas low pH value probably related to the decrease of phytoplankton density and the decomposition of organic matter, that leads to decrease in pH (Toufeek and Korium , 2015).

Dissolved oxygen values varied from a minimum mean of 4.67 mg/l in June to the highest mean of 6.88 mg/l in February. The elevation of water temperature and increase in oxidative of organic matter may be the reason in decrease of DO values in June (Khalifa and Bendary, 2016), or due to the effect of pollution by sewage and agricultural wastes discharged in the water. Increase of DO at low water temperature may be attributed to the high solubility of oxygen and the activities of wind (Mahmoud *et al.*, 2008) and the abundance of phytoplankton which enriched water with oxygen during photosynthesis (Rajagopal *et al*., 2010) or due to turbulence caused by boating activity. There was significant monthly variations in DO measurements ($p<0.01$) (Table 1).

Total alkalinity values increased during February and decreased in September, with a total mean of 820.7 mg/l. The high value during February may be related to shortage of water column and leaching bicarbonate from the soil to the water and presence of high amount of organic matter accessible to bacterial decomposition , where bicarbonate is the final product of the decomposition (Elewa *et al*., 2001) or due to growth of algae population, aquatic vegetation and photosynthetic activity which increase total alkalinity (Raina *et al*., 2013).While the decrease may be attributed to the elevation of temperature that led to increase of carbonic acid which enhanced precipitation of calcium in carbonate form (Mohamed, 2008).

Table 1: Monthly variations (means ± standard deviations) of some physico- chemical parameters of water samples collected from Nozha hydrodrome.

Para.	Months												Total mean	F value
	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.		
T (C°)	20.77	18.32	19.31	29.34	30.38	29.78	31.01	30.28	30.65	21.09	20.86	20.97	25.23	73.9***
	± 4.32	±2.24	± 0.65	± 0.66	±0.73	± 0.53	± 0.31	±0.64	± 0.37	± 0.67	± 0.76	± 0.62	± 5.30	
pH	9.07	8.99	8.94	7.80	7.64	7.84	8.08	8.09	8.22	8.32	8.27	8.22	8.29	2.882**
	± 0.54	± 0.58	± 0.39	± 0.64	± 0.56	± 0.70	± 0.84	± 0.71	± 0.64	± 0.88	± 0.84	± 0.74	± 0.78	
DO (mg/l)	6.72	6.80	6.88	6.30	6.35	6.33	4.67	5.17	5.04	6.42	6.54	6.48	6.14	2.63**
	±1.45	±1.50	±1.42	± 0.89	± 0.95	± 0.92	± 0.62	±0.33	± 0.53	±1.35	±1032	±1.33	±1.26	
T.alk (mg/l)	1037.1	957.3	1045.2	969.6	949.8	962.5	659.6	730.6	695.1	573.4	653.9	613.8	820.7	1.94
	±3.67	±4.39	+3.23	± 2.89	±2.61	± 2.66	± 3.13	±2.72	±2.89	±2.35	±3.81	±3.02	±3.39	
T. H (mg/l)	659.2	627.8	643.3	1067.5	1067.8	1070	1279.5	1327.3	1305	782.5	814	810.6	954.٥	3.82***
	±3.33	± 3.53	± 3.41	± 1.42	± 1.45	± 1.36	±2.89	± 3.07	± 2.91	±4.22	± 5.15	± 4.46	±3.97	
NO_3 (mg/l)	0.407	0.447	0.431	0.366	0.307	0.344	.0.361	0.387	0.382	0.385	0.406	0.396	0.385	0.51
	±0.164	± 0.15	± 0.151	± 0.11	± 0.12	± 0.108	±0.104	± 0.16	0.145	± 0.09	±0.14	± 0.07	±0.12	
NO_2 (mg/l)	0.094	0.112	0.103	0.040	0.036	0.037	0.0753	0.0682	0.073	0.041	0.082	0.039	0.06٧	2.13*
	±0.049	± 0.63	±0.054	±0.003	± 0.01	± 0.005	±0.05	± 0.04	+ 0.041	0.014	±0.11	± 0.01	±0.05	
NH_4 (mg/l)	1.743	1.913	1.825	2.612	3.103	2.844	1.180	1.158	1.166	0.702	0.750	0.722	1.643	18.9***
	±0.62	± 0.43	± 0.49	± 0.82	± 0.56	± 0.563	±0.33	± 0.44	±0.37	± 0.15	± 0.29	± 0.19	±0.92	
T.N (mg/l)	3.488	3.538	3.513	3.068	2.903	2.983	4.112	3.908	4.010	4.807	4.612	4.788	3.811	6.05***
	±0.55	± 0.77	± 0.638	± 0.64	± 0.73	± 0.68	±0.84	± 0.89	± 0.86	± 0.49	± 0.38	0.36	±0.90	
O.P (mg/l)	0.150	0.180	0.165	0.102	0.104	0.103	0.080	0.089	0.084	0.096	0.240	0.099	0.124	1.31
	±0.034	± 0.03	± 0.027	±0.063	± 0.06	± 0.062	±0.029	±0.025	±0.027	±0.045	± 0.33	± 0.05	±0.11	
T.P (mg/l)	0.400	0.421	0.410	0.255	0.255	0.254	0.321	0.336	0.326	0.291	0.309	0.300	0.323	4.01**
	±0.113	±0.117	±0.114	± 0.06	±0.056	±0.059	±0.053	±0.052	±0.051	± 0.04	±0.045	±0.042	±0.09	

*** P ≤ 0.05 ** P ≤ 0.01 *** P ≤ 0.001**

There was significant variation in total hardness concentration (P<0.001). The maximum value was recorded during July and the minimum was found in January with a total mean of 954.5 mg/l. The high value of hardness during July may be mainly due to high rates of evaporation, which lead to increase of concentration of dissolved minerals (Krishnamoorthi *et al*., 2011). Sometimes decomposed materials such as vegetation and algae accelerate the total hardness (Raina *et al*., 2013). The relative low value in January may be attributed to the carbonic acid decrease, leading to precipitation of $CaCO_3$. This coincided with results of Ali (2007), who reported that the decrease of hardness may be due to the higher photosynthetic activity, which caused the release of carboxyl group that help in binding Ca with the carbonate group to form $CaCO_3$.

Nitrate controls the whole aquatic system and also indicates the trophic level of the water body. Nitrate values ranged between 0.307 and 0.447 mg/l, while nitrites were 0.036 and 0.112 mg/l during April and January, respectively. The highest and the lowest total nitrogen values were observed in September (4.807mg/l) and April (2.903mg/l). There were significant monthly variations in nitrite and total nitrogen measurements ($p<0.05$, 0.001). The decrease of the nutrient concentration may be due to their fast absorption by the phytoplankton or their settlement in the sediment (El-Otify, 2015). But the increase may be attributed to low number of phytoplankton and aquatic plants (Abd El-Hamed, 2014) or may be related to sewage effluents which originated from domestic and agricultural wastes.

Ammonia concentrations increased in April with a mean value of 3.103 mg/l. This may be due to break down nitrogenous organic and inorganic matter in water, especially at high temperature and reduction of the nitrogen compounds by micro-organisms, as well as the metabolic activity of fish and other aquatic organisms (Chapman, 1992), also due to municipal waste water which enter the Nozha hydrodrome. While the lowest level of ammonia in September (0.702 mg/l) may be as the result of oxidation of ammonia into NO_2 then NO_3 (Abdo, 1998). There was highly significant monthly variation in ammonia ($p<0.001$).

Orthophosphate values varied from 0.080 to 0.24 mg/l during July and October respectively. While the maximum value of total phosphorus was recorded in January (0.421 mg/l), and the minimum in May (0.254 mg/l). There were significant monthly variations in total phosphorus measurement ($p<0.01$). The increase of phosphorus compound was coinciding with rapid decrease in phytoplankton and hydrophytes, but the decrease attributed to their biomass increase (Abd El-Hamed, 2009). Moreover, the increase may be due to agricultural runoff containing phosphate fertilizers as well as waste water (domestic) containing detergents. According to the standards stipulated by USEPA (2000) total phosphorus levels in oligotrophic, mesotrophic and eutrophic water bodies are 0.012, 0.012-0.024 and > 0.024 mg/l respectively. The present study had a total phosphorus level above 0.024 mg/l and therefore Nozha hydrodrome water can be classified as eutrophic ecosystem.

The data indicated that zooplankton in Nozha hydrodrome is represented by fifteen genera belong to four groups: Rotifera, Copepoda, Cladocera and Ostracoda, forming 82.59%, 12.33 %, 3.86 % and 1.22 % of the total zooplankton population, respectively (Fig.2). The lowest density of zooplankton was recorded during July (44.25 org/l), while the highest was in January (2504.5 org/l) (Table 2). This may be due to high nutrients, favorable temperature and DO conditions. Similar results have been reported by Bhat *et al*. (2014), that may be attributed to high pH. When pH range is between 6.0 and 8.5, this indicates medium productive, more than 8.5 highly productive and less than 6.0 low productive nature of water (Sulehria *et al*., 2013).

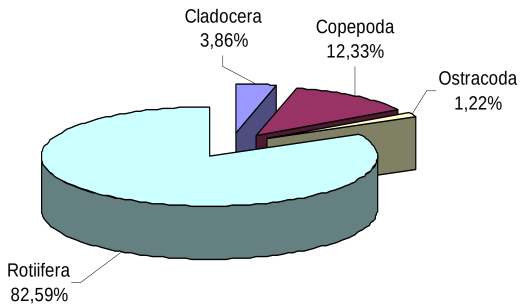

Fig. 2: Community composition of total zooplankton in Nozha hydrodrome.

Rotifera constituted the most dominant group. This is in conformity with the findings of Al-Ghanim (2012), Na *et al*. (2014), Raut and Shembekar (2015), Abdel Mola and Ahmed (2015) and Khalifa and Bendary (2016) in fresh waters as rivers, lakes and ponds. The dominance of Rotifera was explained to be due to their reproductive success ,predation pressure from planktivorous fishes that selectively prey on larger sized zooplankton and short developmental rates under favourable conditions in most fresh water systems (Imoobe and Adeyinka, 2009), or may be related to high dispersal ability. Rotifera distribution followed the same trends observed for total zooplankton with a mean of 2645.6 org/l (Table 2). The low Rotifera population that has been recorded during July may be attributed to higher predation rates (Crispim *et al.*, 2013), while the increase during January may be due to high trophic level of the water and low level of water (Singh *et al*., 2002). Fiorenza *et al*. (2003) reported that the increase in the number of Rotifera taxa may be indicative of a shift in the trophic condition.This eutrophication affects zooplankton composition, shifting the dominance from larger species to smaller ones (Rotifera) (El-Shabrawy, 2000).

Table 2: Monthly variations of zooplankton groups (org/l) in water samples collected from Nozha hydrodrome.

Group	Months												Mean
	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	
Rotif.	1205	8354	4497	1517	1006	342	264	85	373	7407	4204	2493	2645. 6
Cope.	54	1392	313	643	186	125	147	69	310	843	423	235	395
Clad.	44	272	46	88	17	38	64	23	117	555	175	43	123.5
Ostra.	0	0	224	73	0	21	3	0	145	2	0	0	39
Mean	325.75	2504.5	1270	580.25	302.25	131.5	119.5	44.25	236.25	2201.75	1200.5	692.75	800.77
Shann. index	1.073	1.269	1.051	1.443	1.051	1.124	1.255	0.928	1.175	1.338	1.302	1.367	1.198

Rotif: Rotifera Cope: Copepoda Clad: Cladocera Ostra.: Ostracoda Shann.index: Shannon diversity index

Rotifera was represented by *Brachionus* sp. (60.1%), *Keratella* sp. (27.75%), *Filinia* sp. (7.5%), *Platyias* sp. (2.45%), *Hexarthra* sp. (0.665%), *Polyarthra* sp. (0.59%), *Lecane* sp. (0.495%) and *Notholca* sp. (0.45%) (Table 3). Presence of *Brachionus* sp. forming 49.64 % of the total zooplankton population, which was the most common Rotifera in Nozha hydrodrome pointed that the hydrodrome is approaching toward eutrophication and is organically polluted. This is agreement with Saad *et al.* (2013), Elfeky and Sayed (2014) and Abdel Mola and Ahmed (2015). Parveen and Abdel Mola (2013) found that the presence of *Brachionus* sp. with high number indicating eutrophication in the water body and this genus has the ability to tolerate pollution. It is also good indicator of water quality and can be used for the ecological monitoring of water bodies (Bhat *et al.*, 2013). *Keratella* sp. and *Filinia* sp. are common rotifers with a wide range of tolerance to different physico-chemical conditions (Bhat *et al.*, 2014; Elfeky and Sayed, 2014), and they are considered as good indicators of eutrophication and pollution (El-Bassat, 1995). Rotifera species have the ability to resist some degree of eutrophication and some kind of pollution, so classified as bioindicators of water quality (El-Shabrawy and Khalifa, 2002).

Copepoda species formed the second most abundant group of zooplankton. They increased during January (1392 org/l) and decreased in December (54 org/l) and July (69 org/l), respectively. This may be due to the effect of pollution in hydrodrome, where El-Serafy *et al*. (2009) mentioned that Copepoda was the most dominant group in lake Nasser, Egypt which attributed to good environment condition of the lake. Bhanja *et al*. (2014) reported that presence of copepods indicating that water quality is good. *Nauplii* larvae were always higher than the densities of total Copepoda stages (Zakaria *et al.*, 2007), this may be attributed to wide tolerance to variety of environmental factors as well as predation intensity to adult forms (Sampaio *et al*., 2002; Abdulwahab and Rabee, 2015).

Cladocera species formed the third common zooplankton group. They increased during September and decreased in April and July, respectively, with a mean value of 123.5 org/l (Table 2). This may be explained as the grazing impact of planktivorous fishes (Basima *et al*., 2006), where Cladocera comprised the food of adults of many fish species .The maximum abundance of Cladocera during September may be due to the presence of extensive banks of macrophytes, which allow a greater heterogenecity of the environment, and results in the availability of more niches (Gauravi and Rana, 2003). Cladocera was represented by *Diaphanosoma* sp. (41.5%), *Moina* sp. (28.07%), *Ceriodaphnia* sp. (21.25%) and *Bosmina* sp. (9.18%) (Table3). The presence of *Diaphanosoma* sp. and *Bosmina* sp. is usually associated with eutrophic environment (Raina *et al*., 2013). Also, Padmanabhe and Belaghi (2008) and Saad *et al*. (2013) reported that *Moina* sp. and *Bosmina* sp. were pollution tolerant species and indicated high level of organic pollution as a result of high organic load.

Table3: Standing crop (org/l) and percentages frequency of the recorded zooplankton groups and their species in Nozha hydrodrome.

Taxa	Total org/l	% of total group	% of total zooplankton
Rotifera	**31747**	**---**	**82.59**
***Brachionus* sp.**	**19081**	**60.10%**	**49.64%**
***Keratella* sp.**	**8811**	**27.75%**	**22.92%**
***Lecan* sp.**	**157**	**0.495%**	**0.408%**
***Notholca* sp.**	**143**	**0.45%**	**0.372%**
***Polyarthra* sp.**	**187**	**0.59%**	**0.487%**
***Hexarthra* sp.**	**211**	**0.665%**	**0.549%**
***Filinia* sp.**	**2380**	**7.50%**	**6.192%**
***Platyias* sp.**	**777**	**2.45%**	**2.022%**
Copepoda	**4740**	**---**	**12.33%**
***Cyclosp* sp.**	**2227**	**46.98%**	**5.79%**
***Nauplii* larvae**	**2513**	**53.02%**	**6.54%**
Cladocera	**1482**	**---**	**3.86%**
***Diaphanosoma* sp.**	**615**	**41.50%**	**1.60%**
***Moina* sp.**	**416**	**28.07%**	**1.10%**
***Bosmina* sp.**	**136**	**9.18%**	**0.35%**
***Ceriodaphnia* sp.**	**315**	**21.25%**	**0.81%**
Ostracoda	**468**	**---**	**1.22%**
***Ostracoda* sp.**	**468**	**100%**	**1.22%**
Total	**38437**	**100%**	**100%**

Ostracoda was represented by one genus; its number increased during February (224 org/l) then decreased in number and disappeared during most of months. In the present study, they contributed least density in total zooplankton because they are benthic in nature, but become planktonic when water disturbs which brings them to surface (Ahmed *et al.*, 2012).

Many zooplankton species disappear with eutrophication are mainly due to toxins produced by algal blooms especially by cyanabacteria blooms and also clogging of their filter feeding apparatus by algal cells (Sangakkara and Wijeyaratne, 2015).

This may be attributed to the presence of less number of species of zooplankton in the hydrodrome, which is eutrophic.

In Nozha hydrodrome, Shannon diversity index ranged from 0.928 to 1.443 in July and March respectively, with a mean value of 1.198 (Table 2). The low values indicate to low diversity of species and population of zooplankton. Diversity indices are good indicators of pollution in aquatic ecosystems (Mason, 1998).The relation between diversity index and pollution status of aquatic ecosystem are classified as follows: > 3=clean water,1-3=moderately polluted, < 1=heavily polluted. (William *et al*., 2002). The results indicated that Nozha hydrodrome is moderately polluted and eutrophic, according to diversity index and the standards stipulated by USEPA (2000).

Statistical analysis:

From the correlation coefficient of physico-chemical parameters (Table 4), it was found that pH had positive correlation (p<0.01, 0.05) with dissolved oxygen, total alkalinity and total phosphorus (r=0. 431, 0.449 and 0. 29). This indicates that pH affects the solubility and availability of most nutrients, and how they can be utilized by aquatic organisms (Osman and Werner, 2010).

Table 4: Pearson correlation coefficient (r-value) between water parameters in Nozha hydrodrome.

	pH	T	DO	T.alk	T.H	NO_2	NO_3	NH_4	T.N	O.P	T.P
pH	1	-.477**	.431**	.449**	.118	.041	-.202	-.284*	-.050	.014	.290*
T		1	-.423**	-.043	.562**	-.243*	-.202	.325**	-.265*	-.304**	-.396**
DO			1	.621**	.148	-.297*	-.292*	-.027	-.097	.021	.363**
T.alk				1	.437**	-.322**	-.450**	.351**	-.623**	-.095	.295*
T.H					1	-.524**	-.460**	-.052	-.212	-.278*	-.037
NO_2						1	.434**	-.005	.199	.063	.056
NO_3							1	-.029	.333**	.365**	.058
NH_4								1	-.736**	-.050	-.254*
T.N									1	.131	.123
O.P										1	.218
T.P											1

*** P ≤ 0.05 ** P ≤ 0.01 *** P ≤ 0.001**

While water temperature was high positively with total hardness and ammonia (r=0.562 and 0.325), where high temperature lead to increase in the rate of ammonification process that converting the organic matter to ammonia (Abd El-Hamed, 2009), and it increases the concentration of minerals in water. Moreover, nitrate had positive correlation (p<0.01) with nitrite, total nitrogen and orthophosphate. These results agree with those observed by Abubakar and Abdullahi (2015). Total alkalinity with ammonia, total hardness and total phosphorus had positive correlation (r = 0.351, 0.437and 0.295). These results are in accordance with the study of Abd El-Hamed (2014).

A negative correlation was observed between water temperature and dissolved oxygen (where temperature plays important role in the solubility of oxygen), pH, nitrite, total nitrogen, orthophosphate at p<0.01 and 0.05. These are coincided with results of Ahmed *et al.* (2012), Sulehria *et al.* (2013) and Toufeek and Korium (2015).While nitrate and nitrite had negative relation (p<0.05, 0.01) (Table 4) with dissolved oxygen, total alkalinity and total hardness. Similar observation was previously obtained by Abd El-Hamed (2014). Ammonia had negative correlation with pH, total phosphorus and total nitrogen (r = -0.284, -0.254 and -0.736), and this agrees with Mohamed (2005).

The variation of zooplankton and their monthly abundance are greatly related to water parameters. The correlation between different zooplankton groups and physico-chemical parameters are shown in Table (5). Pearson correlation analysis indicated that Rotifera population had negative relation ($p< 0.01, 0.05$) with water temperature (most Rotifer species prefer cold water) (El-Bassat, 1995 and Aboul Ezz *et al*., 2014), total hardness and total alkalinity (r= -0.323, -0.481 and – 0.269), but the positive relations were found with nitrate and nitrite (r= 0.281 and 0.383). Similar correlations were recorded by Abdel Mola and Abd El-Rashid (2012), Khanam *et al.* (2014), Menghong *et al.* (2014) and Sangakkara and Wijeyaratne (2015).

Table 5: Pearson correlation coefficient (r-value) between water parameters and zooplankton groups in Nozha hydrodrome.

	Rotifera	Copepoda	Cladocera	Ostracoda
pH	**-.061**	**.041**	**.166**	**.067**
T	**-.323****	**-.254***	**-.361***	**.015**
DO	**.040**	**.115**	**.138**	**-.077**
T.alk	**-.269***	**-.140**	**-.305***	**.091**
T.H	**-.481****	**-.266***	**-.076**	**-.039**
NO_3	**.281***	**.175**	**.119**	**.050**
NO_2	**.383****	**.146**	**.015**	**.105**
NH_4	**-.084**	**-.024**	**-.236***	**.121**
T.N	**.218**	**.075**	**.242***	**-.082**
O.P	**-.051**	**.020**	**-.025**	**.017**
T.P	**.044**	**.088**	**.136**	**-.003**

*** $P \leq 0.05$ ** $P \leq 0.01$ *** $P \leq 0.001$**

While Copepoda correlated negatively ($p<0.05$) with water temperature and total hardness. This agrees with the study of Parveen and Abdel Mola (2013). Moreover, Cladocera had negative correlation with water temperature,total alkalinity and ammonia (r=-0.361, -0.305 and -0.236), and had positive relation with total nitrogen ($p<0.05$, r= 0.242). This is in conformity with the study of Dvurechenskaya and Yermolaeva (2014) and Menghong *et al*. (2014).

Pearson correlation coefficient indicated that several environmental variables influence the zooplankton abundance and distribution, in particular water temperature, total alkalinity, total hardness, ammonia, total nitrogen, nitrite and nitrate. Similar observation was previously obtained by Bhanja *et al*. (2014) Abdel Mola and Ahmed (2015) Abdulwahab and Rabee (2015), and Abdul *et al*. (2016).

CONCLUSION

The results have been pointed to low zooplankton population throughout the study period, rotifers formed dominance group over the other groups and presence *Brachionus* sp, *Keratella* sp., *Moina* sp., *Bosmina* sp. and others which indicated to eutrophic environment and organic pollution. According to Shannon diversity index and USEPA (2000), the present study revealed that the Nozha hydrodrome is eutrophic and suffer from slight sign of pollution due to direct contamination from sewage, agricultural and industrial effluents from surrounded area. So, these pollutants must be treated before discharging into the hydrodrome. The present study also recommends that zooplankton can be used as indicators and complementary techniques in assessing health status of water bodies with physico-chemical parameters.

REFRENCES

Abd EI-Hamed, N.N.B. (2014). Environmental Studies of Water Quality and Its Effect on Fish of Some Farms in Sharkia and Kafr EL-Sheikh Governorates Ph.D.Thesis, Inst Env. Stud. & Res., Ain Shams. Univ.

Abd El-Hamed, N.N.B. (2009). Impact of Industrial and Agricultural Wastes in El-Gharbia Main Drain Using some Bioindicators. M.Sc. Thesis, Inst. Env. Stud. & Res., Ain Shams. Univ.

Abdel Mola, H.A. and Abd El-Rashid, M. (2012).Effect of drains on the distribution of zooplankton at the southeastern part of lake Manzala, Egypt. Egypt J. Aquat. Biol.& Fish., 16(4):57-68.

Abdel Mola, H.R and Ahmed, N.A.N (2015).Zooplankton community structure and diversity relation to environmental variables in the River Nile from Helwanto EL-Qanater EL-Khayria, Egypt. International J. Environ.,4(2):140-150.

Abdo, M.H. (1998). Some Environmental Studies on the River Nile and Ismailia Canal in Front of the Industrial Area of Shoubra EL-Khemia .M.Sc. Thesis, Fac. Sci., Ain Shams Univ.

Abdul, W.O.;Adekoya, E.O.; Ademola, K.O.; Omoniyi, I.T.; Odulate, D.O.; Akindokun, T.E. and Olajhde, A.E. (2016).The effect of environmental parameters on zooplankton assemblages in tropical coastal estuary, south- west Nigeria. Egyptian Journal of Aquatic Research, 5:1-7.

Abdulwahab, S. and Rabee, A.M. (2015).Ecological factors affecting the distribution of the zooplankton community in the Tigris River at Baghdad region, Iraq. Egyptian Journal of Aquatic Research, 41:187-196

AboulEzz, S.M.; Abdel Aziz, N.E.; Abou Zaid, M.M.; El Raey, M. and Abo-Taleb,H.A.(2014).Environmental assessment of El-Mex Bay, southeastern Mediterranean by using Rotifera as a plankton bio-indicator. Egyptian Journal of Aquatic Research, 40(43):43-57.

Abubakar, A. and Abdullahi, B.A. (2015).Zooplankton as bioindicators of water quality in Jakara Dam, Kano state, Nigeria. Bayero Journal of Pure and Applied Sciences, 8(2):156-165.

Ahmed, U.; Parveen, S.; Abdel Mola, H.R.; Kabir, H.A.and Ganai, A.H. (2012). Zooplankton population in relation to physico- chemical parameters of Lal Diggi pond in Aligarh, India .J. Environ. Biol., 33:1015-1019.

Al-Ghanim, K.A. (2012). Spatio-temporal distribution and composition of zooplankton in Wadi Hanifan Stream Riyadh (Saudi Arabia) and Abu Zabaal lakes (Egypt).Pakistan. J. Zool., 44(3):727-736.

Ali, N.A.(2007).Ecological Study on Some Water Characteristics Used in Fish Farms and Their Relations to Fish Productivity. Ph.D.Thesis, Fac. Sci., AI-Azhar Univ.

American Public Health Association (APHA)(2000). Standard methods for the examination of water and wastewater 16th ed., Washington, D.C.

Basima, L.B.; Senzanje, A.; Marshal, B. and Shick, K.(2006). Impact of land and water use on the plankton diversity and water quality in small man made reservoirs in the Limpop basin Zimbabwe: A preliminary investigation .Phys. Chem. Earth, 31:821-831.

Bhanja, D.; Ghosh, J.; Basu, A.; kundu, G; Ghosh, P. and Roy S.(2014). Dynamics of plankton community in two adjacent unmanaged ponds of west Bengal. India. Bioscience Discovery, 5(2):241-247.

Bhat, N.A.; Raina, R. and Wanganeo, A. (2013). Occurrence and spatial distribution of *Brachionus* species: bioindicator of eutrophication in Bhojwetl and, Bhopal. Angewandten Biologie Forschung, 1(5): 21-28

Bhat, N .A.;Wanganeo, A. and Raina, R. (2014). Spatio-temporal variation of the zooplankton community in a tropical wet land (Bhoj wet land) Bhopal, India. Journal of Ecology and the Natural Environment, 6(8):252-270

Chapman, D. (1992). Water quality assessments a guide to the use of biota, sediments and water in environmental monitoring. London. (ed) Chanpman & Hall on behalf of UNESCO, WHO and UNEP, pp 1-60.

Crispim, M.C.; Aroujo, K.P.P. and Junior, H.D.(2013). Environmental impact analysis of aquaculture in net cages in a Brazilian water reservoir, based in zooplankton communities .African J. Biotechnology, 12(17):2234-2248.

Dvurechenskaya, S.Y. and Yermolaeva, N.I. (2014).Interrelations between chemical composition of water and characteristics of zooplankton in the Novosibirsk Reservoir. Contemporary Problems of Ecology,7(4):465-473.

Edmondson, W.T. (1966). Rotifera in Edmondson, W.T (Ed.), Freshwater Biology, 2nded., John Wiley & Sons ,Inc. ,New York ,N Y and London , 14 pp.

El-Bassat, R.A. (1995).Ecology Studies of Zooplankton on the River Nile. M.Sc. Thesis, Faculty of Science Suez Canal Univ.

Elewa, A.A.; Shehata, M.B. and Abdo, M.H. (2001).Effect of thermal pollution of Shobra El-Kheima eclectic station on the River Nile water quality. The Second International Conference and Exhibition for Life and Environment.3-5 April, 2001.

Elfeky, F.A.and Sayed, N.K.(2014).Distribution and Abundance of rotifers in the River Nile, Egypt. World Journal of Fish and Marine Sciences, 6 (6):557-563.

El-Otify, A.M. (2015).Evaluation of the physicochemical and chlorophyll-a conditions of a subtropical aquaculture in lake Nasser area, Egypt. University Journal of Basic and Applied Sciences, 4:327-337.

El-Serafy, S.S.; Mageed, A.A and El-Enany, H.R. (2009).Impact of flood water on the distribution of zooplankton in the main channel of lake Nasser, Egypt. J. Egypt .Acad .Soc. Environ. Develop.,10: 121-141.

El-Shabrawy, G.M. and Khalifa, N. (2002).Zooplankton abundance and community structure in the northern part and estuary of Rosetta Nile branch in relation to some environmental variables .Egypt. J. Aquat. Bio. Fish., 6(4):69-90.

El-Shabrawy, G.M.(2000).Seasonal and spatial variation in zooplankton structure in the lake Nasser. II-costal area of the main channel and main Khors .J. Egypt. Acad. Soc. Environ. Develop., 1:19-44.

Fiorenza, G.M.; Marcello, B.; Ornella, F.; Lucian, M.M.S. and Daria, V. (2003).Classification of the ecological status of volcanic lakes in central Italy .Paper from Bolsena Conference (2002). Residence tine in lakes: Science, Management, Education J. Limnol., 62 (1):49-59.

Gauravi, Y.P .and Rana, K.S.(2003).Population dynamics of rotifers fauna at Fatehpursikri pond. Agra. Poll. Res., 22(4):541-542

Goswami, A.P. and Mankodi P.C. (2012). Study on zooplankton of fresh water reservoir Nyari-II Rajkot district, Gujarat, India. ISC Journal of Biological Science, 1(1):30-34

Gupta, M.; Kumar, P; Mishra, U.K. and Kumar, D. (2016). Planktonic diversity and density in Keerat Sugar pond at Mahoba District of Ultar Pradesh, India.International Journal of Innovative Research and Development, 5(7):181-186

Imoobe, T.O.T. and Adeyinka, M.L. (2009). Zooplankton based assessment of the trophic state of a tropical forest river .Arch. Biol. Sci., Belgrad, 61(41):7333-740

Khalifa, N.and Bendary, R.E. (2016). Composition and biodiversity of zooplankton and macrobenthic population in El-Rayah El-Menoufy, Egypt .International Journal of Applied Environmental Sciences., 11(2):683-700

Khalifa, N. and Sabae, S.Z. (2012).Investigation on Mutual relations between bacteria and zooplankton in Damietta branch, River Nile, Egypt. Journal of Applied Sciences Research, 8(5):2679-2688.

Khanam, M.R.M.; Naser, M.N. and Ali, M.S (2014).Population dynamics of Planktonic Rotifers in the southern coastal area of Bangladesh. International Journal of Natural and Social Sciences, 1(2): 53-60

Krishnamoorthi, A.; SemthilElango, P. and Selvakumar, P. (2011).Investigation of water quality parameters for aquaculture –a case study of Veeranam Lake in Cuddalore district.Tamilnadu. Int. J. Curr. Res., 33(3):13-17

Madhusudhana, R.k.; Krishna, P.V.; Jyothirmayi, V.and Hemanth, K.V. (2014). Biodiversity of zooplankton communities in a Perennial pond at lake Kolleru region of Andhra Pradesh, India. International Journal of Advanced Research, 2(7):33-41

Mahmoud, S.A.; Tayel, S.I. and Yacoub, A.M. (2008). Histopathological changes in kidneys of the Fish *Tilapia zillii* and *Clarias gariepinus* under the effect of several pollutants along the River Nile. J. of the Egyptian German Society of Zoology, 56(c):219-246.

Mason, C.F. (1998). Biology of fresh water pollution. Longman Scientific and Technical.New York

Menghong, H.; Lili, Y. and Qigen, L. (2014). Do physicochemical variables regulate the distribution of zooplankton communities in reservoirs by filter- feeding Carp? Chinese Journal of Oceanology and Limnology, 32(2):266-277.

Mohamed, H.H. (2008).Assessment of some water quality characteristics and determination of some heavy metals in lake Manzala, Egypt, J.Aquat. Biol. and Fish, 12:133-154.

Mohamed, M.A.E. (2005). Impact the Disposal of Wastes from Drinking Water Treatment Plants of the River Nile Ecosystem, M.Sc. Thesis, Inst. Env. Stud. & Res., Ain shams Univ.

Moustafa, M.; Abd-Elazeem, W. and Yousef, B. (2009).Wastewater pollution control in EL-Kalaa drain, Alexandria Governorate. 13th International Water Technology Conference, IWTC, Hurghada, Egypt, pp 941-950

Na, Y.; Erchao, L.; Dexiang, F.;Baicia,X.; Chaoqun W.; Meiling, Z. and Liqiao,C.(2014).Correlations between zooplankton assemblages and environmental factors in the downtown rivers of Shanghai, China. Chinese Journal of Oceanology and Limnology, 32(6):1352-1363.

Osman, A.G.M. and Werner, K. (2010). Water quality and heavy metal monitoring in water, sediment and tissues of the African Catfish (*Clarias gariepinus*) from the River Nile, Egypt. J. Environ. Prote., 1(4):389-400

Padmanabha, B. and Belaghi, S.L. (2008). Ostracods as indicators of pollution in lake Mysore.J.Environ, Biol., 29(3):415-418.

Parveen, S. and Abdel Mola, H. (2013). Comparison of physic-chemical parameters and zooplankton diversity in two Perennial ponds at Aligarh, India, Journal of

Environmental Biology, 34:709-716

Pennak, R. W. (1953). Freshwater inverbrates of the United States. The Ronald press CO., New York, New York

Raina, R.; Kumar, P.; Sonaullah, F. and Wanganeo, A. (2013).Limnological study on a Smart AshokSagar with special reference to zooplankton population. International Journal of Biodiversity and Conservation, 5(6):317-332

Rajagopal, T.; Thangamani, A. and Archunan, G.(2010). Comparison of physico-chemical parameters and phytoplankton species diversity of two Perennial ponds in Sattur area, Tamil Nadu. J. Enivron. Biol., 31:787-794.

Raut, K.S .and Shembekar, V.S. (2015).Manipulation of zooplankton as bio-indicators of water quality at Borna (Chandapur) Dam near Parli. V. Dist .Beed Maharashtra, India. Indian Journal of Applied Research, 5(8):587-592

Rifaat, A. and Ahdy, H.H. (2011). Temporal changes in the concentration of zinc and cadmium in the sedimentary strata of Nozha Hydrdrome, Alex. Egypt.Oceanlogia, 53(4):993-1004

Saad, A. H.; Emam, W.M.; EL-Shabrawy, G.M. and Gowedar, F.M. (2013).Sewage pollution and zooplankton assemblages along the Resetta Nile branch at El Rahway area, Egypt .International Journal of Environmental Sciences and Engineering, 4:29-45

Sampaio, E.V.; Rocha, O.; Matsumura-Tundisi, T. and Tundisisio, J.G. (2002).Composition and abundance of zooplankton to in the limnetic zone of seven reservoirs of the Paranapanema River .Brazil. Braz. J. Biol., 62:525-545

Sangakkara, S.M.A. and Wijeyaratne, M.J.S. (2015).Community structure of zooplankton and trophic status of some inland reservoirs in the low country intermediate zone of Sri Lanka. Sri Lanka J. Aquat. Sci., 20(2):59-74.

Singh, Sp; Pathak, D.and Singh,R.(2002). Hydrobiological studies of two ponds of Satna (M.P) India.Ecol.Environ.Conserv.,8:289-292.

Sulehria, A.Q.K; Ejaz, M.; Mushtaq, R.and Saleem, S. (2013). Analysis of Planktonic Rotifers by Shannon- Weaver index in Muraliwala (Dist. Gujranwala). Pakistan Journal of Science, 65(1):15-19.

Toufeek, M.E.F. and Korium, M.A.(2015).Impact of physicochemical characteristics of some Khors of lake Nasser, Egypt. Current Science International, 4(3):342.350

Trivedi, S.; Siddiquw, A.A. and Rawat, R. (2015).Studies of zooplankton ecology in TriveniSangam, Kshipra River Ujjain (M.P). Int. J. Pharmacol. Bio. Sci., 9(3):49-54.

United States Environmental Protection Agency (USEPA) (2000). Nutrient criteria-technical guidance manual: lakes and reservoirs. First Edition, United States Environmental Protection Agency, Washington, Dc.P.232.

William, E.S.; William, G.K. and Anthomy, R.B.(2002).Biotic Index Guide.Pennsylvania State University.

Wu, Z. ; He, H.; Cai, Y.; Zhang, L. and Chen, Y. (2014). Spatial distribution of chlorophyll a and its relationship with the environment during summer in Lake Poyang: a Yangtze – connected lake. Hydrobiologia, 732:61-70.

Xiao, B. ; Sun, L. ; Feng, D.; Yu, N. and Chen, L. (2012). Meta-zooplankton community structure and its relationship with environmental factors in Wenruitating River. Journal of Hydroecology, 33(4):14-20.A

Zakaria, H.Y.; Radwan, A. A. and Said, M.A. (2007). Influence of salinity variations on zooplankton community in El-Mex bay, Alexandria, Egypt. Egypt. J. Aquat. Res., 33 (3):52-67.

ARABIC SUMMARY

تأثير الخصائص الطبيعية والكيميائية للمياه على تركيب وتنوع عشائر الهائمات الحيوانية ببحيرة النزهة، الأسكندرية، مصر

منى حامد احمد[١] – نادية نظمى بسيونى عبد الحميد[٢] - نجلاء اسماعيل شلبى[١]
١- المعمل المركزى لبحوث الثروة السمكية بالعباسة،مركز البحوث الزراعية،مصر.
٢- الجامعة العمالية فرع كفرالشيخ، مصر.

هدفت الدراسة الى التعرف على تأثير الخصائص الطبيعية والكميائية للمياه على تنوع وتوزيع الهائمات الحيوانية فى بحيرة النزهة بالاسكندرية خلال الفترة من ديسمبر٢٠١٥ الى نوفمبر٢٠١٦.وقد أشارت النتائج إلى وجود اختلافات واضحة في الخصائص الطبيعية والكميائية لمياه البحيرة،خاصة درجة الحرارة،تركيز الأس الهيدروجيني، الأكسجين الذائب، الأمونيا، النتريت، القلوية الكلية، العسر الكلي،النتروجين الكلى والفوسفور الكلى.

كما أوضحت الدراسة الحالية ان الهائمات الحيوانية تمثلت بأربعة مجموعات هى العجليات ومجدافية الارجل ومتفرعة القرون والقشريات الصدفية.وكانت العجليات الاكثر سيادة بين الأنواع الأخرى. كما أشارت النتائج ان اكثر العوامل تأثير على تركيب وتوزيع الهائمات الحيوانية كانت درجة الحرارة و القلوية الكلية و العسر الكلي والأمونيا و النتريت و النترات والنتروجين الكلى.

وقد اظهرت النتائج من خلال قيم مؤشر التنوع البيولوجى وبعض خصائص المياه وظهور بعض انواع الهائمات الحيوانية المقاومة للثلوث، ان بحيرة النزهة تعانى الى حد ما من التلوث العضوى.