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RESEARCH ARTICLE

Impacts of construction of the new Assiut barrages on zooplankton community structure inhabiting Nile River at Assiut Egypt

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Abstract

The present study was carried out during establishing the new Assiut barrages and hydropower plant project at the city of Assiut, Upper Egypt during the period of one year 2012. The present study was designed to estimate the implications of construction of the barrages on zooplankton community structure at the working region. The new barrages are being implemented across the Nile River and located away from the old one about five hundred meters. The sites of sampling zooplankton included 8 sites; four of them are situated upstream of the old barrages and the other four are located downstream after the old barrages around the construction area. The study recorded eighty zooplankton species at the investigated sites during the period from January to December 2012. The composition of zooplankton showed differences between up and down stream sites. The sites located upstream of the old barrages have similar compositions (79 taxa in each site) while sites located downstream have different compositions (76, 63, 72 and 68 taxa) were recorded in sites 5, 6, 7 and 8; respectively. The highest value of total abundance of zooplankton was (272 Indv/m3) recorded at upstream while the highest value recorded at downstream was (96 Indv/m3). Taxa richness reached the highest peak value (42 taxa) at upstream and (24 taxa) at downstream. Shannon- wiener's diversity index ranged between (2.74) and (2.69) at upstream while it ranged between (2.45) and (2.59) at downstream.

INTRODUCTION

The new Assiut barrages and hydro-power plant project is one of the biggest multi-purpose water projects in Egypt. The project serves in secure the water needs for irrigating 1.65 million feddans (0.7 million ha) of agricultural land. In addition, the new barrages support a high-capacity bridge for cross-river traffic, replacing the narrow and congested road over the old barrages.

Construction of barrages on a River changes the hydraulic regime of that River (Moffat *et al.*, 1990and Alan, 1992) by increasing water depths and reducing velocities in areas of developed backwater curves.

Plankton is generally highly sensitive; their dynamics can be affected by environmental perturbation. Zooplankton can provide meaningful and quantifiable indicators of ecological change in short timescales (Paerl *et al*. 2003).

Changes in species abundance, diversity, or community composition can provide important indications of environmental change or disturbance (Beenamma and Sadanand, 2011). The abundance of zooplankton depends on a great variety of abiotic and biotic factors, which affect the zooplankton community (Harris and Vinobaba, 2012). The present paper is a part of comprehensive study which was designed to record the impacts of the construction of the new Assiut barrages on the structure of common invertebrate community inhabiting the Nile River at Assiut. The main objective of the present paper is to estimate the implications of the construction of the barrages on zooplankton community structure at the working region of the new Assiut barrages and Hydro-power Plant Project.

Materials and Methods

Studied area

The present study was carried out at Assiut, Upper-Egypt. Eight different locations were randomly chosen; four sites (Sites 1-4) located before the old barrages (Upstream) which represent control sites and the other four sites (Sites 5- 8) located after the old barrages (Downstream) around the construction area of the new Assiut barrages and hydropower plant project (Fig. 1). The latitude and longitude coordinates of sampling stations were recorded using the survey vessel's Garmin, Global Positioning System (GPS) unit navigation system (table 1).

Fig. (1): Map showing the locations of studied sites. Sites 1- 4 represent upstream while sites 5- 8 represent downstream.

Zooplankton sampling

Quantitative and qualitative samples of zooplankton were collected from the studied eight sites using plankton net (mesh size 100 µm) and (a radius ~ 6.5 cm). Sampling of water and plankton were carried out monthly from January 2012 till December 2012. Sampling was carried out between 9:00 a.m. and 12:00 noon.

Separation and counting

The volume of each sample was concentrated to 10 ml, transferred into a counting cell and each zooplankter was counted separately using a binocular microscope (40X). The density of zooplankton organisms was calculated as their total number per cubic meter.

Identification of zooplankton

The following references were used to identify the collected zooplanktons: Sars (1927), Gurney (1933), Rylov (1948), Brooks (1959), Tresseler (1959), Wilson and Yeatman (1959), Edmondson (1959), Simirnov (1974), Harding and Smith (1974), Kiefer (1978), Khan *et al.* (1978), Kiefer and Fryer (1978), Lehmkuhl (1979), Van de Velde (1984), Korinek (1984), Bronshtein (1988), Dussart

(1989), Henderson (1990), Mohammed (1994), Mahmoud (1995), Obuid-Allah (2001), Martens (2001) and Fangary (2003).

Samples treatment

The dominance structure of species was determined according to Engelmann`s classification (Engelmann, 1978) as subrecedent (below 1.3%), recedent (1.3-3.9%), subdominant (4-12.4%), dominant (12.5-39.9%), eudominant (40-100%). Shannon wiener diversity index (H`) was calculated to show zooplankton diversity within the collected community by using shannon-wiener equation:

H`= -Σpi (lnpi), where pi is the proportion of individuals belonging to the i^{th} species. Zooplankton richness of the community was calculated.

Statistical analysis

Analysis of variance on SPSS software package (version 18, SYSTAT statistical program) was used to test the present data. In case of significant differences, the Duncan test

Results

was selected from the PostHoc window on the same statistical package to detect the distinct variances between means. Probability values ≤ 0.05 were defined as significant throughout the present study; however the values >0.05 were defined as non-significant. Probability values between 0.05 and 0.01 (both are included) were evaluated as significant.

Table (1): The coordinates and localities of sampling locations at upstream and downstream of the old Assiut barrages on the Nile River

No	Location	Lat.	Lon.
Site1	1.5 km upstream of existing barrages – left bank.	27°11'21.00"N	31°11'34.00"E
Site2	1.5 km upstream of existing barrages- right bank.	27°11'25.39"N	31°11'42.73"E
Site3	1 km upstream of existing barrages – left bank.	27°11'34.00"N	31°11'28.00"E
Site4	1 km upstream of existing barrages – right bank.	27°11'40.39"N	31°11'37.83"E
Site5	1 km downstream of existing barrages – left bank.	27°12'28.00"N	31°10'51.00"E
Site6	1.4 km downstream of existing barrages – left bank.	27°12'35.00"N	31°10'34.00"E
Site7	1.6 km downstream of existing barrages- right branch	27°12'58.04"N	31°10'51.82"E
Site8	3 km downstream of existing barrages	27°12'58.00"N	31° 9'53.00"E

Table (2): The mean density (Indv/m^3), frequency percent (F %) and the dominancy of the zooplankton taxa at sites located upstream and downstream of the old barrages. (Sub-R: Subrecedent R: Recedent, Sub-D: Subdominant, D: Dominant,Eu-D: Eudominant).

N.	Taxa	**Site1**	**Site2**	**Site3**	**Site4**	**Up-S**	**D**	**Site5**	**Site6**	**Site7**	**Site8**	**D-S**	**D**
		Indv/m^3	Indv/m^3	Indv/m^3	Indv/m^3	F%		Indv/m^3	Indv/m^3	Indv/m^3	Indv/m^3	F%	
1	*Paramecium Aurelia*	92	62	93	93	21	D	62	0	31	0	6	Sub-D
2	*Asplanchna* sp.	218	125	218	31	23	D	187	31	93	93	13	D
3	*Branchionus angularis*	156	187	187	125	15	D	31	0	93	0	6	Sub-D
4	*Brachionus quadridentatus*	125	374	125	0	15	D	62	60	156	0	10	Sub-D
5	*Brachionus urceolaris*	91	312	343	156	21	D	125	93	125	0	13	D
6	*Brachionus calyciflorus*	1055	374	403	279	33	D	436	280	436	497	40	Eu-D
7	*Brachionus havanaensis*	373	249	156	434	33	D	31	0	0	0	2	R
8	*Brachionus rubens*	156	125	125	218	19	D	31	125	62	62	13	D
9	*Brachionus bidentatus*	62	249	93	0	13	D	61	62	31	93	10	Sub-D
10	*Brachionus falcatus*	374	62	246	0	15	D	31	0	62	0	6	Sub-D
11	*Keratella cochlearis*	5777	1542	6194	2699	69	Eu-D	3971	2549	4076	1231	58	Eu-D
12	*Keratella valga*	809	312	530	218	33	D	125	405	187	62	17	D
13	*Keratella tecta*	592	278	93	433	31	D	93	0	125	31	10	Sub-D
14	*keratella hiemalis*	31	249	125	31	15	D	31	31	62	31	8	Sub-D
15	*keratella quadrata*	530	155	125	125	19	D	155	31	93	0	13	D
16	*keratella testudo*	187	280	217	280	27	D	0	187	60	0	6	Sub-D
17	*Trichocerca rattus*	712	280	311	93	33	D	62	125	93	215	17	D
18	*Trichocerca longiseta*	187	187	187	215	19	D	218	436	654	935	33	D
19	*Kellicottia* sp	156	404	187	30	17	D	30	0	62	0	4	Sub-D
20	*Notholca laurentiae*	186	0	125	312	23	D	0	0	91	31	6	Sub-D
21	*Notholca squamula*	685	186	62	156	25	D	124	124	62	156	17	D
22	*Collotheca* sp	0	156	123	156	13	D	62	31	0	62	6	Sub-D
23	*Colurella uncinata*	31	249	156	312	19	D	31	31	93	0	6	Sub-D
24	*Euchlanis parva*	93	280	31	62	15	D	125	0	373	0	19	D
25	*Lecane tenuiseta*	156	125	93	156	19	D	62	0	0	0	2	R
26	*Ascomorpha* sp.	218	62	156	623	23	D	62	0	93	0	6	Sub-D
27	*Ploesoma* sp	404	187	155	123	23	D	0	31	62	92	8	Sub-D
28	*Synchaeta grandis*	312	62	31	312	17	D	62	62	62	93	13	D
29	*Conochiloides natans*	125	156	92	93	21	D	31	0	0	31	4	Sub-D
30	*Monostyla lunaris*	187	156	185	31	27	D	30	0	31	0	4	Sub-D
31	*Bosmina longirostris*	18590	15650	20506	15084	100	Eu-D	5157	5382	7053	7496	98	Eud-D
32	*Ceriodaphnia reticulata*	1525	1305	684	589	75	Eu-D	372	809	622	404	56	Eu-D
33	*Macrothrix laticornis*	779	405	312	590	52	Eu-D	62	218	312	156	29	D
34	*Alona bukobensis*	3860	3567	4081	2702	83	Eu-D	3017	1495	1805	1739	71	Eu-D
35	*Chydorus sphaericus*	10151	6769	6601	6400	90	Eu-D	2114	2365	3424	1493	81	Eu-D
36	*Oxyurella* sp.	1182	747	964	1213	67	Eu-D	156	310	186	248	38	D
37	*Simocephalus expinosus*	466	374	528	527	50	Eu-D	62	218	341	374	27	D
38	*Simocephalus vetulus*	280	374	342	373	50	Eu-D	91	62	249	312	21	D
39	*Camptocercus australis*	2143	1931	2586	2212	71	Eu-D	561	1181	810	530	54	Eu-D
40	*Ilyocryptus sordidus*	530	592	371	279	44	Eu-D	62	280	93	93	17	D
41	*Pleuroxus* sp.	436	807	868	561	58	Eu-D	249	338	187	405	33	D
42	*Moina micrura*	2667	1584	1144	1087	69	Eu-D	436	648	711	278	46	Eu-D
43	*Diaphanosoma birgei*	965	1402	1057	900	69	Eu-D	187	685	779	592	50	Eu-D

Table (2): Continued

44	*Euryalona* sp.	997	1184	1052	989	63	Eu-D	156	592	156	402	31	D
45	*Scapholeberis kingi*	156	280	186	184	33	D	93	31	218	0	17	D
46	*Leydigia acanthocercoides*	312	249	374	310	38	D	93	218	62	0	17	D
47	*Leydigia quadrangularis*	716	343	280	311	38	D	31	156	0	62	10	Sub-D
48	*Dunhevedia crassa*	1121	902	748	1059	60	Eu-D	433	405	403	156	35	D
49	*Daphnia longispina*	1057	1433	962	1117	81	Eu-D	465	653	403	714	54	Eu-D
50	*Thermodiaptomus galebi*	1087	746	933	683	79	Eu-D	436	621	714	247	63	Eu-D
51	*Schizopera nilotica*	872	997	778	530	65	Eu-D	340	156	374	560	50	Eu-D
52	*Tropocyclops confinis*	311	374	31	340	25	D	312	62	218	62	21	D
53	*Thermocyclops consimilis*	806	934	465	280	63	Eu-D	311	341	218	248	40	Eu-D
54	*Thermocyclops neglectus*	248	125	311	156	29	D	125	93	31	93	13	D
55	*Eucyclops serrulatus*	155	249	62	186	29	D	0	0	0	0	0	Sub-R
56	*Ectocyclops phaleratus*	217	156	62	125	21	D	62	31	93	0	10	Sub-D
57	*Afrocyclops gibsoni*	93	467	218	93	23	D	62	187	62	124	21	D
58	*Mesocyclops ogunnus*	374	433	92	30	27	D	125	93	31	125	19	D
59	*Macrocyclops albidus*	808	779	591	618	67	Eu-D	312	466	186	312	42	Eu-D
60	*Microcyclops linjanticus*	279	343	187	60	29	D	125	187	218	0	23	D
61	*Microcyclops varicans*	1273	1306	621	589	65	Eu-D	187	560	465	466	52	Eu-D
62	*Paracyclops fimbriatus*	1277	1366	1148	1153	75	Eu-D	810	498	650	654	52	Eu-D
63	*Copepodite* S	434	93	279	374	40	Eu-D	155	156	125	62	29	D
64	Nauplius larva	806	1151	934	748	77	Eu-D	652	621	372	651	50	Eu-D
65	*Cypridopsis Vidua*	2551	1867	2087	3142	94	Eu-D	872	1588	1088	1152	90	Eu-D
66	*Potamocypris variegata*	435	436	155	1059	46	Eu-D	218	218	156	93	25	D
67	*Hemicypris Dentatomarginata*	496	374	343	1090	52	Eu-D	31	404	279	125	27	D
68	*Fabaeformiscandona holzkampfi*	91	31	62	280	13	D	31	0	312	0	13	D
69	*Pseudocandona semicognita*	218	218	31	405	21	D	31	62	62	0	10	Sub-D
70	*Limnocythere inopinata*	312	373	623	716	50	Eu-D	156	93	61	93	19	D
71	*Ilyocypris biplicata*	62	187	187	280	29	D	124	62	342	62	29	D
72	*Ilyocypris gibba*	218	310	465	467	50	Eu-D	93	62	125	60	19	D
73	Chironomid larva	1680	1306	1215	1805	85	Eu-D	715	996	840	746	75	Eu-D
74	Water mites	125	187	218	218	27	D	61	155	125	30	23	D
75	Mosquitos larva	187	343	436	311	42	Eu-D	125	125	187	62	27	D
76	Ephemeroptera, siphlonuridae	156	156	0	31	13	D	0	0	31	0	2	R
77	Caddisflies (Trichoptera)	93	156	124	187	23	D	93	31	62	0	10	Sub-D
78	Water boatman nymph	93	125	62	125	19	D	31	0	0	31	4	Sub-D
79	Dragonfly nymph	93	125	30	62	21	D	60	0	0	93	6	Sub-D
80	Mayfly larva	156	156	249	62	21	D	93	31	156	124	21	D

Table (3): MANOVA for zooplankton total abundance, taxa richness and Shannon diversity at the eight studied sites during different seasons.

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.
Sites	Abundance	279254.16	7	39893.45	12.690	0.000
	Richness	3864.66	7	552.09	16.233	0.000
	Diversity	2.70	7	0.39	2.586	0.021
Season	Abundance	76127.20	3	25375.73	8.072	0.000
	Richness	1775.86	3	591.95	17.405	0.000
	Diversity	0.31	3	0.10	0.689	0.562
Sites * Season	Abundance	112096.22	21	5337.92	1.698	0.055
	Richness	1213.22	21	57.77	1.699	0.055
	Diversity	2.19	21	0.10	0.698	0.819
Error	Abundance	201196.67	64	3143.70		
	Richness	2176.67	64	34.01		
	Diversity	9.56	64	0.15		

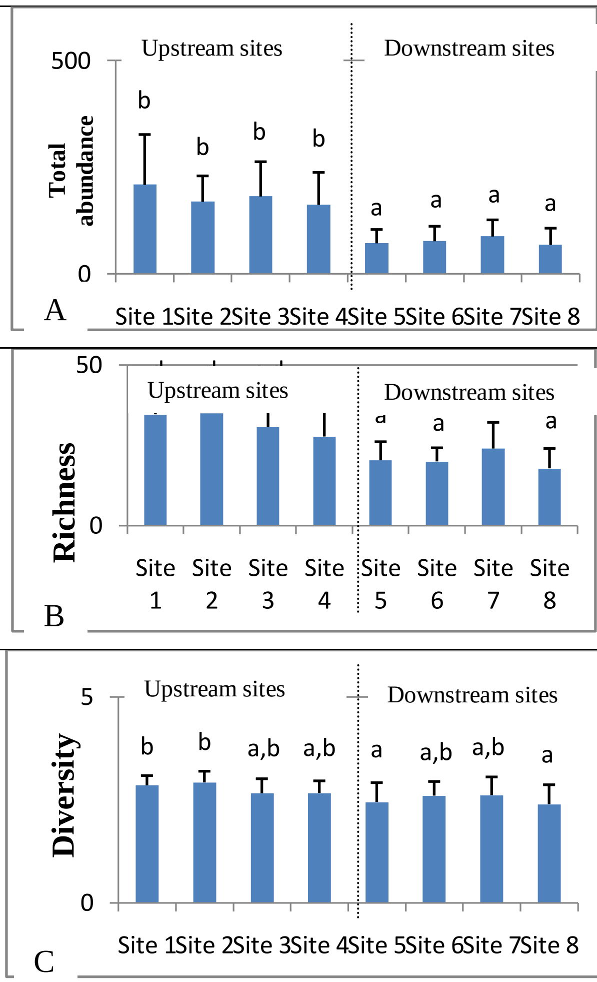

Fig.(2): A: Total zooplankton abundance, **B:** taxa richness and **C:** diversity at sites located upstream and downstream of the old barrages on the Nile River (The similar characters show no significant difference).

Zooplankton community composition:

The composition of zooplankton showed differences between upstream and downstream. The sites located upstream of the old barrages recorded similar compositions (79 taxa at each site) while sites located downstream recorded different compositions (76, 63, 72 and 68 taxa in sites 5, 6, 7 and 8; respectively).

Table (2) shows the mean density, the frequency percent and the dominancy scale of zooplankton species recorded in upstream and downstream sites during the period from January to December 2012. The present investigation revealed that there were great differences between the densities of the total zooplankton recorded at sites located upstream and downstream of the old barrages on the Nile River. Zooplankton species which disappeared completely or partially at downstream sites during the investigation period were recorded. The copepod species; *Eucyclops serrulatus* was disappeared completely at downstream sites although its frequency percent was 29% at upstream. The rotiferan species; *Brachionus havanaensis* and *Lecane tenuiseta* appeared in all upstream sites as well as in site 5 only at downstream sites. *Paramecium aurelia, Branchionus angularis, Brachionus falcatus, Kellicottia* sp, *Euchlanis parva, Ascomorpha* sp, *Fabaeformiscandona holzkampfi* and *Monostyla lunaris* appeared in all sites except sites 6 and 8 (downstream). Species; *Brachionus quadridentatus*, *Brachionus bidentatus* and *Brachionus falcatus* disappeared in site 4 (upstream). The taxa: Ephemeroptera, Siphlonuridae appeared at all upstream sites and site 7 (downstream). In the present study, it was noticed that the frequency percent of the species; *Brachionus calyciflorus, Trichocerca longiseta* and *Euchlanis parva* at downstream were higher than that of upstream.

Dominancy of the recorded zooplankton species

By treating the dominance structure of zooplankton species according to Engelmann's classification (Engelmann, 1978) as illustrated in Table (2) which reveals the following classification: subrecedent (bellow 1.3%), recedent (1.3-3.9%), subdominant (4-12.4%), dominant (12.5-39.9%) and eudominant (40-100%). The present investigation revealed that zooplankton species showed dominant and eudominant scales at sites located upstream of the old barrage. In the opposite, they showed different dominance scales like; subrecedent, recedent, subdominant, dominant and eudominant.

Total Zooplankton abundance, Richness and Shannon diversity

The total zooplankton abundance and taxa richness at downstream sites were usually lower than upstream sites (Fig.2.a, b). The highest value for Shannon- wiener's diversity index was recorded in sites 1and 2 (upstream) while the lowest value was recorded in sites 5and 8 (downstream) (Fig. 2c).

By applying the statistical two way multivariate analysis of variance (MANOVA) for zooplankton total abundance, taxa richness and Shannon diversity (table 3) at the eight studied sites during different seasons during the period of investigation, it was concluded that:

- There were significant differences among the studied sites and seasons on the concepts of abundance ($p > 0.001$) and richness ($p > 0.001$).
- There were significant differences among the studied sites on the concepts of Shannon diversity ($p = 0.021$), while it showed a non- significant difference among seasons ($p = 0.562$).
- The interaction among sites and seasons and on abundance, richness and diversity showed non-significant differences ($p > 0.05$).
- It was noticed that the standard deviation of the zooplankton species recorded at downstream sites was higher than those recorded at upstream sites.

Discussion

The present study indicated the presence of eighty zooplankton taxa at the eight investigated sites (upstream and downstream) during the period of investigation. They were represented, by common freshwater crustacean groups (Cladocera, Copepoda (Cyclopoida and Calanoida) and Ostracoda), rotifers, and other group. Only one individual belonging to Protozoa group was also recorded. It was concluded from the study that the total density of zooplankton recorded at sites located upstream of the old barrages did (269504 Indv/m3) constitute 70.32% of the total zooplankton at both streams. On the other hand, the total density of zooplankton recorded at sites located downstream of the old barrages was (113744 Indv/m^3) constituting 29.68% of the total zooplankton at both streams. This great difference in zooplankton community between upstream and downstream could be attributed to bifold impacts of the old barrages and the activities associated with the construction of the new Assiut barrages. Jones and Candy (1981); Poiner and Kennedy (1984) reported that a further effect of dredging may be that the disturbance of sediments, releases sufficient organic materials to enhance the species diversity and population density of organisms outside the immediate zone of deposition of suspended material.

In the present study, each site showed differentiation in the dominancy and community distribution of each group. This may interpret why the standard deviation of zooplankton species recorded at downstream sites was higher than those recorded upstream sites. This may be due to lack of stability for samples because of the dredging and construction of the new barrages. El-Sherbiny *et al*. (2006) indicated that effect of dredging and dumping operations on zooplankton can vary depending on the degree of turbidity, duration of exposure, sediment composition and the quality of sediments being dredged.

The species; *Eucyclops serrulatus* disappeared completely at downstream sites. This may be due to the unstable conditions which occurred at downstream sites because of the construction of the new barrages. Jonathan *et al*. (2010) indicated that patterns of association between diversity and environmental stability indicate that increasing frequency of extreme events and greater ranges of variability may be more important than changes in average conditions. Scheffer (1998) indicated that turbidity is a very important structuring variable for zooplankton communities. Ueda *et al.* (1989) reported that the siltation have no fatal effects on copepods, even if the silt load is extremely high. Paffenhöfer and Sant (1985) stated that however, the extreme abundance of suspended, non-food particles in water reduces the feeding rate of copepods even though they can still feed selectively upon nutritious particles. Ayadi (2002) and Dejen *et al*. (2004) concluded that factors such as salinity precipitations or turbidity have been identified as critical factors in the development of zooplankton.

In the present study, the zooplankton species frequency for the overall zooplankton species was high at upstream sites than that of downstream sites except for the species; *Brachionus calyciflorus*, *Trichocerca longiseta* and *Euchlanis parva* it was higher at downstream sites. This relative high value of frequency of zooplankton at upstream sites could be attributed to stability of conditions as well as low water current in this region as a result of the presence of the old barrages. It is well known that barrages and dams make upstream conditions looks like lake conditions which enhance the development of true associations of zooplankton. However the relative increase of frequency of some species at downstream like that of *Brachionus calyciflorus*, *Trichocerca longiseta* and *Euchlanis parva* may be due to the ability of these species to tolerate the disturbance occurred by the construction of the new barrages. These species belong to the rotifer zooplankton group. Badsi *et al.* (2010) indicated that rotifers are opportunistic, small size, with short life cycles and highly tolerant to a variety of environmental factors. Gabriel (2013) reported that water movement can alter environmental parameters that influence zooplankton growth and it can also transport zooplankton into and out of a system.

The present study revealed that the mean value of Shannon diversity index (H) recorded slight fluctuations among different studied sites. Concerning upstream, the value of index (H) ranged from (2.65) in site 3 to (2.92) in site 2. On the opposite side, the value of index (H) at downstream increased from (2.44) in site 5 to (2.61) in site 7. In comparing upstream and downstream, the values of index (H) were (2.77) and (2.55); respectively.

This result agrees with that of Abdel-Hady (2013) who studied the influence of the High Dam on the quantity and quality of aquatic arthropods (Crustacean Zooplankton and Insects) in Aswan, Egypt where she concluded that the sites situated upstream of the High Dam are higher in species richness and abundance than that in downstream of the High Dam. Kerkhoff (2010) reported that typical values of the index are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. According to the abovementioned results it was concluded that the diversity from the studied upstream sites (undisturbed habitat) is relatively higher than that from the sites located downstream (highly disturbed habitat). So, the present investigation illustrated how diversity is impacted by different management strategies in the studied area. Attayed and Bozelli (1998) reported that changes in zooplankton diversity are known to be significant indicators of environmental disturbance. Omori and Ikeda (1984) illustrated that the measurement of species diversity provides useful information on the community structure and may be used as an index for assessing the degree of environmental pollution.

Many authors agreed that among the abiotic parameters, the structure of zooplankton is affected by the concentration of dissolved solids, the temperature, the size and land use of the basins, and environmental heterogeneity, because the higher number of habitats offered by larger lake environments exerting positive effects on the richness and abundance of zooplanktons (Kobayashi, 1997; Hobæk *et al*., 2002; Kalff, 2002; Hall and Burns, 2003 and Dodson *et al*., 2007).

The present study revealed that the mean value of zooplankton species richness fluctuated among studied sites; upstream and downstream of the old barrages on the Nile River. The species richness was higher at site (1) and site (2) which represented by 16.59 % of the richness recorded in the eight studied sites. According to the results of Richness; there were obvious decline in species Richness at sites located downstream. Li *et al*. (2006) and Guo *et al*. (2003) indicated that zooplankton species richness was generally going up with the salinity. Gaston (2000) stated that species richness often increase with ecosystem size. Hammer (1986) and Williams *et al*. (1990) indicated that extreme environments are typically characterized by a dominant environmental variable limiting species richness, and in hyper saline lakes, diversity is largely limited by the ability of each species to tolerate salinity stress. In many saline lakes around the world, a negative correlation between species richness and salinity has been observed. Jonathan *et al*. (2010) indicated that patterns of association between diversity and environmental stability indicate that increasing frequency of extreme events and greater ranges of variability may be more important than changes in average conditions. Scheffer (1998) indicated that turbidity is a very important structuring variable for zooplankton communities. In conclusion, the regional depletion of the density of zooplankton at downstream of the Nile River provides clear evidence of the effects of the new barrages on zooplankton community during the construction period at the construction work area.

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