



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

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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.

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-Tecedor, 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 30°7'6.99"N which toward Warrak El-Hadder city and the main human activities were farming practices, while stations S5-S8 lies at 31°13'32"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 (°C) 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 20 μ m 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 (NO₂⁻), nitrate (NO₃⁻), ammonia (NH₃⁺), 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 to common 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:

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

Where, TSI = Trophic State Index, ln = natural logarithm and (Chl-*a*) = concentration of chlorophyll-*a* (μ g/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:

$$H' = -\sum \left[\frac{ni}{N} \ln \left[\frac{ni}{N} \right] \right]$$

Where ni is the number of individuals in each species, N equals the total number of individuals in the sample, and \sum 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:

$$HBI = \sum \left[\frac{(ni * ai)}{N} \right]$$

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 ($\mu\text{s}/\text{cm}$)	pH	TDS (mg/l)	Ammonia (NH_3) ($\mu\text{g}/\text{l}$)	Nitrite (NO_2) ($\mu\text{g}/\text{l}$)	Nitrate (NO_3) ($\mu\text{g}/\text{l}$)	Phosphate (PO_4) ($\mu\text{g}/\text{l}$)
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- <i>a</i> (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	<i>Actinastrum sp.</i>	+		+		+	+	+	+
	<i>Ankistrodesmus acicularis</i>	+(2)	+(2)	+(2)	+(2)	+(2)	+(2)	++(2)	++(2)
	<i>Chodatella cillata</i>	+	+		+				
	<i>Coelastrum microporum</i>	+	+	+		+			+
	<i>Cosmarium bioculatum</i>	++	+	+					
	<i>Mougeotia scalaris</i>	±	+		+				+
	<i>Nephrocytium sp.</i>	+		+					+(1)
	<i>Oocystis parva</i>	+						+	+
	<i>Pediastrum clathratum</i>	+		+	+				
	<i>Pediastrum gracilimum</i>			+			+		+
	<i>Pediastrum tetras</i>		+					+	+
	<i>Scenedesmus obliquus</i>	+(4)		+(4)	+(4)				
	<i>Scenedesmus quadricauda</i>	++(4)	+(4)	+(4)	++(4)	+(4)	+(4)	+(4)	++(4)
	<i>Staurastrum paradoxum</i>	+	+			+(4)	+(4)		+(4)
<i>Tetraedron minimm</i>	+	+	+	+	+	+	+	++	
<i>Ulothrix subtilissima</i>	+		+				+	+	
Cyanophyta	<i>Gomphaspheria lacustris</i>	+(11)	+(1)		+(4)	+(1)	+(1)	+(1)	+(1)
	<i>Merismopedia elegans</i>	+	+	+	+	+	+	+	+
	<i>Phormidium sp.</i>	+(1)	+(1)						
	<i>Oscillatoria limnetica</i>		+(4)	+(4)	+	+(4)	+(4)	+(4)	+(4)
	<i>Microcystis flos-aquae</i>	±	+	+			+	+	+
Bacillariophyta	<i>Amphora coffeaeformis</i>		+			+			+
	<i>Cocconies placentula</i>	+	+						+
	<i>Cyclotella comta</i>	++(1)	++(1)	++(1)	++(1)	+++ (1)	+++ (1)	+++ (1)	+++ (1)
	<i>Diatoma elongatum</i>	+++	+++	++	+	+++	+++	+++	+++
	<i>Fragilaria capucina</i>	+++	+++	+	++				
	<i>Melosira granulata</i>	++(1)	++(1)	+(1)	+(1)	++(1)	++(1)	++(1)	++(1)
	<i>Navicula cuspidata</i>	+(3)	+(3)			+(3)	+(3)	+(3)	
	<i>Nitzschia acicularis</i>	++(3)	+++ (3)	+(3)	++(3)	+(3)	+(3)	+(3)	+(3)
	<i>Nitzschia filiformis</i>	++(3)	++(3)			+(3)	+(3)	+(3)	+(3)
	<i>Nitzschia linearis</i>	++(3)	+(3)		+(3)	++(3)	+(3)	+(3)	+(3)
	<i>Stephanodiscus dubius</i>	++	+		+	+		+	+
	<i>Synedra ulna</i>	+(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	Damesfly	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			

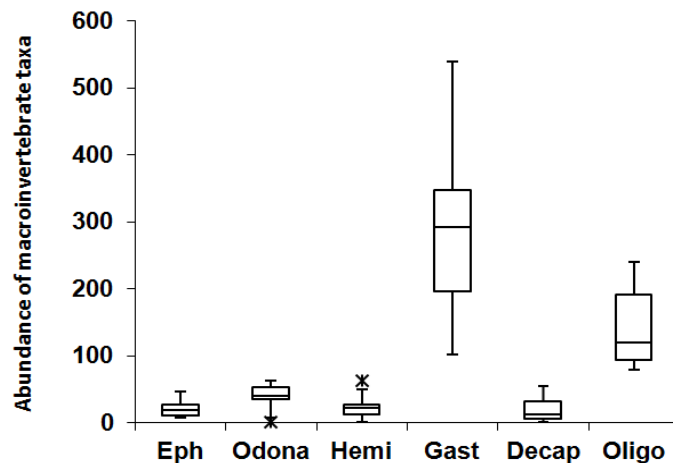


Fig. 2: Box plot illustrated the abundance of macroinvertebrate orders; the horizontal line inside each box represents the median, while the top and the bottom of the boxes represent the 25th and 75th percentile, respectively. Vertical lines from the end of the box encompass the extreme point, represent 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 (NO₂) and phosphate (PO₄), respectively. Meanwhile, all macroinvertebrates taxa avoid founding at station S2 due to high ammonia (NH₃) and nitrate (NO₃).

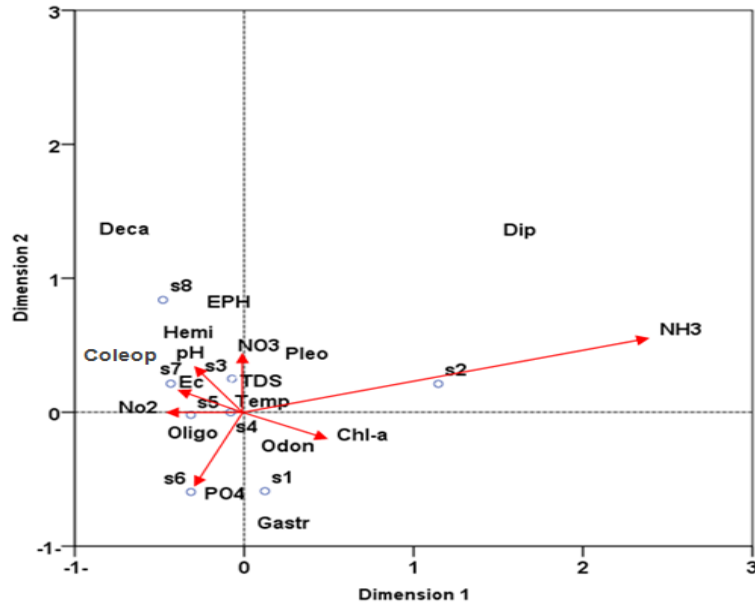


Fig. 3: Correlation biplot diagram of physicochemical variables and macroinvertebrates taxa from investigated stations. Codes of macroinvertebrates were stated in Table 4.

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 CO₂ 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 Oligochaeta 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 (Thorpe 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 and municipal 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.

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ARABIC SUMMARY

التقييم البيئي لنهر النيل حول جزيرة الوراق بدراسة مجموعات العوالق النباتية واللافقاريات الكبيرة

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

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 نوعاً من الطحالب الخضراء وخمسة أنواع من الطحالب الخضراء المزرققة وإثنى عشر نوعاً من الدياتوميات. وأوضحت النتائج وفقاً لمؤشر بالمر (Palmer index) أن جميع المواقع محل الدراسة كانت على درجة عالية من التلوث العضوي. بينما أظهرت نتائج مؤشر الحالة الغذائية للماء (Trophic index) لكل من مواقع 1، 2، 4، 6، 8 أنها غنية بالعناصر الغذائية (شديدة التغذية) بينما لوحظ أن المواقع 3، 5، 7 كانت حالة الماء فيها (عالية التغذية). وقد سجلت النتائج أعلى النسب المئوية تواجداً لأنواع اللافقاريات الكبيرة، حيث كانت كثافة الرخويات والديدان الحلقية بنسبة 50.8% و 24.6% على التوالي. بينما تراوحت نتائج مؤشر التنوع (H') ما بين (1.14 – 2) والذي يشير إلى أن التركيب البيئي لللافقاريات الكبيرة كان سيئاً. علاوة على ذلك، تراوح مؤشر التكافؤ (J) ما بين (0.016 – 0.043)، مما يشير إلى عدم التساوي في توزيع الكائنات المجمع. وأظهرت نتائج المؤشرات الحيوية (HBI) المعتمدة على أنواع اللافقاريات الكبيرة أن جودة مياه نهر النيل غير جيدة مصحوبة بدرجة عالية من التلوث العضوي.