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Research Article

Effect of Zooplankton and Environmental Parameters on African Catfish *Clarias gariepinus* (Burchell, 1822) in Egypt

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Abstract

The relationships between physico-chemical parameters, planktonic groups, of African catfish (*Clarias gariepinus*) at Al-Mahmoudia canal and Nubaria canal. The water Seasonal determination of some environmental factors: water temperature, pH, electrical conductivity, water transparency, dissolved oxygen, nitrate, nitrite, silica, biological oxygen demand and chemical oxygen demand. Were carryout in an attempt to explain that this parameter are the most factors affecting on the density and distribution of the plankton in the investigated African catfish. Plan is developing to take advantage of study the environmental parameters (Physico-chemical characters), abundance and diversity of plankton of the investigated regions water due to their great impact on African catfish.

Keywords: Planktonic groups; *Clarias gariepinus*; Brachionus

Introduction

In aquatic environments, zooplankton plays an important role in the transfer of energy from the primary producers to the higher level in the food chain [1]. Zooplankton species succession and spatial distribution result from differences in ecological tolerance to abiotic and biotic environmental factor [2]. In addition, Ni et al. [3] found that the water quality parameters deteriorated with increasing stocking density suggesting that the decrease in growth at high stocking density is in part caused by deterioration in water quality. Zooplanktons include floating animals. They may be classified according to their habitats, size and duration of planktonic life [4].

The ecological studies of rotifers in different world regions indicated that some rotifers have the ability to exist in polluted waters and are considered as pollution bio-indicators, like Brachionus species and Polyarthra species [5]. The water characteristics, phytoplankton and zooplankton population of El-Mex Bay and El-Umoum Drain were previously studied [6] and showed that, the continuous discharging polluted water into the bay caused massive development of algal blooms and a gradual deterioration of water quality created. So, the main objective of the present study is to investigate the relationship between environmental parameters (Physico-chemical characters), abundance and diversity of zooplankton and their impact on African catfish, *Clarias gariepinus*.

Material and Methods

The study area

The selected areas for the study were Al-Mahmoudia canal and Nubaria canal of Egypt (Figure 1 and Tables 1-3). The period of survey started from March 2013 to April 2014 on a seasonally basis.

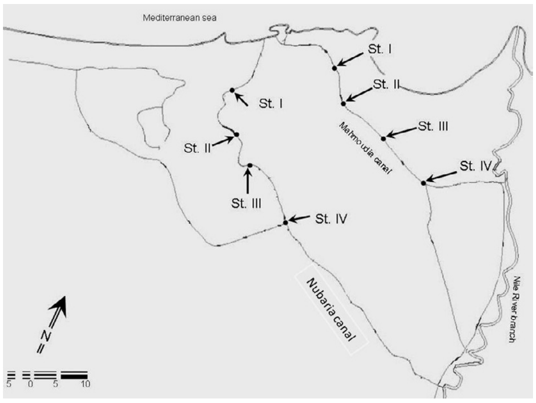

Figure 1: Map showing the location of the studied stations at Al-Mahmoudia and Nubaria canals.

Determination physico-chemical characters of water

Water temperature: Water temperature was measured by using an ordinary thermometer 110°C graduated to 0.1°C.

Water turbidity: The turbidity of water samples was measured by trurbidimeter bench HACH 2100N (SN 08040CO2711).

Hydrogen ion concentration (pH): The pH values of the water samples were measured in the field by using a pocket digital pH meter levibond sensodirect pH200 SN (0814375).

Electrical conductivity (EC): The limit of visibility of water was measured by (E.C -meter portable) HACH (HQ/ 4D) SN 070800010514.

Total dissolved solids (TDS): The total dissolved solids of samples were determined by using salinometer (Oyster, inspected 82738, Extech instruments, Germany).

Dissolved oxygen (DO): Determination of the dissolved oxygen was measured by DO- meter (HQ30d flexi meter) HACH S.N 080600022236.

Nitrate (NO_3) and Nitrite (NO_2) and Silica (SiO_2): Nitrate, Nitrite & Silica were determined by using spectrophotometer perkinelemer (S. N 50150806300S).

Free ammonia (NH_3): Water samples required for the determination

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Stations	Locations	Latitude (N)	Longitude (E)
I	Al-Mahmoudia canal	31°11'49"	30°22'89"
II		31° 82'58"	30°64'33"
III		31°72'36"	30°15'43"
IV		31°51'57"	30°24'28"
I	Noubaria canal	30°59'56"	29°51'51"
II		30°56'42"	29°57'3"
III		30°54'13"	29°59'38"
IV		30°53'73"	30°72'03"

Table 1: GPS locations of the selected study stations at Al-Mahmoudia and Nubaria canals during the investigation period (2013-2014).

of ammonium were fixed immediately after collection. Ammonium was determined spectrophotometrically.

Biological studies

Estimation of the algae: Water samples were collected by Bottles of 1-liter capacity. The samples were examined under binocular research microscope identification. A drop method technique was applied for counting and identifying different phytoplankton species, (drop method technique applied for counting phytoplankton community [7].

Estimation and identification of the zooplankton population:

		Winter				Spring				Summer				Autumn			
Species	**phylum**	**I**	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**
Keratella cochlearis	Rotifers	65	130	65	-	195	195	65	65	65	195	65	260	65	195	-	65
Metamorphosis		-	-	-	-	-	65	-	-	260	-	-	65	65	-	65	65
Brachionus caudatus		65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichocerca semilis		-	-	-	-	-	130	-	65	-	-	-	-	-	-	-	-
Polyarthra vulgaris		-	-	-	-	-	-	-	-	-	-	130	-	-	-	195	65
Syncheata okai		-	-	-	-	-	-	-	-	-	-	-	-	-	65	-	-
Keratella tropica		-	-	-	-	130	-	130	-	-	-	-	-	-	-	-	-
Brachionus badapesteninsis		-	-	-	-	-	65	-	-	65	-	-	-	-	-	-	-
Brachionus calyciflorus		-	-	-	65	65	-	-	-	-	-	-	-	-	-	-	-
Filinia lonogiseta		-	-	-	-	-	-	-	-	-	-	-	-	130	-	-	-
Synchaeta oblonga		-	-	-	-	-	-	-	-	-	-	-	65	-	-	-	-
Ascomorpha saltans		-	-	-	-	-	-	-	-	-	-	65	-	-	-	-	-
Brachionus angularis		-	-	-	130	-	-	-	65	-	-	-	130	-	-	-	-
Brachionus urceolaris		-	-	-	-	-	-	-	-	65	-	-	-	-	-	-	-
Spienid larva	Polychaeta	-	-	-	-	-	-	65	-	-	-	-	-	-	-	-	-
Polycheata sp		-	-	-	65	65	-	65	-	195	-	65	-	-	-	-	-
Lamellbranchve-ligar	Mollusca	-	-	-	65	-	-	-	-	-	65	-	-	-	-	-	-
Gastropoda veligars		-	-	-	-	-	-	-	-	-	65	-	-	-	-	-	-
Nauplius larva	Copepoda	-	65	-	-	-	-	-	-	130	-	-	260	-	-	-	-
Shizopera clandestinnae		-	-	-	-	-	-	-	-	-	-	65	-	-	-	-	-
Centropyxis aculata	Protozoa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65	-
Difflogia sp		65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bosmina longirostris	Cladocera	65	-	130	-	65	-	65	325	-	65	130	65	130	65	-	-
Lynceus bukobensis		-	-	-	-	-	-	-	-	65	-	-	-	-	-	-	-
Oxyurella tenuicaudis		-	-	-	-	-	-	-	-	-	-	-	-	65	-	-	-
Conochilus unicornis		-	-	-	-	-	-	-	-	-	-	65	-	-	-	-	-
Cypris larva	Cirripedia	-	-	-	65	-	-	-	-	-	-	-	-	-	-	-	-
Cycredia punitellata	Ostracoda	-	-	-	-	-	-	-	-	-	-	-	65	65	-	-	-
Free living nematoda	Nematoda	-	-	195	-	-	-	-	-	-	130	-	130	-	-	65	-
Egg fish	Chordata	-	65	-	-	-	-	-	65	-	65	-	-	-	-	-	65
Chironomus larvae	Diptera	-	-	-	-	-	65	-	-	-	-	-	-	-	65	-	-

Table 2: Seasonal variation of the zooplankton species collected from different sites at Al Mahmoudia Canal during the period of the study from March 2013 till April 2014.

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Species (Sp)	phylum	Winter				Spring				Summer				Autumn			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
keratella cochlearis	Rotifers	-	130	65	195	-	-	260	130	65	-	65	65	65	65	-	-
Metamorphosis		-	-	-	-	65	-	-	65	-	-	-	-	195	195	-	-
Brachionus caudatus		-	-	65	-	-	-	-	-	65	-	-	-	65	-	-	-
Polyarthra vulgaris		65	65	-	-	-	-	-	-	-	65	195	-	130	-	-	-
Syncheata okai		-	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Keratella tropica		-	-	-	-	-	-	-	65	-	-	-	260	-	-	-	-
Brachionus badapesteninsis		-	-	-	-	-	-	-	-	65	65	-	-	65	-	-	-
Brachionus calyciflorus		65	-	-	65	-	130	65	-	130	-	-	65	-	65	-	-
Filinia lonogiseta		-	-	65	-	-	65	-	-	-	-	65	-	-	-	-	-
Synchaeta oblonga		-	-	65	-	-	-	-	-	-	-	-	-	-	-	-	-
Brachionus angularis		-	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brachionus urceolaris		-	-	195	-	-	-	-	-	-	-	-	-	-	-	-	-
Asplanchna priodonta		-	-	-	65	-	-	-	-	-	-	-	-	-	-	-	-
Brachionus urceolaris		-	-	-	-	65	-	-	-	-	195	-	260	-	-	-	-
Brachionus quadridentatus		-	-	-	-	-	-	-	-	65	-	-	-	-	-	-	-
Horaella brehmi		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Keratella quadrata		-	-	-	-	-	-	-	-	130	-	-	-	-	-	-	-
Proales decipiens		-	-	-	-	-	-	-	-	-	-	-	-	65	-	-	-
Halycyclops magnisips	copepod	-	-	-	-	-	-	-	-	-	-	65	-	-	-	-	-
Nauplius larva		-	-	-	-	-	-	65	-	-	-	130	195	-	-	-	-
Cyclops vernalis		-	-	-	-	-	-	-	-	-	-	-	65	-	-	-	-
Euterpina aqutifrons		-	-	-	-	-	-	-	-	-	-	65	-	-	-	-	-
Bosmina longirostris	Cladocera	-	-	-	-	-	-	-	-	-	65	-	-	-	195	-	-
Alonella excisa		-	-	-	-	-	-	-	-	65	-	-	-	-	-	-	-
Moina micrura		65	-	-	65	-	-	-	-	-	-	-	-	-	-	-	-
Bosmina longirostris		130	195	-	65	260	65	65	-	325	130	-	130	-	65	-	-
Cycredia punitellata	Ostracoda	-	-	-	-	65	-	-	-	-	-	-	65	-	-	-	-
Thycredia punitullata		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lamellbranch veligar		-	-	-	-	-	-	-	-	-	1950	-	-	-	65	-	-
Veligar of lamelli branchiata	Mollusk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Free living nematoda	Nematode	195	-	-	-	-	-	-	-	-	130	-	-	-	260	-	-
Polycheata sp	Polychaeta	-	-	-	-	-	65	-	-	-	-	-	-	-	-	-	-
Egg fish	chordate	-	-	-	-	-	-	65	-	-	-	65	-	-	-	-	-
Glopigerina Jnflata	foraminifera	-	-	-	-	65	-	-	-	-	-	-	-	-	-	-	-
Centropixis Aculata	protozoa	-	-	-	-	-	65	-	-	-	-	-	-	-	-	-	-

Table 3: Seasonal variations at zooplankton standing crop (ind./m^3) collected from different sites at Nubaria Canal during the period of the study from March 2013 till April 2014.

Samples collections were carried out at each station by standard plankton net of 55 µm mesh size which lowered 100 liters of the water. The zooplankton organisms which retained in the net were then transferred into small glass bottle and preserved in 5% neutralized formalin solution and the sample volume was then adjusted to 50 ml. The samples were examined under a binocular research microscope. The identification was undertaken to species levels according to Sars [8]. For estimation of standing crop, sub samples of 5 ml were transferred to a counting chamber (Bogorov chamber) using a plunger pipette this operation performed three times and the average of the three counts was taken [9]. The standing crop was calculated and estimated as organisms per cubic meter according to the formula of Santhanam and Srinivasan [10]:

$$N = n \left(v / V \right) * 1000$$

Where:

N: Total number of zooplankton per cubic meter.

n: Average number of zooplankton in 1 ml of the sample.

v: Volume of zooplankton concentrates (ml).

V: Volume of total water filtered (L).

Growth performance: Growth performances of 225 individual of African catfish species were collected from Al-Mahmoudia and Nubaria canals.

Stomach content: The contents of 185 individual of African catfish in the stomach were removed by using soft brush and collected in glass petri dishes separately and fixed in 10% formalin. The large sized food materials were isolated from stomach. The small sized materials were collected in 50-100 ml. vials containing 10% formalin. Numerical and volumetric methods of stomach content were analyzed according to Hyslop [11] and William et al. [12]. Gut content of different size group of both fish species were analyzed for different variables like undigested food, digested food, semi-digested food, number of food items, and the percentage of food type (origin/animal origin/Detritus). The difference in gut content and its relation to habitat variations were also analyzed.

Data analysis

Statistical analysis: Data was subjected to one-way analysis of variance (ANOVA) followed by the Duncan's multiple comparison test for the means. The results were presented as mean ± SE (standard error).

Cluster analysis: The similarity between stations for hydrographic conditions and species composition were done, according to Shannon and Weaver [13].

Results

Physico-chemical characters

Water temperature: The recorded data showed that at Nubaria Canal, the maximum seasonal temperature was recorded in summer (28.11 ± 0.1°C), while the minimum one occurred in winter (18.9 ± 0. 00°C). However, seasonal temperature changes at Al-Mahmoudia Canal did not deviated from that recorded for Nubaria Canal as the maximum temperature values (28.46 ± 0.2°C) was measured in summer, while the minimum one occurred in winter (16.4 ± 0.43°C) (Figure 2).

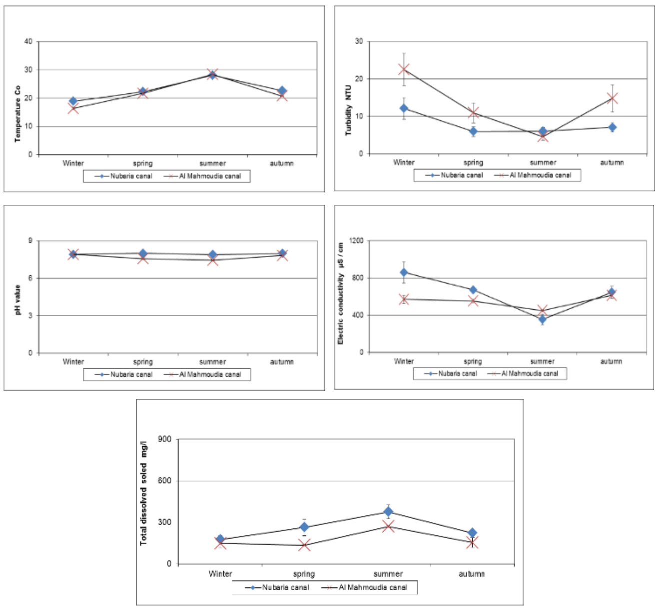

Figure 2: Seasonal variations of water temperature (°C), turbidity (NTU), pH value, electric conductivity (µS / cm) and total dissolved soled (mg/l) recorded in all sites at Nubaria and Al-Mahmoudia Canal.

	Seasons			
Species	**Winter**	**Spring**	**Summer**	**Autumn**
Rotifers	-	+	+	+
Copepoda	+	+	+	-
Cladocera	-	+	-	+
Ostracoda	-	-	+	+
Mollusca	+	+	+	+
Nematoda	-	+	+	-
Polychaeta	+	+	-	+
protozoa	-	-	+	-
Fish	-	+	+	-
Detrates	+	+	+	+

Table 4: Seasonal variation in the stomach contents of African catfish from collected different sites at Al Mahmoudia Canal during the period from March 2013 till April 2014.

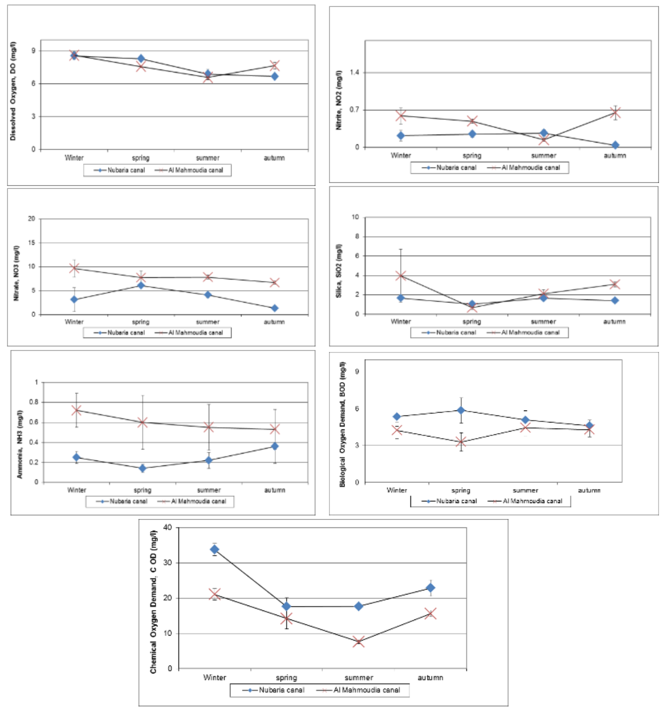

Figure 3: Seasonal variations of water dissolved oxygen (mg/l), Nitrite (mg/l), Nitrate (mg/l), Silica(mg/l), Ammonia(mg/l), biological oxygen demand (mg/l) and Chemical oxygen demand (mg/l) recorded at all sites at Nubaria and Al-Mahmoudia Canals.

Turbidity: The data showed that the recorded value of turbidity was the minimum at Nubaria Canal recorded the minimum value (5.97 ± 1.35 NTU) during the spring, while, the maximum value (12.13 ± 2.91 NTU) was recorded in winter. Meanwhile the minimum value (4.61 ± 0.98 NTU) was measured at Al-Mahmoudia Canal during summer, but the maximum values recorded during the winter (22.53 ± 4.31 NTU) (Figure 2).

Hydrogen ion concentration (pH): Generally, pH values of the two studied canals were always tended to be alkaline. The values at Nubaria Canal ranged between a maximum of 8.0 ± 0.13 and a minimum of 7.9 ± 0.06. On the other hand at Al-Mahmoudia Canal the seasonal pH value of ranged between 7.91 ± 0.1 and 7.44 ± 0.06 at winter and summer respectively (Figure 2).

Electrical conductivity (EC): Table 4 showed that the mean values of EC at Nubaria Canal ranged between 859 ± 112. 56 µS / cm and 354.5 ± 53.85 µS / cm during winter and summer respectively. While at Al-Mahmoudia Canal the maximum values were recorded in utumn 612 ± 31.46 µS / cm and the minimum values in summer 451 ± 9.72 µS / cm (Figure 2).

Total dissolved solids (TDS): At Nubaria Canal the maximum recorded value was 375.71 ± 50.2 mg/l in the summer, while, the minimum value (176.95 ± 26.38 mg/l) was recorded in winter. While at Al-Mahmoudia Canal the minimum obtained data was measured during spring (135.63 ± 5.25 mg/l), but the maximum values were recoreded at the summer (270.6 ± 5.83 mg/l) (Figure 2).

Dissolved oxygen (DO): Figure 3 showed that the dissolved oxygen (DO) values ranged from 8.54 ± 0.31 mg/l and 6.67 ± 0.25 mg/l in winter and autumn respectively at Nubaria Canal, while at Al-Mahmoudia Canal the mean value ranged between (8.59 ± 0.31 mg/l and (6.58 ± 0.22 mg/l in winter and summer respectively.

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Nitrite (NO_2): The mean NO_2 data at Nubaria Canal ranged between 0.27 ± 0.36 mg/l and 0.04 ± 0.01 mg/l during summer and autumn respectively, however at Al-Mahmoudia Canal values varied between 0.65 ± 0.13 mg/l and 0.14 ± 0.03 mg/l during autumn and summer respectively (Figure 3).

Nitrate (NO_3): Figure 3 showed that the seasonal variations of Nitrate values ranged between 6.07 ± 0.44 mg/l and 1.35 ± 0.11 mg/l at Nubaria Canal during spring and autumn respectively. Meanwhile at Al-Mahmoudia Canal No_3 values ranged between 9.65 ± 1.81 mg/l and 6.68 ± 0.82 mg/l during winter and autumn respectively.

Silica (SiO_2): The obtained data showed that the seasonal variations of silica at Nubaria Canal ranged between 1.05 ± 0.31 mg/l and 1.67 ± 0.19 mg/l during spring and winter respectively. While the recorded data from Al-Mahmoudia canal ranged between 3.97 ± 2.72 mg/l and 0.68 ± 0.19 mg/l during winter and spring respectively.

Ammonia, free (NH_3): Figure 3, showed that the highest value was recorded in autumn (0.36 ± 0.17 mg/l), but the lowest was recorded in the spring (0.14 ± 0.04 mg/l) at Nubaria Canal. The highest mean value of ammonia was listed in winter (0.72 ± 0.17 mg/l), while the lowest one was in the autumn (0.53 ± 0.20 mg/l) at the Al-Mahmoudia Canal.

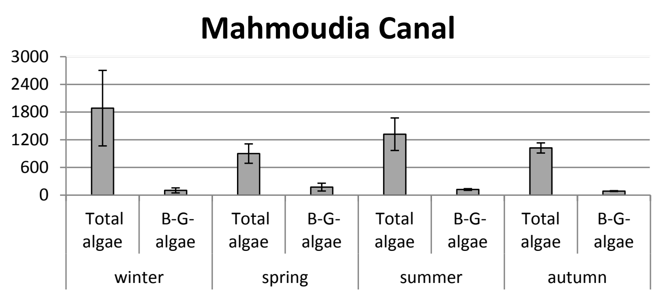

Figure 4: Seasonal variation in the phytoplankton (cell/ml) collected from different sites at Al-Mahmoudia Canal.

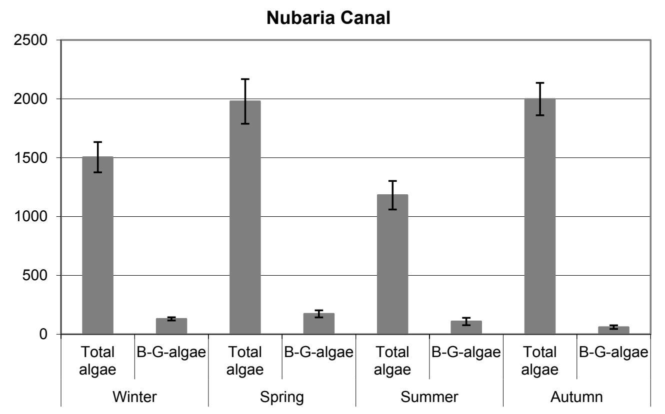

Figure 5: Seasonal variations of phytoplankton (cell /ml) collected from different sites at Nubaria canal.

	Seasons			
Species	**Winter**	**Spring**	**Summer**	**Autumn**
Rotifers	-	+	+	+
Copepoda	+	+	+	+
Cladocera	+	+	-	+
Ostracoda	-	-	+	+
Mollusca	+	+	+	+
Nematoda	-	+	+	-
Polychaeta	-	+	+	+
foraminifera	-	-	-	-
protozoa	+	+	+	-
Fish	-	+	+	-
Detrates	+	+	+	+

Table 5: Seasonal variation in the stomach content of African catfish from collected different site at Nubaria Canal during the period from March 2013 till April 2014.

Biological study

Phytoplankton at Al-Mahmoudia canal: The recorded results in Figure 4 showed that the highest mean annual value of total algae was 1885.6 ± 818.62 cell /ml at the winter, but the lowest one was 899.6 ± 210.74 cell /ml at the spring. Regarding seasons, the highest mean value of blue green algae was recorded in spring 172.4 ± 24.56 cell/ml, but the lowest one was in autumn 87.0 ± 8.72 cell /ml.

Phytoplankton in the Nubaria canal: The recorded value of total algae was mean 1998.8 cells /ml ± 137.6 and 1181.6 cell /ml ± 121.4 during autumn and summer respectively. However, the highest value of blue green algae was recorded in spring (173.5 cell /ml ± 30.2), but the lowest one was listed in autumn (60.4 cell /ml ± 15.5) (Figure 5).

Zooplankton communities at Al-Mahmoudia canal: A total of 31 zooplankton species in addition to fish eggs and larvae of Nematoda and Amphipods were collected during the period of this study from March 2013 to April 2014 (Table 2).

Zooplankton communities in the Nubaria canal: Total of 36 zooplankton species in addition to fish eggs and larvae of Nematoda and Amphipod were collected, during the period of study (Table 3).

Stomach content of African catfish at Al-Mahmoudia canal

A total of 7 groups of zooplankton included rotifers, copepoda, cladocera, ostracoda, mollusca, polycheata, protozoa, fish and detrates were detected from the stomach contents during the period of this study (Table 4).

Stomach content of African catfish at Noubaria canal

The data showed a total of 9 groups of zooplankton rotifers, copepoda, cladocera, ostracoda, mollusca, nematode, polycheata, foraminifera, protozoa, fish and detrates were detected during the period of this study (Table 5).

Diversity of African catfish at Al-Mahmoudia and Nubaria canal

The recorded data (Figure 6) showed that the highest number of fish (68 ± 6.3 and 55 ± 3) was recored in summer at Al-Mahmoudia and Nubaria Canal respectively while the lowest of number of fish (13 ± 1 and 11 ± 0.5) was recorded during winter at Al-Mahmoudia and Nubaria Canal respectively during the period of study.

The body weights of African catfish in the Al-Mahmoudia and Nubaria canals

The present data listed in Figure 7 showed that the highest weight of catfish was recorded (330.25 g/fish ± 30.7 and 468.5 g/fish ± 26.5) while during the autumn, the lowest body weight of catfish was 102.5 g ± 15.5 and 99.75 g/fish ± 25.9 during the spring at Al-Mahmoudia and Nubaria Canals, respectively.

Cluster analysis of Al-Mahmoudia and Nubaria canal

The result of cluster analysis using MINITAB Release 14 computer programs based on seasons and stations data including the physico-chemical parameters and zooplankton composition is presented in.

Four clusters are constructed between different seasons, where the highest similarity was observed between autumn and spring (98.85%) followed by the similarity between summer and autumn which reached to 96.5% and the lowest similarity was listed between autumn and winter (92.6%) (Figure 8).

At Nubaria canal four clusters were constructed between different seasons, where the highest similarity was recorded between autumn and spring (98.8%) followed by the similarity between summer and autumn reached to 97.7% while the lowest similarity was recorded between autumn and winter (92.4%) (Figure 9).

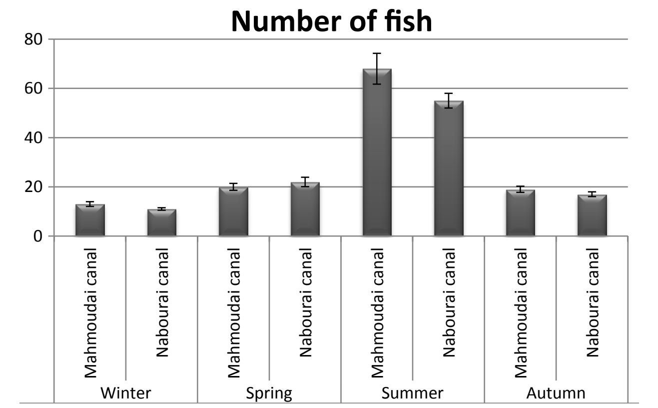

Figure 6: Seasonally of African catfish collected from different sites at Al-Mahmoudia and Nubaria canals during the period of investigation.

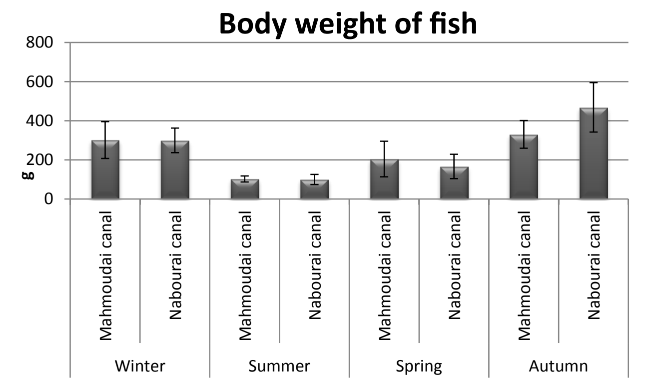

Figure 7: Seasonal variation of body weight g/fish of African catfish collected from different sites at Al-Mahmoudia and Nubaria canals during the period of investigation.

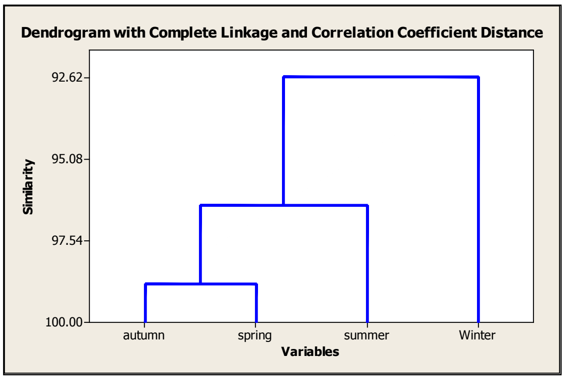

Figure 8: Dendrogram represented the similarity between serveyed sites at Al-Mahmoudia canal during the period of investigation.

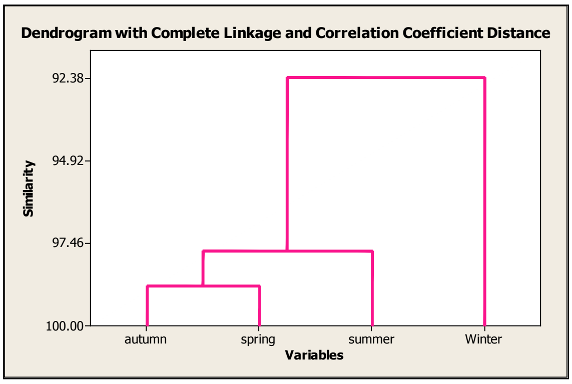

Figure 9: Dendrogram represented the similarity between the servayed sites at Nubaria canal during the period of investigation.

Discussion

One of the main goals of the zooplankton is to identify factors, which effect on the distribution, abundance and species composition of zooplankton. This goal is difficult to achieve due to the complexity of natural marine environment [14]. Egyptian Mediterranean coast, receiving huge amount of agricultural, industrial, and sewage wastes from adjacent Lake Mariut through El-Umoum Drain. Lake Mariut receiving from Nubaria Canal and Mahmudia Canal. According to different estimations, the bay receives about 2.547×10^9 m^3 y^{-1} of agricultural wastes mixed with water effluents (surplus water) from a neighboring sewage-polluted lake (Lake Mariut) with a rate of 262.8×10^6 m^3 y^{-1} via El-Umum Drain [15].

Regarding factors affecting on the distribution of zooplankton species in the investigated area, it is well known that a species range may be determined seasonally, or geographically by one or more of a number of limiting factors such as competition with other species, abundance of suitable food, air and water temperature, hydrogen ion concentration, dissolved oxygen, transparency, conductivity, NO_2, NO_3, SiO_2, or other hydrographic factors. Thus, it is preferable to seek the factors those affecting on the distribution of the zooplankton. It is generally recognized that the water temperature is the chief factor regulating the distribution of the zooplankton [16]. The present mean values of transparency are in full agreement with Bedair [17] but contradict Iskaros et al. [18].

The highest value ammonia was recorded in autumn (0.36 mg/l), but the lowest was recorded in the spring (0.14 mg/l) at Nubaria Canal. The highest mean value of ammonia was in winter (0.72 mg/l), while the lowest one was in the autumn (0.53 mg/l) at Al-Mahmoudia Canal. This is in consistent with Abdelhamid [19] who recorded that the physico-chemical parameters of water were within the acceptable ranges recommended for pisciculture especially the culture of African catfish; *C. gariepinus*. On the same side, Salem [20] found that the best physico-chemical parameters of water for Nile tilapia were atmospheric temperature ranged from 23.5°C to 27.8°C, salinity was between 0.2‰ to 0.3‰ and hydrogen ion concentration (pH) was 8.2 to 8.63.

The recorded data showed that the highest mean annual value of total algae was (1885.6 cell /ml) at the winter, but the lowest one between (899.6 cell /ml) at the spring. Regarding seasons, the highest mean value of blue green algae was recorded in spring (172.4 cell/ml), but the lowest one was in autumn (87.0 cell /ml). The continuous discharging polluted water into El-Mex Bay caused massive development of algal blooms and a gradual deterioration of water quality created [6]. Conversely, uncontrolled eutrophication of productive systems can lead to undesirable consequences [6].

A total of 31 zooplankton species in addition to fish eggs and larvae of Nematoda and Amphipods were recorded in the present study the dominance of Rotifera agrees with that reported by Ndawula et al. [21] at upper Voctoria Nile; Bedair [17] at northern part of Nile and Aboul Ezz [22]. Heneash [15] the uniformity of zooplankton composition clearly appeared in the different stations, especially evident in the two dominant groups; Copepoda and Protozoa, where relative importance of the individual species showed characteristic high ranking of *Oithona nana* and *Schmidingerella serrata*. Protozoa was the richest group having 31 species followed by Copepoda.

A total of 36 zooplankton species in addition to fish eggs and larvae of Nematoda and Amphipod. This agrees with Bedair [17] who recorded 95 zooplankton species at the northern part of the River Nile, Iskarose et al. [18]. A total of zooplankton in addition to rotifers, copepoda, cladocera, ostracoda, mollusca, polycheata, protozoa, fish and detrates were detected from the stomach contents.

Four clusters are constructed between different seasons, where the highest similarity was between autumn and spring (98.85%) followed by the similarity between summer and autumn reached to 96.5% and the lowest similarity was observed between autumn and winter. Each zooplankton species has a specific tolerance for temperature. This agrees with Goldman and Heron [16]. At Nubaria canal four clusters are constructed between different seasons, where the highest similarity was recorded between autumn and spring (98.8%) followed by the similarity between summer and autumn reached to 97.7% while the lowest similarity was observed between autumn and winter (92.4%). It serves as indicator for the water condition [23,24].

Conclusion

The results indicated that the environmental parameters (Physico-chemical characters), abundance and diversity of plankton of the investigated regions water due to their great impact on African catfish (*Clarias gariepinus*).

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