Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 - 6131 Vol. 22(4): 13- 24 (2018)
ejabf.journals.ekb.eg

Ecological Assessment of the River Nile Status around Gizert El-Warrak using Phytoplankton and Macroinvertebrates Assemblages

Kadria M. A. Mahmoud; Sara S. M. Sayed and Mohamed R. Habib
Department of Environmental Research and Medical Malacology, Theodor Bilharz Research Institute.

ARTICLE INFO

Article History:
Received: July 18, 2018
Accepted: Aug. 2, 2018
Available online: Aug. 5, 2018

Keywords:
River Nile
Gizert El-Warrak
Phytoplankton
Macroinvertebrates
Bioassessment
Biotic index
Palmer′s index

ABSTRACT

Biological assessment is considered a useful tool for assessing the ecological status of the aquatic ecosystems. Therefore, the goal of the present study was to use phytoplankton and macroinvertebrates as biological tools for ecological assessment of the River Nile around Gizert El-Warrak. A total of 33 phytoplankton species were recorded at the studied stations; these include 16 species of Chlorophyta, 5 Cyanophyta and 12 Bacillariophyta species. All investigated stations were characterized by high organic pollution according to Palmer′s index. Trophic state index showed a hyper-eutrophic status in stations S1, S2, S4, S6 and S8 and an eutrophic status in stations S3, S5 and S7.Gastropoda and Oligochaeta were the most dominant of macroinvertebrates taxa recorded 50.8 and 24.6% of all biota, respectively. Diversity Index (H′) ranged between (1.14 - 2), which indicated that the structure of macroinvertebrate habitats was poor. Moreover, Evenness Index (J) ranged between (0.016 – 0.043), which indicated that individuals were not distributed equally. The values of biotic index (HBI) depending on macroinvertebrates categories showed that the River Nile's water quality is fairly poor with significant organic pollution.

INTRODUCTION

Although the chemical analysis of water gives a good sign of the quality of the aquatic system, it does not necessarily reflect the ecological status of the system (Karr *et al.,* 2000). Generally, the chemical assessment of water quality is based on determining the most important water parameters; nitrate, nitrite, soluble reactive phosphorus, ammonia, oxygen and biochemical oxygen demand. Whereas phosphorus and nitrogen are the relevant parameters for assessing the nutrient loading, ammonia and oxygen saturation are the pertinent criteria with respect to saprobity levels which demonstrated that these environments are undergoing a process of degradation (Rangel *et al.,* 2012). Nevertheless, the most acceptable ecosystem assessment requires evaluating physical and chemical factors as well as the composition and structure of biotic assemblages (Lobo and Callegaro, 2000).

In the last few decades, several developed and developing countries have been interested in rapid evaluation methods for the bioassessment of water quality (Al-Shami *et al.*, 2011). Most of these methods depend on phytoplankton and macroinvertebrates for the development of adequate tools to measure the ecological status of freshwater systems.

Indexed in Scopus ELSEVIER DOAJ IUCAT

In addition, these communities give insights about both the environmental effects of water chemistry and the physical characteristics of rivers (Stevenson and Pan, 1999). Furthermore, bioindication is considered easy and cost-effective tools for short- and long-term monitoring of the environmental and ecosystem integrity (Neumann *et al.,* 2003).

Phytoplankton is considered as a suitable bioindicator, they have a worldwide distribution, high reproduction rate and each species has high sensitivity towards different levels of organically polluted waters (Moura *et al.,* 2007). Also, they are used as indicators for saprobic conditions such as salinity, acidification and eutrophication in lakes and rivers (Smith *et al.,* 2014). Moreover, pH, ionic strength, substrate, current velocity, light (degree of shading), grazing and temperature affect the distribution patterns of phytoplankton in lotic systems (Santos *et al.*, 2016). Furthermore, Chlorophyll-*a* concentrations have been a subject of interest for many researchers concerned with the water quality for determining phytoplankton distribution as an indicator of the water body's health, composition, and ecological status (Kasprzak *et al.,* 2008). At water surface, high chlorophyll-*a* levels indicated to high algal growth or blooming and this is usually associated with excessive nutrients such as phosphorus and nitrogen. Upon dying, algae are depleted dissolved oxygen levels and lead to fish death (Horrigan *et al.,* 2002).

Another approach in water quality assessment, it is macroinvertebrates assemblages that have been traditionally used in the biomonitoring of stream and river ecosystems for various environmental stress types, such as organic pollution (Li *et al.,* 2010) and river pollution (Sharifinia *et al.,* 2016). Utilizing macroinvertebrates-based biotic indices has been developed for rapid bioassessment of rivers (Elias *et al.,* 2014; Kaaya *et al.,* 2015), since they are adapted to specific environmental conditions. If these conditions change, some organisms can disappear and be replaced by others. Therefore, variations in the composition and structure of their assemblages in running waters can indicate possible pollution (Alba-Tercedor, 1996). So that, using bioindication depending on phytoplankton and macroinvertebrates assemblages may give us a scope to assess the ecological status of the River Nile water quality around Gizert El-Warrak in the current work that aims at (1) estimate chlorophyll-*a* content, ammonia, nitrite, nitrate and phosphate for the assessment of the present water quality in the River Nile, (2) apply different indices based on phytoplankton and macroinvertebrates for determining water pollution levels and (3) study the compatibility of biological and chemical results to give an integrative picture about the water quality of the River Nile.

MATERIALS AND METHODS

Study area

Gizert El-Warrak is an Egyptian island in the River Nile with an area of about 1400 acres. The island located in El-Warrak city in Giza governorate, Egypt. It has a distinguishable location, bordered by Qalyubiya governorate from the North and Cairo governorate from the East. The study was conducted during December 2016 to February 2017 in the River Nile around Gizert El-Warrak from two sides of the island using a boat. Four stations were selected from each side, at a distance about 100 meters between stations. Stations, S1-S4 lies at 30º7′6.99″N which toward Warrak El-Hadder city and the main human activities were farming practices, while stations S5-S8 lies at 31º13′32″E which toward Shubra city and fishing was the common activities (Fig. 1).

Fig. 1: A map of Gizert El-Warrak showing the location of the investigated stations.

Field study

Total dissolved solids (TDS), water temperature (ºC) and electrical conductivity (EC) were measured monthly using a portable conductivity meter (HI 9635) and a portable pH meter (HI 9024) in three times per each station *in situ* at a mid-day, at 20 cm under the water surfaces. About three liters of water samples from each station were filtered *in situ* through a plankton net with mesh diameter 20µm and specimen were preserved by adding few drops of 4% formaldehyde. All samples were transferred in the labeled plastic containers to the laboratory for identification. Macroinvertebrates samples were collected in five times, using D-shaped aquatic net (20 x 40 cm) equipped with about 1m. long handle. Additionally, all macrophytes were removed from the stream and visually searched for macroinvertebrates, then all samples were transferred in the labeled plastic containers to the laboratory for identification.

Laboratory study

Water samples were collected from each station in three liters' plastic containers by the simple dip method and transferred to the laboratory. Nitrite (NO_2^-), nitrate (NO_3^-), ammonia (NH_3^+), phosphate and quantification of chlorophyll-*a* concentration were determined in collected water samples by standard methods according to APHA (2005).

Phytoplankton species were determined by a microscope Olympus 200x according tocommon taxonomic keys stated by Komárek and Komárkova (1992).

The trophic status of each station was calculated according to Carlson (1977), depending on chlorophyll-a concentration using the following equation:

$$\mathbf{TSI = 30.6 + 9.81\ In\ (Chl\text{-}a)}$$

Where, TSI = Trophic State Index, ln = natural logarithm and (Chl-a) = concentration of chlorophyll-a (µg/l). TSI value indicated as follows: >30 = Ultra oligotrophic, 30-50 = Oligotrophic, 51-60 = Mesotrophic, 61-70 = Eutrophic and <70 = Hyper-eutrophic.

On the other hand, organic pollution/ site was evaluated according to the Palmer′s pollution index (Palmer, 1968) depending on the major list of the algal genera that are tolerant to organic pollution. Palmer′s pollution index score was indicated as follows: <15 = very light organic pollution, 16-20 = moderate organic pollution and >20 = high organic pollution.

Macroinvertebrates samples were washed with dechlorinated tap water through a sieve (300 mm pore diameter), sorted out and identified based on orders taxonomic level according to published keys (Hynes, 1984; Elliott *et al.*, 1988; Pescador *et al.*, 2004).

Diversity Index (H′) was used according to Shannon and Wiener (1949) formula:

$$H' = -\sum [ni/N] \ln [ni/N]$$

Where **ni** is the number of individuals in each species, **N** equals the total number of individuals in the sample, and ∑ equals the total number of species in the sample. Results are generally between >4 = high status, 4-3= good status, 2-1= poor status and <1 =bad status.

Evenness Index (J) was used according to Pielou (1966) formula: $J = H' / \ln S$
H = Shannon – Wiener diversity index, ln = natural logarithm and S = total number of species in the sample. The values are between 0 – 1.When the value is getting closer to 1, it means that the individuals are distributed equally.

Biotic Index (BI) is based on categorizing macroinvertebrates into categories depending on their response to organic pollution according to Hilsenhoff (1977) formula: $HBI = \sum [(ni * ai) / N]$

Where **ni** is the number of specimens in each taxonomic group, **ai** is the pollution tolerance score for that taxonomic group, and **N** is the total number of organisms in sample.

Statistical analysis

Multivariate analysis of ecological data by canonical correspondence analysis (CCA) was conducted to detect the distribution pattern of macroinvertebrates orders related to physical parameters using XLSTAT 2016, Statistical software for Microsoft Excel, Par-is, France.

RESULTS

The average values of water temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), ammonia (NH_3^+), nitrite (NO_2^-), nitrate (NO_3^-) and phosphate (PO_4) are shown in Table (1). Generally, water pH values ranged (8.5-9). Phosphate concentrations at stations S1, S2, S3, S4, S5 and S6 were higher than stations S7 and S8. The highest concentrations of ammonia (303 mg/l) and nitrate (271 mg/l) were recorded at stations S2.

Table 1. The mean of physico-chemical characteristics of water collected from the eight investigated stations.

Stations	T (°C)	EC (µs/cm)	pH	TDS (mg/l)	Ammonia (NH_3) (µg/l)	Nitrite (NO_2) (µg/l)	Nitrate (NO_3) (µg/l)	Phosphate (PO_4) (µg/l)
S1	18.9±0.51	460±0.04	8.5±0.17	220±0.02	49±0.04	38±0.01	175±0.05	114±0.05
S2	19.3±1.34	430±0.03	8.7±0.16	280±0.10	303±0.36	25±0.02	271±0.07	167±0.08
S3	18.7±1.70	440±0.04	8.7±0.20	210±0.03	49±0.04	23±0.02	153±0.06	104±0.06
S4	18.0±1.75	360±0.09	8.8±0.15	210±0.03	60±0.06	51±0.03	201±0.01	151±0.08
S5	18.2±0.76	450±0.05	9.0±0.05	222±0.02	33±0.06	44±0.01	181±0.09	124±0.05
S6	18.2±1.60	420±0.07	8.9±0.12	220±0.02	ND	40±0.02	206±0.10	248±0.25
S7	18.0±1.00	450±0.02	8.9±0.04	230±0.01	ND	30±0.01	172±0.10	83±0.02
S8	18.3±0.43	440±0.03	9.0±0.06	220±0.01	ND	38±0.02	253±0.10	48±0.04

Temperature (T), Electrical conductivity (EC) and Total dissolved solids (TDS), Not Detected (ND).

While TSI results indicated that stations S1, S2, S4, S6 and S8 were hyper-eutrophic and water quality was poor, stations S3, S5 and S7 were eutrophic and water quality was fair as shown in Table (2).

Table 2. Classification of the investigated stations according to the Carlson's Trophic State Index (TSI) depending on average chlorophyll-*a* concentration.

Carlson's Trophic state index (TSI)	Criteria	sites	Mean of Chl-*a* (µg/l)	TSI calculated/ site	Trophic state/site	Water quality depend on TSI/ site
Ultraoligotrophic	<30	S1	170.5	81.01	Hyper-eutrophic	Poor
Oligotrophic	30-50	S2	150.2	79.76	Hyper-eutrophic	Poor
Mesotrophic	51-60	S3	30.26	64.05	Eutrophic	Fair
Eutrophic	61-70	S4	95.13	75.28	Hyper-eutrophic	Poor
Hyper-eutrophic	>70	S5	34.83	65.43	Eutrophic	Fair
Water quality depend on TSI values		S6	62.50	71.16	Hyper-eutrophic	Poor
Good	0-59	S7	40.13	66.81	Eutrophic	Fair
Fair	60-69	S8	66.56	71.78	Hyper-eutrophic	Poor
Poor	70-100					

In the current work, a total of 33 identified phytoplankton species were 16 species of Chlorophyta (green algae); 5 species of Cyanophyta (blue green algae) and 12 species of Bacillariophyta (diatoms). Diatoms were more dominant than green algae and blue green algae which showed an appreciable presentation (Table 3).

Table 3: List of the identified phytoplankton taxa and scoring of Palmer′s pollution index of the River Nile at Gizert El-Warrak stations.

Algae Taxa		S1	S2	S3	S4	S5	S6	S7	S8
Chlorophyta	*Actinastrum sp.*	+		+		+	+	+	+
	Ankistrodesmus acicularis	+ (2)	+(2)	+(2)	+(2)	+(2)	+(2)	++(2)	++(2)
	Chodatella cillata	+	+		+				
	Coelastrum microporum	+	+	+		+			+
	Cosmarium bioculatum	++	+	+					
	Mougeotia scalaris	±	+		+			+	+(1)
	Nephrocytium sp.	+		+					
	Oocystis parva	+					+	+	
	Pediastrum clathratum	+		+	+				
	Pediastrum gracilimum		+			+	+		+
	Pediastrum tetras		+				+	+	
	Scenedesmus obliquus	+(4)		+(4)	+(4)				
	Scenedesmus quadricauda	++(4)	+(4)	+(4)	++(4)	+(4)	+(4)	+(4)	++(4)
	Staurastrum paradoxum	+	+			+(4)	+(4)		+(4)
	Tetraedron minimm	+	+	+	+	+	+	+	++
	Ulothrix subitllssima	+		+		+	+	+	
Cyanophyta	***Gomphaspheria lacustris***	+(11)	+(1)		+(4)	+(1)	+(1)	+(1)	+(1)
	Merismopedia elegans	+	+	+	+	+	+	+	+
	Phormidium sp.	+(1)	+(1)						
	Oscillatoria limentica		+(4)	+(4)	+	+(4)	+(4)	+(4)	+(4)
	Microcystis flos-aquae	±	+	+			+	+	+
Bacillariophyta	*Amphora coffeaeformis*		+			+			+
	Cocconies placentula	+	+						+
	Cyclotella comta	++(1)	++(1)	++(1)	++(1)	+++(1)	+++(1)	+++(1)	+++(1)
	Diatoma elongatum	+++	+++	++	+	+++	+++	+++	+++
	Fragilaria capucina	+++	+++	+	++				
	Melosira granulata	++(1)	++(1)	+(1)	+(1)	++(1)	++(1)	++(1)	++(1)
	Navicula cuspidata	+(3)	+(3)			+(3)		+(3)	
	Nitzschia acicularis	++(3)	+++(3)	+(3)	++(3)	+(3)	+(3)		+(3)
	Nitzschia filiformis	++(3)	++(3)			+(3)	+(3)	+(3)	+(3)
	Nitzschia linearis	++(3)	+(3)		+(3)	++(3)	+(3)	+(3)	+(3)
	Stephanodiscus dubius	++	+		+	+		+	+
	Synedra ulna	+(2)	++(2)	+(2)	+(2)	++(2)	++(2)	++(2)	++(2)
Palmer′s pollution index		**38**	**28**	**21**	**24**	**29**	**31**	**28**	**24**

++++: Dominant; +++: Plenty; ++: Many; +: Appreciable; ±: Rare. Species in bold font represent major list of algal genera that tolerant to organic pollution and their scoring. Palmer′s pollution index: <15 very light organic pollution, 16-20 moderate organic pollution and >20 high organic pollution.

In addition, all the investigated stations characterized by high organic pollution according to palmer′s index (Table 3), that may explain the low number of the identified phytoplankton taxa as many of species might be disappeared due to the heavy pollution. The green algae (*Actinastrum* sp., *Ankistrodesmus acicularis, Scenedesmus obliquus* and *Scenedesmus quadricauda*) and diatoms (*Diatoma elongatum, Syndra ulna, Nitzschia acicularis, Nitzschia filiformis* and *Nitzschia linearis*) were the most dominant in the present examined stations.

Data of the collected macroinvertebrates taxa from sampling stations are presented in Table (4). Generally, the highest number of taxa was recorded at S1 and S4 with 789 and 776, respectively. Gastropoda and Oligochaeta were the highest taxa in relative abundance (Fig. 2).

Table 4. Taxonomic composition of macroinvertebrates taxa of the River Nile at Gizert El-Warrak stations.

Macroinvertebrates orders		Code	Taxon	S1	S2	S3	S4	S5	S6	S7	S8	Total	%
Insecta macroinvertebrates	**Ephemeroptera**	**Eph**	**Mayflies**	21	19	9	47	13	8	26	35	178	3.86
	Plecoptera	**Pleo**	**Stoneflies**	12	12	10	12	12		3	7	68	1.47
	Diptera (Chironomidae)	**Dip**	**Midgefly**		4	6						10	6.55
	Coleoptera	**Coleop**	**Riffle Beetle**	2	2		8		2	6	4	24	0.52
			Water Peny			35		5	12			52	1.13
	Odonata	**Odon**	**Dameslfly**	79	46	2	56	32	33	37	17	302	6.55
			Dragon fly	5	6		3	7	10	3	9	43	0.93
	Hemiptera	**Hemi**	**Water strider**	1					8			9	0.20
			True Bugs	1			5	2			1	9	0.20
			Water Scorpion			15						15	0.33
			Water Boatman	25	20		59			25	29	158	3.42
Non-Insecta macroinvertebrate	**Gastropoda**	**Gastr**	**Gastropods**	539	307	199	332	277	398	190	102	**2344**	**50.8**
	Bivalva (Class)		**Bivalves**	4				2		1		7	0.15
	Decapoda	**Deca**	**Shrimps**	14		5	39	22		10	45	135	2.93
			Cray fish	1	4	2	10	6	2	2	10	37	0.80
	Amphipoda		**Scuda**	5								5	0.11
	Euphausiacea		**Krill**	10	4	12	13	4	9	12	14	78	1.69
	Oligochaeta	**Oligo**	**Aquatic worms**	79	95	90	190	240	200	135	105	**1134**	**24.6**
	Hirudinea		**Leeches**		2	2	2					6	0.13
	Total			**789**	521	387	**776**	622	682	450	378	4614	

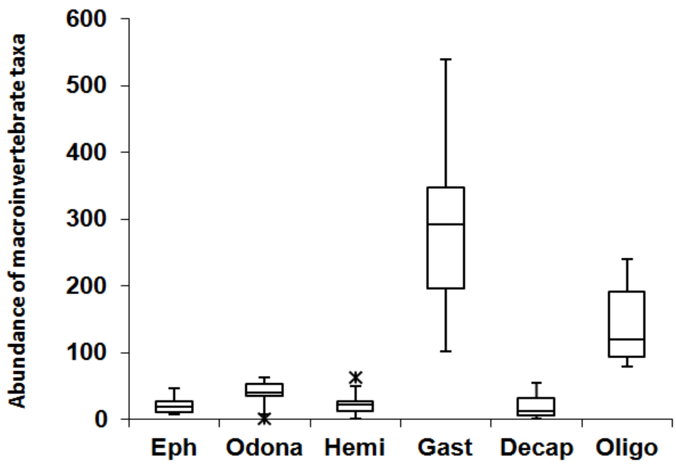

Fig. 2: Box plot illustrated the abundance of macroinvertebrate orders; the horizontal line inside each box represents the median, while the top and the bottom of the boxes represent the 25th and 75th percentile, respectively. Vertical lines from the end of the box encompass the extreme point, represent the maximum outlier.

The results of correlation between physicochemical parameters and macroinvertebrates taxa depending on multivariate analysis were shown in Fig. (3), the first two principal components (D1 = 45.1%, D2 = 21.1%), cumulatively explained 66.2% of the total variance. Generally, Gastropoda and Odonata were clustered together at S1 which distinguished by high chlorophyll-*a* (chl-a) level that indicated to high algal biomass. Oligochaeta was found at S5 and S6 which characterized by high nitrite (NO_2) and phosphate (PO_4), respectively. Meanwhile, all macroinvertebrates taxa avoid founding at station S2 due to high ammonia (NH_3) and nitrate (NO_3).

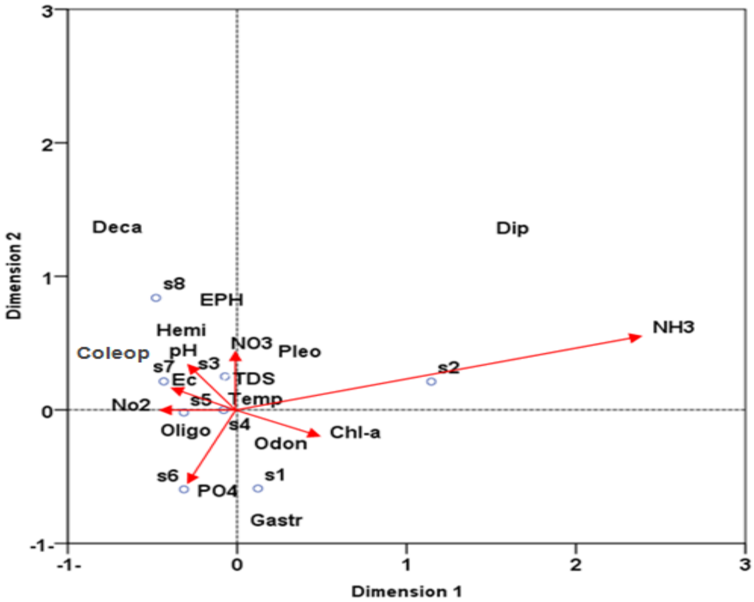

Fig. 3: Correlation biplot diagram of physicochemical variables and macroinvertebrates taxa from investigated stations. Codes of macroinvertebrates were stated in Table 4.

Concerning the calculated Diversity Index (H′) ranged (1.14 – 2) which indicated that the structure of macroinvertebrates habitat was poor. Also, the calculated Evenness Index (J) ranged (0.016 – 0.043) which indicated that individuals were not distributed equally. In addition, *Hilsenhoff* Biotic Index (HBI) results showed that all examined stations have a significant organic pollution, except station 8 was fairly significant pollution (Table 5).

Table 5: Macroinvertebrates-based indices Shannon-Wiener diversity index (H′), Pielou evenness index (J) and Hilsenhoff biotic index *(*HBI*)* in the River Nile at Gizert El-Warrak stations.

Stations	H′ index	J index	HBI	Water quality	Degree of pollution
1	1.24±0.08	0.018±0.01	6.62	Fairly poor	Sig. organic pollution
2	1.37±0.09	0.022±0.02	6.72	Fairly poor	Sig. organic pollution
3	1.51±0.10	0.026±0.03	6.68	Fairly poor	Sig. organic pollution
4	2.00±0.12	0.027±0.03	6.64	Fairly poor	Sig. organic pollution
5	1.70±0.12	0.043±0.11	6.83	Fairly poor	Sig. organic pollution
6	1.14±0.10	0.016±0.02	6.64	Fairly poor	Sig. organic pollution
7	1.59±0.11	0.023±0.03	6.39	Fairly poor	Sig. organic pollution
8	1.96±0.11	0.028±0.02	5.99	Fair	Fairly sig. organic pollution

DISCUSSION

The present water samples were alkaline ranged from 8.5 to 9. These results are in parallel to Svobodova *et al.* (1993) who declared that high water alkalinity was attributed to uptake a considerable amount of CO_2 during the day by algae and aquatic plants for photosynthetic activity in eutrophic waters. The high concentrations of phosphate were at stations S1, S2, S3, S4, S5 and S6, while the high concentrations of ammonia (303 mg/l) and nitrate (271 mg/l) were recorded at stations S2. This may be due to run-off the agriculture wastewater, where the farming practices were the main human activities at those stations. Yadav and Kumar (2011) stated that phosphate levels increased during winter due to agricultural run-off containing phosphate fertilizers and (detergents) municipal wastewater. Nevertheless, high concentrations of phosphate are rarely found in water where it is actively consumed by aquatic plants.

According to TSI results, stations S1, S2, S4, S6 and S8 were hyper-eutrophic state, while stations S3, S5 and S7 were eutrophic state.These results may be attributed to high chlorophyll-*a* content which is often used as an estimate of algal biomass (Wetzel, 2001). In the present work, diatoms were more dominant than green algae and blue green algae which showed an appreciable presentation. These results are in agree with Bilous *et al.* (2012) who reflected that the eutrophic state of the river ecosystem mostly due to the presence of green algae and diatoms. In addition, Ganai and Parveen (2014) stated that Bacillariophyta was the most dominant group of phytoplankton community in Wular Lake at Lankrishipora, Kashmir, and attributed that to their ability to grow under unsuitable conditions such as weak light, low temperature and nutrients (Ganai *et al.*, 2010).

According to palmer's index, all the investigated stations were characterized by high organic pollution. This may be explained the low number of the identified phytoplankton taxa as many of species might be disappeared due to the heavy pollution. Furthermore, the present results showed that the most dominant phytoplankton species in the present examined stations were from green algae (*Actinastrum* sp., *Ankistrodesmus acicularis, Scenedesmus obliquus* and *Scenedesmus quadricauda*) and from diatoms (*Diatoma elongatum, Syndra ulna, Nitzschia acicularis, Nitzschia filiformis* and *Nitzschia linearis*). These findings are in agree with Szabo *et al*. (2005) who demonstrated that *Achnantidium minutissimum* and many *Nitzschia* species are tolerant to a variety of pollution and are dominated in the environments that have stress. Kumar and Sharma (2014) explained that some species such as *Aulacoseira granulata* , *Cocconeis placentula, Cymbella spp., Fragilaria capucina* , *Gomphonema olivaceum, Diatoma elongatum, Navicula radiosa* and *Syndra ulna* were indicative to trophic status of aquatic ecosystems between oligotrophic to eutrophic.

On the other hand, the highest number of macroinvertebrates taxa was recorded at S1 and S4 with 789 and 776, respectively. Gastropoda and Oligochaeta were the highest taxa in relative abundance. This is in parallel with the pervious study of El-Khayat *et al.* (2011) who indicted that freshwater snails are generally tolerant to organic pollution. In addition, Andem *et al.* (2015) who stated that the highest Oligocheata abundance is an indication to poor water quality of Ediba River in Cross River State, Nigeria. Hence, a high density of them is a good indication of organic pollution because they are able to tolerate unfavorable conditions such as low dissolved oxygen and high pollutant concentrations.

The results of correlation between physicochemical parameters and macroinvertebrates taxa showed that Gastropoda and Odonata were found together at S1 which distinguished by high chlorophyll-*a* (chl-a) level. Most of the Gastropods feed on algae and their increase may be related to an increase in the periphyton and phytoplankton. Algal and diatoms remains to dominate in the gut of snails (Thorp and Covich, 2009). Therefore, gastropods have a greater affinity for nutrient-rich conditions than other macroinvertebrate orders. Additionally, Rosset *et al.* (2013)

stated that local and regional dragonfly (Odonata) species richness diversity was not negatively affected by eutrophication except at the local scale in the enriched water bodies. Oligochaeta was found at S5 and S6 which characterized by high nitrite (NO_2) and phosphate (PO_4), respectively. These species are reportedly more abundant in polluted streams and possess the ability to thrive in areas of reduced competition and low concentrations of oxygen (Arimoro *et al.,* 2007). Meanwhile, all macroinvertebrate taxa avoid founding at S2 due to high ammonia (NH_3) and nitrate (NO_3). Ammonia and nitrite can be extremely toxic for macroinvertebrates (Berenzen *et al.,* 2001).

The calculated Diversity Index (H′) ranged (1.14 - 2) which indicated that the structure of macroinvertebrates habitat was bad. Also, the calculated Evenness Index (J) ranged (0.016 – 0.043) which indicated that individuals were not distributed equally. In addition, Hilsenhoff Biotic Index (HBI) results showed that all examined stations have a significant organic pollution, except station 8 was fairly significant pollution. This organic pollution may be attributed to human activities such as farming andmunicipal wastewater nearby the tested stations. These results in agree with Dahl *et al.* (2004) and Ojija (2015) who concluded that agricultural activities, washing and bathing alter physico-chemical parameters of the stream and hence changing the abundance of macroinvertebrates as well as the quality of water.

CONCLUSION

The present study was conducted for short-term because of the degradation of the aquatic system, resulting in to reduce or disappearing species of phytoplankton and macroinvertebrates, which was a barrier to collect more samples for long-term. However, the present case study stated that the ecological status of River Nile’s water quality around Gizert El-Warrak is bad based on non-taxonomic measurements of algae (chlorophyll-a) and biotic indices of macroinvertebrates which reflected the actual conditions of the water quality. Therefore, such measurements may be considered as a vital method that reflects disturbances in aquatic systems and should be performed at different intervals of time to study how the aquatic ecosystem recovers their health.

Conflict of interest: The authors declare that they have no conflict of interest.

ACKNOWLEDGMENT

The authors express their deep thanks to Dr. Sayeda Mohamed Abdo, Research Water Pollution Department, National Research Centre, Dokki, Egypt, for her help, identified phytoplankton and water chemicals analysis.

REFERENCES

Alba-Tercedor, J. (1996). Macroinvertebrados acuáticos y calidad de las aguas de los ríos. In IV Simposio del agua en Andalucía (SIAGA). Almería, 2: 203-213.

Al-Shami, S.A.; MdRawi, C.S.; Ahmad, A.H.; Abdul Hamid, S. and MohdNor, S.A. (2011). Influence of agricultural, industrial, and anthropogenic stresses on the distribution and diversity of macroinvertebrates in Juru River Basin, Penang, Malaysia. Ecotoxicol.Environ.Saf., 74: 1195–1202.

Andem, A.B.; Esenowo, I.K. and Bassey, D.O. (2015). Application of biotic indices and pollution tolerance index in assessing macro-invertebrate assemblage of

Ediba River, cross river state, Nigeria. J. Environ. Anal. Toxicol., Doi:10.4172/2161-0525.S7-007.

APHA, (American Public Health Association) (2005). Standard methods for the examination of water and wastewater, 21st edn. AWWA, WPAE, N.Y. Washington.

Arimoro, F.O.; Ikomi, R.B. and Iwegbue, C.M. (2007). Water quality changes in relation to Diptera community patterns and diversity measured at an organic effluent impacted stream in the Niger Delta, Nigeria. Ecol. indic., 7(3): 541-552.

Berenzen, N.; Schulz, R. and Liess, M. (2001). Effects of chronic ammonium and nitrite contamination on the macroinvertebrate community in running water microcosms. Water Res., 35(14): 3478-3482.

Bilous, O.; Barinova, S. and Klochenko, P. (2012). Phytoplankton communities in ecological assessment of the Southern Bug River upper reaches (Ukraine). Ecohydrol. Hydrobiol., 12: 211-230.

Carlson, R. E. (1977). A trophic state index for lakes.Limnol. Ocean., 22: 361-369.

Dahl, J.; Johnson, R.K. and Sandin, L. (2004). Detection of organic pollution of streams in southern Sweden using benthic macroinvertebrates. In Integrated Assessment of Running Waters in Europe (pp. 161-172). Springer, Dordrecht.

Elias, J.D.; Ijumba, J. N. and Mamboya, F. A. (2014). Effectiveness and compatibility of non-tropical bio-monitoring indices for assessing pollution in tropical rivers - a review, 4(3): 128–134.

El-Khayat, H.M.; Mahmoud, K.M.; Mostafa, B.B.; El-Deeb, F.A.; Tantawy, A.A.; Ragb, F.M.; Ismail, N.M.; El-Said, K.M. and Abu Taleb, H.M. (2011). Habitat characteristics for different freshwater snail species as determined biologically through macroinvertebrate information, Egypt. J. Egypt. Soc. Parasitol., 41: 651-664.

Elliott, J.M.; Humpesch, U.H. and Macan, T.T. (1988). Larvae of the British *Ephemeroptera*: a key with ecological notes. (No. 49). Freshwater Biological Association.

Ganai, A.H. and Parveen, S. (2014). Effect of physico-chemical conditions on the structure and composition of the phytoplankton community in Wular Lake at Lankrishipora, Kashmir. Int. J.Biodiv. Conv., 6: 71-84.

Ganai, A. H.; Parveen, S.; Khan, A. A. and Maryam, H. (2010). Phytoplankton diversity at WatlabGhat in Wularlake, Kashmir. J. Eco. Nat. Environ., 2: 140-146.

Hilsenhoff, W.L. (1977). Use of arthropods to evaluate water quality of streams.Technical Bulletin (No. 100). Department of Natural Resources, Madison. Wisconsin.

Horrigan, L.; Lawrence, R. S. and Walker, P. (2002). How sustainable agriculture can address the environmental and human health harms of industrial agriculture. Environ. Health Pers., 110: 445–456.

Hynes, H.B.N. (1984). A key to adult and nymphs of the British stoneflies (Plecoptera) with notes on the ecology and distribution.(No. 17).Freshwater Biological Association.

Kaaya, L.T.; Day, J.A. and Dallas, H.F. (2015). Tanzania River Scoring System (TARISS): a macroinvertebrate-based biotic index for rapid bioassessment of rivers. Afric. J. Aqua. Sci., 40(2): 109-117.

Karr, J.R.; Allen, J.D. and Benke, A.C. (2000). River conservation in the United States and Canada. In: Boon, P J; Davies, B R; Petts, G E (Eds.) Global perspectives on River conservation. Science, Policy and Practice.Wiley, New York.

Kasprzak, P.; Padisak, J.; koschel, R.; Krienitz, R. and Gervais, R. (2008). Chlorophyll a concentration across of trophic gradient of lakes: An estimator of phytoplankton biomass. Limnolo., 38: 327-338.

Komárek, J. and Komárkova, L. J. (1992). Variability of some planktonic gomphosphaerioidcyanobrokaryotes in northern lakes.Nordic. J. Bot., 12: 513-524.

Kumar, A. and Sharma, M.P. (2014). Application of water quality index and diversity index for pollution assessment of Kankarialake at Ahmedabad, India. J Civil Environ Engin., doi:10.4172/2165- 784X.1000144.

Li, L.; Binghui, Z. and Lusan, L. (2010). Biomonitoring and Bioindicators Used for River Ecosystems: Definitions, Approaches and Trends. Procedia. Environ. Sci., 2: 1510 –1524.

Lobo, E.A. and Callegaro, V.L. (2000). Avaliação da qualidade de águas doces continentais com base em algas diatomáceas epilíticas: Enfoque metodológico. *Avaliação e Controle da Drenagem Urbana. Porto Alegre: Ed. Universidade/UFRGS*, 558: 277- 300.

Moura, A.N.; Bittencourt-Oliveira, M.C. and Nascimento, E.C. (2007). Benthic Bacillariophytaof the ParipeRiverestuary in Pernambuco state, Brazil.Braz. J. Biol., 67: 393-40.

Neumann, M.; Liess, M. and Schulz, R. (2003). An expert system to estimate the pesticide contamination of small streams using benthic macroinvertebrates as bioindicators, Part 2: The knowledge base of LIMPACT. Ecol. Indic., 2: 391–401.

Ojija, F. (2015). Analysis of water quality parameters and ecosystem services of Nzovwe stream. Int. J. Biol. Sci. Tech., 7(1): 1.

Palmer, C.M. (1968). Keys to water quality indicative organisms (South Eastern United States) Dept. of Interior, Federal Water Pollution Control Administration. Ohio, U.S.A.

Pescador, M.L.; Rasmussen, A.K. and Harris, S.C. (2004). Identification manual for the caddisfly (Trichoptera) larvae of Florida. Department of Environmental Protection. Florida.

Pielou, E.C. (1966). The measurement of diversity in different types of biological collections. J. Theoret. Biol., 13: 131-144.

Rangel, L.M.; Silva, L.H.S.; Rosa, P.; Roland, F. and Huszar, V.L.M. (2012). Phytoplankton biomass is mainly controlled by hydrology and phosphorus concentrations in tropical hydroelectric reservoirs. Hydrobiol.,693: 13–28.

Rosset, V.; Simaika, J. P.; Arthaud, F.; Bornette, G.; Vallod, D.; Samways, M.J. and Oertli, B. (2013). Comparative assessment of scoring methods to evaluate the conservation value of pond and small Lake biodiversity. Aquatic Conservation: Marine and Fresh. Ecosys., 23(1): 23-36.

Santos, J.B.O.; Silva, L.H.S.; Branco, C.W.C. and Huszar, V.L.M. (2016). The roles of environmental conditions and geographical distances on the species turnover of the wholephytoplankton and zooplankton communities and their subsets in tropical reservoirs.Hydrobiol., 764: 171-186.

Shannon, C.E. and Wiener, W. (1949). The mathematical theory of communication.Urbana, University of Illinois.Press., P. 177

Sharifinia, M.; Mahmoudifard, A.; Gholami, K.; Namin, J.I. and Ramezanpour, Z. (2016). Benthic diatom and macroinvertebrate assemblages, a key for evaluation of river health and pollution in the Shahrood River, Iran.Limnol., 17: 95–109.

Smith, W.S.; Gaeta, E.L. and Rocha, O. (2014). Environmental gradient in reservoirs of themedium and low Tietê River: limnological differences through the habitat sequence. Acta. Limnol. Brasil., 26: 73-88.

Stevenson, R.J. and Pan, Y. (1999). Assessing environmental conditions in Rivers and streams using diatoms. In: Stoermer, E.F, Smol, J.P. (Eds.), The diatoms. Applications for the environmental and earth sciences. Cambridge University Press, Cambridge.,11–40.

Svobodova, Z.; Lloyd, R.; Machova, J. and Vykusova, B. (1993). Water Quality and Fish Health (No. 35). EIFAC, Rome.

Szabo, K.; Kiss, K.T.; Taba, G. and Acs, E.(2005). Epiphytic diatoms of the Tisza River, KiskoreResevior and some oxbows of the Tisza River.Acta.Botan.Croatica.,64*:* 1-46.

Thorp, J.H. and Covich, A. P. (Eds.). (2009). Ecology and classification of North American freshwater invertebrates. Academic press.

Wetzel, R.G. (2001). Limnology: lake and river ecosystems. gulf professional publishing.

Yadav, S.S. and Kumar, R. (2011). Monitoring water quality of Kosi river in Rampur district, Uttar Pradesh, India. Adv. Appl. Sci. Res., 2(2): 197-201.

ARABIC SUMMARY

التقييم البيئى لنهر النيل حول جزيرة الوراق بدراسة مجموعات العوالق النباتيه واللافقاريات الكبيرة

قدرية محمود على محمود ، ساره سيد محمود سيد ، محمد رمضان حبيب
قسم بحوث البيئة والرخويات الطبية – معهد تيودور بلهارس للابحاث

يعتبر التقييم البيولوجي وسيلة جيدة لتقييم الوضع البيئي للنظم الإيكولوجية المائية. ولذلك، استهدفت الدراسة الحالية دراسة الفيتوبلانكتون واللافقاريات الكبيرة كأدوات بيولوجية لتقييم الوضع البيئي لنهر النيل حول جزيرة الوراق. وأظهرت النتائج وجود ثلاثة وثلاثون نوعاً من الفيتوبلانكتون تم تحديدها في المواقع محل الدراسة ، حيث اشتملت هذه الأنواع على ستة عشر نوعا من الطحالب الخضراء وخمسة أنواع من الطحالب الخضراء المزرقة وإثنى عشر نوعا من الدياتوميات. وأوضحت النتائج وفقا لمؤشر بالمر(Palmer index) أن جميع المواقع محل الدراسة كانت على درجه عالية من التلوث العضوى. بينما أظهرت نتائج مؤشر الحالة الغذائية للماء (Trophic index) لكل من مواقع 1، 2، 4، 6 & 8 انها غنية بالعناصر الغذائية (شديدة التغذية) بينما لوحظ ان المواقع 3، 5 & 7 كانت حالة الماء فيها (عالية التغذية). وقد سجلت النتائج أعلى النسب المئوية تواجدا لأنواع اللافقاريات الكبيرة، حيث كانت كثافه الرخويات والديدان الحلقية بنسبة 50.8٪ و 24.6 ٪ على التوالى . بينما تراوحت نتائج مؤشر التنوع (H′) ما بين (1.14 – 2) والذى يشير الى ان التركيب البيئى للافقاريات الكبيرة كان سيئا. علاوة على ذلك، تراوح مؤشرالتكافؤ (J) ما بين (0.016 – 0.043)، مما يشيرالى عدم التساوى فى توزيع الكائنات المجمعه. وأظهرت نتائج المؤشرات الحيوية (HBI) المعتمدة على أنواع اللافقاريات الكبيرة أن جودة مياه نهر النيل غير جيدة مصحوبة بدرجة عالية من التلوث العضوى.