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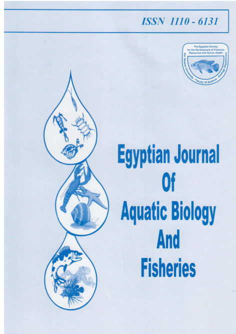

Environmental Indices and Phytoplankton Community Structure as Biological Indicators for Water Quality of the River Nile, Egypt

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ABSTRACT

The River Nile is the principal freshwater resource in Egypt, meeting nearly all demands for drinking water, irrigation, and industry. The objective of this present study is to characterize the current environmental variables and the existent populations of phytoplankton along a segment of the River Nile near Mansoura City. The direct estimation of phytoplankton cell number gave an estimation of the standing crop. A total of 214 different planktonic algal taxa belonging to 64 genera were identified. Maximum peak of $106.9X10^6$cellsl^1 was recorded at S2 in April, of which cyanophycean species were the most dominant. Most of used indices, especially those diatom-dependent ones, gave a reliable indication of water quality with distinct irregular local variations. A significant decrease in species diversity was recorded at S4 during June indicating a significant level of water pollution. However, the diversity index was 1.06 referring to a moderate to light pollution conditions. The saprobic index mean value is 1.96 indicating an oligosaprobic to β-mesosaprobic conditions and the existence of blue-greens indicates a degree of toxicity. The integrated results between (measured and calculated) generally described the Nile water quality as in moderated level with some cases of temporal disqualify of potable with poor to very poor status at some sites, which mean it is within the standard level of drinking water as approved by the national and international agencies. Although temporal and spatial data confirmed the importance to set some environmental legalization and policies to ensure that the Nile water is maintained appropriately for the identified usage sector.

INTRODUCTION

Quality of the drinking Water is a crucial demand worldwide; however the world's finite supply of freshwater has been subjected to increasing pressures over the last decades. Keeping the current trends of overpopulation and water use, would increase the demand for freshwater by > 56% than the current available quantity by 2025 (UNEP, 2002). This consider as a major obstacle for sustainable development or/and use of natural water resources worldwide, particularly fresh-water ones.

The River Nile is the life donor and the main artery for drinking water in Egypt. Unfortunately, Nile ecosystem is currently suffering from the discharge of contaminated agricultural wastewater, oil discharge and untreated domestic wastewater (Hammad and Ibrahim, 2012).

This might be due to the introduction of the heavy industries (e.g. chemicals, food, metal products, and textiles industries) at the beginning of the Nineteenth century along with the Nile (i.e. in Delta, Cairo and Alexandria) (Hamza and Gallup, 1982). The increasing discharges into the River Nile with its decreased ability to swept-out effluents into the sea are behind the great danger of becoming a waste collecting system (Abdel-Satar, 2005). For esample, the industrial pollutants exhibited deleterious effects on structure and function of the resident biological communities and low water quality has been determined within the water downstream of Damietta and Rosetta branches (El-Ayouty and Ibrahim, 1980; Abdel- Hamid *et al*., 1992a, b; Shaaban-Dessouki *et al.,* 1994a,b and Abdel-Aal, 2006).

One of the ultimate national developmental goals in Egypt is saving the Nile water and plan for a promoting sustainable use to prevent, eliminate or mitigate the Nile water quality and sustain the Nile ecosystem balance. Monitoring the Nile River is crucially targeted not only for Egypt but also for the other 10 countries. However, the ability to properly track progress toward minimizing impacts on natural environments and improving access of human to safe water depends on the availability of a huge data set that document trends of change at both space and time dimensions.

In fact, chemical and physical components of the Nile System are affecting water quality and could be good indicatives of water pollution level and sources of pollutants (Ali, *et al*., 2014). Chemical analyses of water provide a good indication of the quality of aquatic systems; however, they do not integrate ecological factors and do not necessarily reflect the ecological status of the system (Barbour *et al.,* 2000 and Karr *et al.,* 2000). However, Biological assessment could be a useful alternative since biological communities integrate the environmental effects of water chemistry, in addition to the physical and geomorphological characteristics of rivers and lakes (Stevenson and Pan, 1999). Biological indicators could be a descriptive measure not only for the level of pollution and eutrophication phenomenon of any aquatic system but also for the system balance and functionality. Aquatic living communities could also reflect the influence of chemical and physical disturbances that occur over an extended period. It can provide a holistic and an integrated measure of the integrity or health of the river as a whole (Chutter, 1998).

Ecosystem variations usually lead to concomitant quantitative changes in planktonic organisms, especially phytoplankton (Adam *et al*., 1990). Phytoplankton could be used to mirror any aquatic ecosystem and would reflect significantly the system interactions. This could be provided through information of the system biodiversity, community structure, species richness and biomass shifts. There is a hundreds of biological variables and indices could be examined and measured, of which some variables provide a general indication of water pollution level, whereas others can tackle the source of pollution, type and fate of pollutants.

This segment of the River Nile has been previously studied (Ali, *et al*. 2014) based on chemical constituents of the water either through chemical analyses or through the application of chemically based water quality index (WQI). The main objective of this research is to provide an overview of the major biological components and characteristics of the Nile surface water quality at a segment of the River Nile near Mansoura City. The study focused on detailed analyses of phytoplankton community structure and integrated the inter-linkage between biological aspects of the system and pollution level/pollutants. Application of a mathematical integrated analysis of biological water indices would help to generate a descriptive image of the Nile system functionality. It could propose solutions and/or recommendations to minimize the impacts of the continuously developed man-made activities or to mitigate the reflected health problems outbreaks.

MATERIAL AND METHODS

Study Area

The River Nile is one of the world longest rivers and is the donor of life to Egypt and represents the principle freshwater resource that meets nearly all demands for drinking water and irrigation. The River Nile flows from south to north with 6,850 kilo meters long and over 35 degrees of latitude. Its catchment basin covers approximately 10 % of the African continent, with an area of 3 106 Km2, and spreads over 10 countries from Uganda in the south to Egypt in the north. Passing through Kenya, Tanzania, Rwanda, Burundi, DR Congo, Zaire, Ethiopia, and Sudan 42.

For the current research, five sampling sites named; Meet Khamis (S1), Nawsa El Bahar (S2), Meneit Samanoud (S3), El Nasria (S4) and Abou Sair (S5) were selected lengthwise to represent a selected segment of the River Nile along Damietta branch. These sites were distributed between Aga town (31°03’41.34”N, 31°34’84.45”E) at the south and Mansoura city (30°92’33.15”N, 31°22’25.57”E) at the northern part of the River Nile (Figure 1). This section of the Nile River is typically bounded by variable land uses (including agriculture, urban, industrial and others) that experiencing direct and indirect impacts on the water quality. It is worth mentioning that El-Nasria sampling site (S4) is a receiving site for water from El-Nasria Pumping Station.

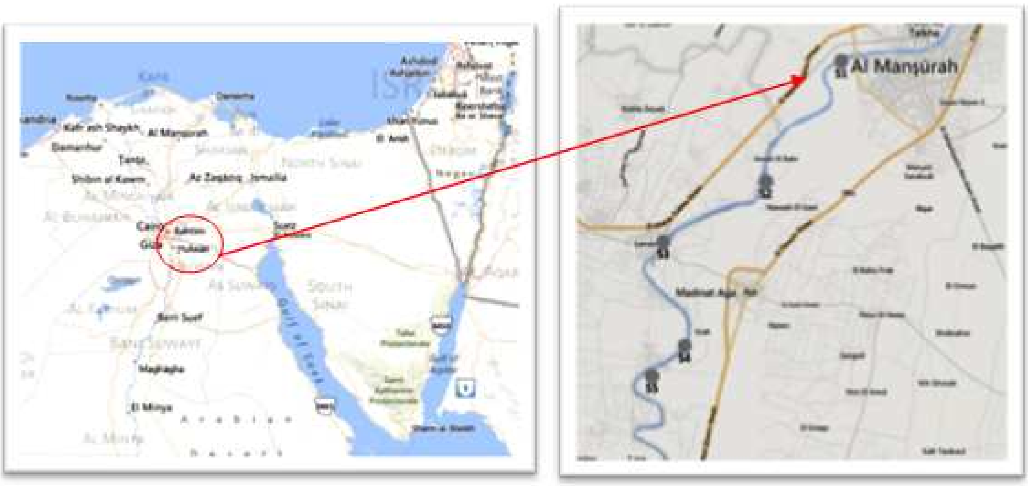

Fig. 1: A map showing the study segment of the River Nile and the five sampling sites

Sampling Procedure

Water samples were collected once a month during the period from March, 2011 to February, 2012. Surface water samples (1 m) were collected using non-metallic water sampler and kept in dark until reach the laboratory for biological analyses.

Analyses of physical and chemical characteristics of water samples were carried out according to the standard methods for water examination (APHA). Phytoplankton species structure was identified and counted according to Utermöhl (1958). For diatoms identification, sub-samples of sediment phytoplankton were treated with 10% HCL, heated gently for one hour, rinsed with distilled water, heated again for one hour with 30% H_2O_2 in a water bath at 60°C and then rinsed with distilled water (Cronberg, 1982). Identification of algal taxa (to level of species and variety) was done according to Smith (1920); Patrick and Reimer (1966); Phlipose (1967); Fott (1969); Weber (1971); Schoeman and Archibald (1976); Prescott (1978) and VanL & Ingham (1982).

Biological Assessment of Water Quality

Relevant biological indices were applied to evaluate the trophy and pollution status of the study area of the River Nile. Five indices were used including; 1) Diversity index (Shannon and Weaver, 1963) to calculate phytoplankton species diversity; 2) Saprobic index which relate the existent biological composition to level of pollution (Guhl, 1987; 3) the trophic diatom index (Kelly and Whitton, 1995) to indicate the trophic status of the River Nile; 4) The diatomic index (DI) which based on the weighted average equation of Zelinka and Marvan (1961) to estimate the degree of water pollution; and 5) the Generic Diatom Index GDI to assess water quality based on the diatoms genus level (Coste and Ayphassorho, 1991) and 6) The Pollution Index which determine the level of organic pollution according to the existent algal community (Palmer, 1969). It assign an index factor from 1-5 for each of the 20 most tolerant species to organic pollution, where 5 is given to the more tolerant species and vice versa (Palmer, 1969).

Statistical Analyses:

Statistical analyses were conducted to measure the dependence of the integrated water quality attributes. Correlation (predictive statistics) was carried out using STATGRAPHICS (STSC, ver. 4.2) program. The correlation coefficients are considered significant at the 95% confidence level ($p \leq 0.05$). Also canonical corresponding analysis (CCA) was carried out using the Past program (multivariate statistical package, ver. 1.72).

RESULTS

Phytoplankton Community Structure and Species Composition:

Phytoplankton community along the studied Nile segment was represented by 214 planktonic taxa belonging to 51 genera (Appendix I), of which, Chlorophyta was represented by 96 species followed by Bacillariophyta by 59 species and Cyanophyta by 29 species. Community structure of phytoplankton was markedly varies during the period of the study (Fig. 2 & Table 1) with Chlorophyta as the most dominant group in species richness. However, Cyanophyta was the dominant group at all sites with regards to cell number followed by Chlorophyta in the second position. Although, Euglenophyta (15 species) and Charophyta (14 species) were contributed less to the total number of genera (214 species), Euglenophyta showed significant peaks at S4 (El-Nasria site) during the entire period of investigation.

Table 1: Number of genera and species per each algal Phylum.

Number / Division	No. of genera	No. of species
Cyanophyta	12	29
Chlorophyta	31	112
Cryptophyta	1	1
Bacillariophyta	17	59
Euglenophyta	2	15
Total Number	64	214

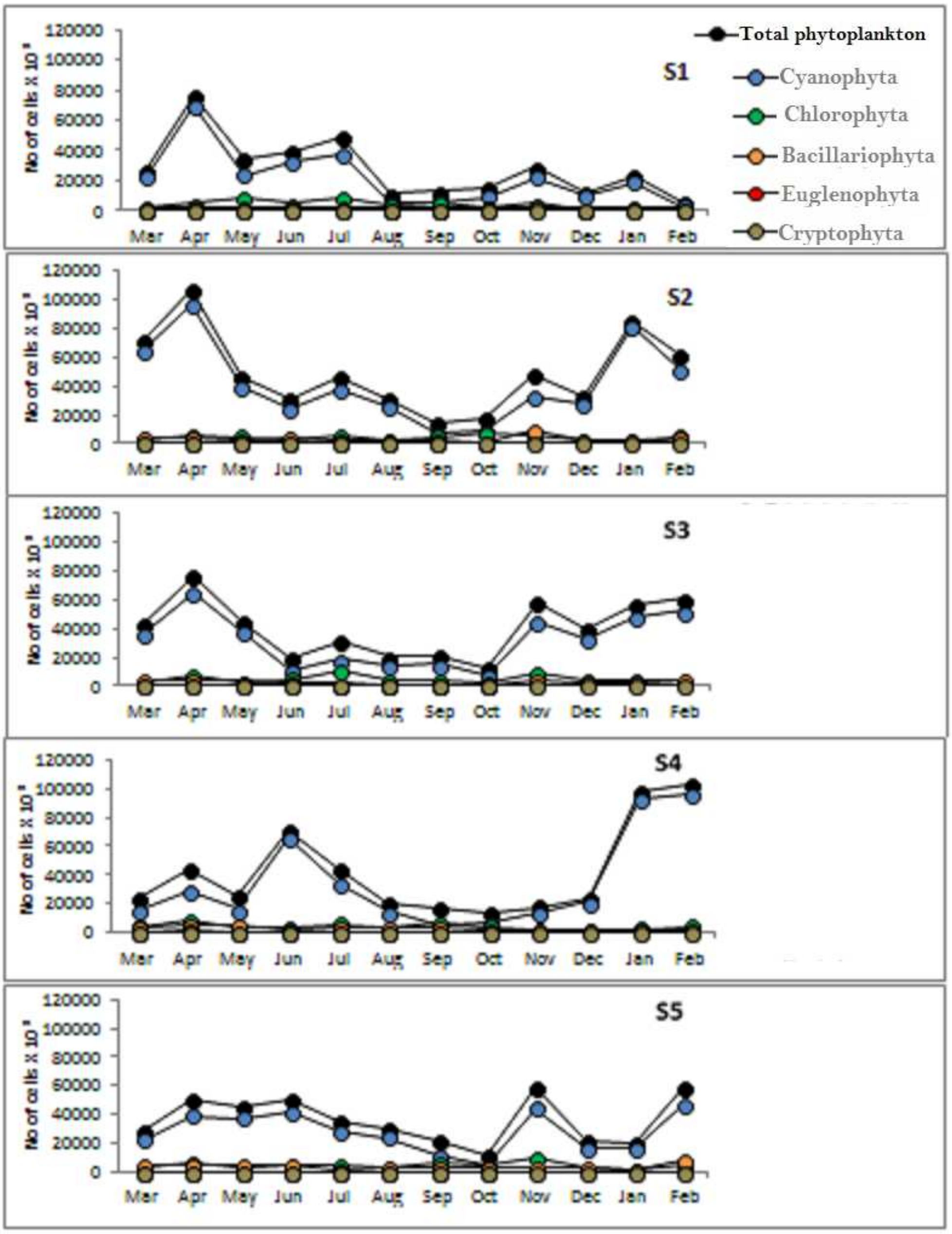

Fig. 2: Monthly changes in phytoplankton species richness at Meet Khamis (S1), Nawsa El-Bahr (S2), Meneit Samanod (S3), El-Nasria (S4) and Abo Sair (S5) sites.

Spatial and Temporal variations in Phytoplankton Standing Crop:

Phytoplankton total standing crop (estimated as cell number) undergoes continuous changes during the period of study (Fig. 3). Maximum peak of 106.9 X 10^6 cells l^{1} was recorded at S2 (Nawsa El-Bahr) in April 2011. Of which the following are the dominant cyanophycean species, *Anabaena flos-aquae*, *Chroococcus minutus*, *Microcystis incerta*, *Nostoc* sp, *Merismopedia gluaca* and *Gloeocapsa sanguinea* with more than 50% contribution at all sites giving 93.3%, 91.7%, 81.7%, 78.3%, 68.3% and 60% frequency of occurrence, respectively. A highly diversified community of Chlorophyta was determined with a distinguished difference among sites. For example, some taxes were solely present at one site (or two) and not at others. *Eudorina elegans, Kirchneriella obesa, Lagerheimia ciliata, Lagerheimia* sp., *Monoraphidium nanoselene, Pandorina charkoviensis, Pandorina morum, Scenedesmus arcutus, Tetraedron muticum and Tetrastrum triangulare* were only determined at S1 (Meet Khamis).

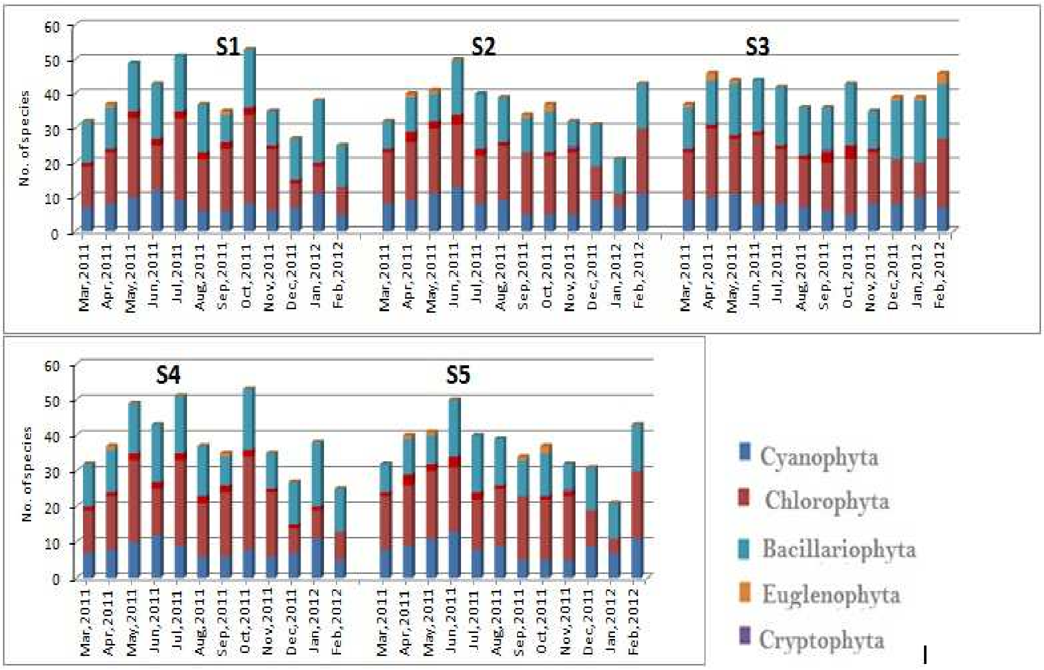

Fig. 3: Monthly variations in total phytoplankton standing crop along the study area represented as total cell number X 10^3.

Biological Assessment of Water Quality

Biological indices were variably dependent on qualitative and quantitative analysis of phytoplankton communities. Most of used indices, especially those diatom-dependent ones, gave a reliable indication of water quality which was significantly coincident with indications reflected by the physic-chemical results that has been published earlier (Ali *et al*., 2014).

The diversity index showed distinct irregular local variations. The most striking observations were the significant decrease in diversity of El-Nasria site during June, 2011 where the diversity index equal 1.06. Diversity showed a moderate to light pollution conditions (Fig. 4).

The saprobic index values ranged between 1.21 and 3.56 with a mean value of 1.96. These results show that the saprobity of water ranged from oligosaprobic to β – mesosaprobic with few exceptions.

The pollution index showed distinct irregular local variations (Fig. 4). The pollution index values ranged between 8 and 25 with a mean value of 15 (Figure 4). Relatively higher values of this index were recorded at El-Nasria site. Values of the Trophic Diatom index (TDI) indicated an intermediate to high levels of nutrient concentrations. All the TDI values showed distinct irregular local variations (Fig. 4).

Similar to TDI, values of the Generic Diatom Index (GDI) indicated the same level of concentrations. Slight local variations in diatomic index values (Fig. 4) at different sites without any distinct seasonal trend were recorded. The Id values ranged from 2.4 to 4.1. The diatomic index results show average pollution with very few exceptions.

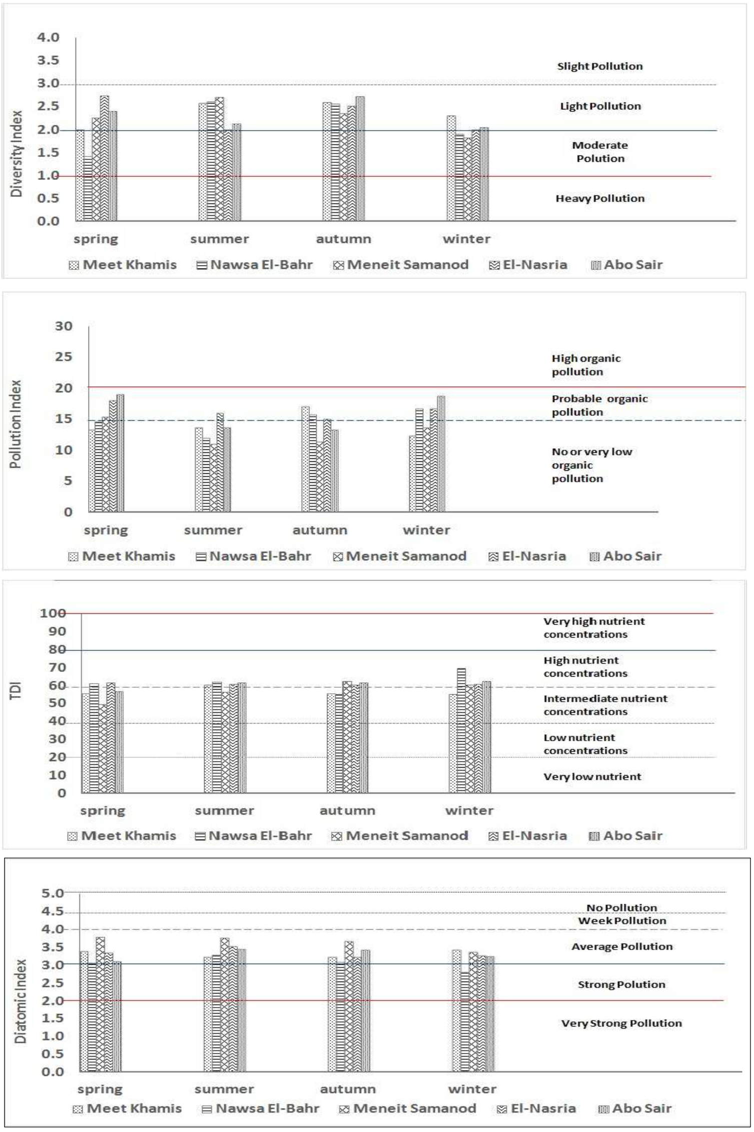

Fig. 4: Monthly variations in five indices namely (from up to bottom): the diversity index, pollution index, trophic diatom index and diatomic index at different sampling sites within the study area

Table 2: Values of saprobic index at different sampling sites within the study area.

Months \ Sites	Meet Khamis S1	Nawsa El-Bahr S2	Meneit Samanod S3	El-Nasria S4	Abo Sair S5
Mar., 2011	2.00	1.83	1.88	1.76	1.91
Apr., 2011	1.80	1.77	1.78	2.02	1.87
May, 2011	1.90	2.00	1.87	1.84	1.83
June, 2011	1.82	1.96	1.83	2.26	1.85
July, 2011	1.84	1.88	2.41	2.00	1.85
Aug., 2011	1.21	1.92	1.84	2.03	1.81
Sept., 2011	1.83	2.64	1.83	2.12	1.91
Oct., 2011	1.91	1.86	1.77	1.85	3.56
Nov., 2011	1.86	1.90	1.75	1.80	1.68
Dec., 2011	2.04	2.05	2.23	1.75	2.39
Jan., 2012	2.15	2.08	2.23	1.75	2.41
Feb., 2012	2.17	2.09	1.89	1.69	2.09

Using Canonical corresponding analysis (CCA) the CCA of the biological parameters were illustrated in Figure 5. Overlaying this figure with the physic-chemical data of the studied segment of the River Nile, good correlations were determined between the abundance of different phytoplankton groups and the environmental variables.

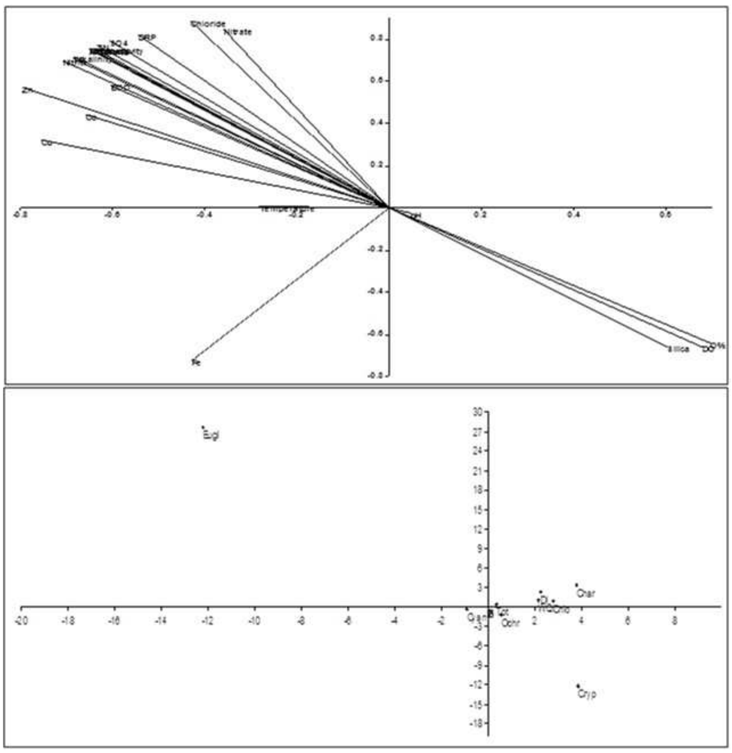

Fig. 5: Conoco analysis plot of physic-chemical (above) and Biological (below) parameters.
N.B. i) Phylum names are represented by the first four letters. ii) A positive correlation is expressed by relatively long lines pointed in the same direction, whereas lines pointed in the opposite direction indicates a negative correlation**.**

DISCUSSION

Water quality of studied segment of the River Nile was assessed biologically through various biological parameters, indicators and indices. There is a universal agreement that the biological assessment of water quality is preferable, reliable and accurate approach (reviews e.g. Biggs, 2000). Knowledge of freshwater algae that respond rapidly and predictably to environmental change has been particularly useful, with the identification of particular indicator species or combinations of species being widely used in assessing water quality (Bellinger and Sigee, 2010). Existence of selective algal types could be used as indicators of pollution (Shaaban-Dessouki *et al.*, 1994b).

The highly diversified community of phytoplankton with Chlorophyta (56 taxa), Bacillariophyta (29 taxa), Cyanophyta (19 taxa) and Charophyta (7 taxa) is, more or less, comparable to that earlier reported by Abdel-Baky, 1995 & Abdel-Aal, 2006) for the River Nile. A noticeable fluctuation in Bacillariophyta species especially at S4 (El-Nasria) was mainly attributed to impacts of sewage pollutants (Schelske *et al.*, 1978) and excessive concentration of reactive silica (Gibson, 1981). In a similar way, compared to other sites along the study area, a relatively low number of phytoplankton species recorded at El-Nasria site gave an indication of heavily polluted water Seaborn (1997).

Variation in phytoplankton density is strongly influenced by temperature and pH and maximum population always demined in hot seasons (Laskar and Gupta, 2013) This is might relate to the fact that higher temperatures support faster growth rates and enable some biota to attain significant populations (Chapman *et al*., 1996). In the present study, the maximum density of phytoplankton was controlled by temperature with a relative increase in species number during hot seasons compared to cold ones. A moderate positive correlation (r = 0.6) has been found between temperature and total number of species.

Specific algal species (such as *Anabaena flos-aquae, Chroococcus minutus, Microcystis incerta, Cyclotella sp*, *Melosira granulata* and *Nitzschia palea*) occurred at a significantly high frequency along the study segment of the River Nile. Those species are known as good survivals for wide range of pollutants types (Sobhy, 2008). However, the dominance of diatom species was mainly attributed to the presence and availability of certain elements in the Nile water, such as iron and silicon (Shehata and Badr, 2010). It was reported earlier that phytoplankton standing crop at the polluted sites of the Damietta Branch was mainly consists of Cyanophyta, Chlorophyta, Bacillariophyta and Euglenophyta (Shaaban-Dessouki *et al.*, 1994a). In a similar way, the presence of Euglenophyta (mainly *Euglena* sp.) indicated a level of organic pollution, as Abdel Baky (1995) reported that organic matters create a suitable medium for euglenophyceans particularly *Euglena* sp. is specifically grow favorably in organically polluted water bodies Hutchinson (1967). This explains their highest frequency of occurrence at El-Nasria site, which is the most pollutant site, comparing to others. Domestic sewage discharges into the Nile from adjacent urban areas could be the main source of organic matter (Ali, *et al*., 2014).

The existence of blue-green algae (e.g. *Microcystis, Anabaena, Aphanizomenon, Coelosphaerium and Oscillatoria*), is another indicative sight for water lower quality with a degree of toxicity along the River, as these blue greens are toxin-secreting species (Gorham, 1960). *Microcystis aeruginosa* is among the most harmful species among all toxic blue-greens (Ali, 2009 & Gorham, 1960). Kemp *et al.* (2009) indicated that in a Cyanophyta community, the abundance of non-heterocytic (non N-fixing) species decrease with the decreasing inorganic N. This is in contrast to heterocytic (N-fixing) species. Based on this fact, *Anabaena flos-aquae* and *Nostoc sp.* were recorded with low abundance level in June, 2011when the inorganic N content was high (especially NH□-N) (Ali., *et al.*, 2014).

Existence of *Cyclotella spp* in a freshwater body indicated an oligotrophic status of this body (Hutchinson, 1957). Therefore, the 100% frequency of occurrence of *Cyclotella spp.* along the studied area gave an indication of a relatively low nutrient load along the River Nile.

With regards to the diversity index, one can expect low values of the diversity index at El-Nasria Site, especially during April, 2011 and June, 2011. This was not held true in this study area. Abdel-Hamid *et al.*, (1992a) reported that, in many cases the values of Shannon-Wiener diversity index did not always fit with the expected aspects of water quality of many inland water courses in Egypt including the river Nile.

The saprobic index is an approach to relating the biological composition of a water body to the degree of organic pollution (Guhl, 1987) through a consistent proportional relationship between the degree of organic pollution and the index values (Schräder, 1959). Saprobic index has been locally (Abdel-Hamid *et al.*, 1992a and Ibrahim, 2002) and worldwide (e.g. Sládeček, 1973 and Guhl, 1987) proven to be a reliable parameter for water quality characterization. The saprobity of water ranged from oligosaprobic to β –mesosaprobic. The pollution index showed distinct irregular local variations. Relatively higher values of this index were recorded at El-Nasria (probable to high organic pollution). The values of the trophic diatom index (TDI) have indicated that El-Nasria is a wastewater receiving site with results greater than 60 (with few exceptions). This indicates that this site is more eutrophic when compared to other sites.

Slight local variations in diatomic index and the Generic Diatom Index (GDI) values were recorded at different stations with no distinct seasonal trend were recorded. These results were not what expected to this habitat.

Integrating the obtained results of this study provide a fair characterization for the water quality status of the studied segment of the River Nile near Mansoura City. It indicated a moderated level of water quality mostly during the year with some cases of disquality as portable water for drinking with a temporal poor to very poor status at some sites. This concluded that the River Nile water is not always within the standard level of drinking water as approved by most agencies; e.g. The World Health Organization (WHO) and/or The European Water Framework Directive (EU WFD).

This enhances the ultimate need for sustainable development plans for the Nile Water. This could be through setting some environmental legalization and policies to ensure that the Nile water is maintained at appropriate quality for an identified sector of usage. This would also help to mitigate the outbreak of health disorders and the detrimental impacts on the Nile ecosystem. Regular and continuous monitoring for the Nile water can help to understand the system functionality with the changeable environmental conditions. This in turn would help to identify pollution sources and fates of contaminants at both space and time dimensions.

For preserve a good water quality and improve the Nile ecosystem, this research recommended to: 1) find out other dumping areas to divert the polluted water away off the River Nile; 2) apply better treatment technique to the wastewater pumped into the Nile (at S3 - El-Nasria) via El-Nasria pumping station; and 3) apply a reliable and continuous monitoring mechanism (e.g. fixed monitoring stations with the regular discrete water sampling) along the River. Indeed, this will provide enhanced tools to sustainably develop the Nile ecosystem and ensure appropriate use of this vital source via solutions and/or measures to prevent, eliminate or mitigate the Nile water quality and sustain the Nile ecosystem balance and functionality.

Appendix 1: Algal taxa identified along the River Nile (a Nile segment near Mansoura City).

#	Sites / Algal taxa	S1	S2	S3	S4	S5	T.F
	Cyanophyta						
1	*Anabaena circinalis* RABENHORST	0	4	4	5	2	**15**
2	*A.cylindrica* Lemmermann	0	0	0	0	1	**1**
3	*A. flos-aquae* Brébisson ex Bornet & Flauhault**	11	12	12	10	11	**56**
4	*A.spiroides* Kleb.	2	1	1	1	0	**5**
5	*Aphanizomenon flos-aquae* (Linnaeus) Ralfs	0	0	8	6	7	**21**
6	*Aphanizomenon* sp	6	6	0	0	0	**12**
7	*Aphanothece clathrata* W.et G.S. West	0	1	0	0	0	**1**
8	*A.* sp	0	0	0	0	1	**1**
9	*Chlorogloea microcystoides* Geitler	4	1	0	1	2	**8**
10	*Chroococcus limneticus* Lemmermann**	4	7	4	1	2	**18**
11	*C.minutus* (Kütz.)Nägeli	10	11	12	11	11	**55**
12	*C. turgidus*(Kützing)Näg.	6	4	2	2	2	**16**
13	*Coelosphaerium kuetzingianum* Nägeli	2	3	2	0	3	**10**
14	*Gloeocapsa kuetzingiana* Nägeli	0	0	0	1	1	**2**
15	*G.sanguinea* (Ag.) Kütz.	9	7	4	8	8	**36**
16	*Gomphosphaeria compacta* (Lemm.) Ström**	2	2	4	2	4	**14**
17	*G. naegeliana* (Unger) Lemmermann**	0	2	1	1	1	**5**
18	*G.pusilla* (Goor) Kom.**	1	3	1	2	5	**12**
19	*G. rosae* (Snow.) Lemmermann	2	2	1	2	2	**9**
20	*Merismopedia gluaca* (Ehrenberg) Kütz.	8	8	9	9	7	**41**
21	*M.punctata* Meyen	0	1	3	2	1	**7**
22	*M. tenuissima* Lemm.	5	1	4	2	1	**13**
23	*Microcystis aeruginosa* Kütz.	3	5	4	1	2	**15**
24	*M.grevillei* (Hass.) Elenkin **	2	0	0	0	2	**4**
25	*M. incerta* Lemm.**	9	10	10	10	10	**49**
26	*Nostoc entophytum* Born. et Flah.	1	0	0	1	1	**3**
27	*N.*sp	8	9	10	11	9	**47**
28	*Oscillatoria mougeotii* Kützing ex Forti**	0	0	0	0	1	**1**
29	*Pelonema subtilissimum* Skuja	0	0	1	1	0	**2**
	Chlorophyta						
30	*Acanthosphaera zachariasii* Lemmermann	4	3	2	0	3	**12**
31	*Actinastrum hanzschii* Lagerhiem	6	7	11	4	8	**36**
32	*Ankistrodesms falcatus* (Corda)Ralfs.	0	0	1	0	0	**1**
33	*A. fusiformis* Corda	7	3	2	5	7	**24**
34	*A. gracilis* (Reinsch)Kors.	1	1	2	1	0	**5**
35	*Chlamydomonas debaryana* Goroschankin	0	2	0	0	0	**2**
36	*C. nivalis* (F.A.Bauer) Wille	0	0	0	1	0	**1**
37	*C.regularis* Korshikov	0	0	0	1	0	**1**
38	*C.simplex* Pascher	2	3	3	6	2	**16**
39	*C.*sp	7	6	4	8	4	**29**
40	*Chlorella* sp	9	11	10	11	11	**52**
41	*Coelastrella striolata* Chod.	1	1	1	1	1	**5**
42	*Coelastrum astroideum* De Notaris	6	8	3	2	6	**25**
43	*C.cambricum* Arch.**	3	2	5	3	10	**23**
44	*C. microporum* Nägeli	2	0	1	3	0	**6**
45	*C.proboscideum* Bohlin	0	1	1	0	0	**2**

46	*C.pseudomicroporum* Korshikov	0	0	1	0	0	**1**
47	*C. recticulatum* (Dengeard) Senn**	1	1	1	0	0	**3**
48	*Crucigenia apiculata* (Lemmermann) Schmidle	0	0	0	2	0	**2**
49	*C. neglecta* B.Fott & H.Ettl	0	0	1	0	0	**1**
50	*C. rectangularis* (Nägeli) Gay**	0	0	0	3	0	**3**
51	*C.tetrapedia* (Kirch.) West & West	0	2	2	0	5	**9**
52	*Crucigeniella* sp	0	2	0	0	0	**2**
53	*Dictyosphaerium pulchellum* Wood**	0	1	3	0	0	**4**
54	*Eudorina elegans* Ehrenberg	1	0	0	0	0	**1**
55	*Golenkinia radiata* (chod.)	1	6	8	7	7	**29**
56	*Kirchneriella contorta* (Schmidle) Bohl.**	7	3	9	10	6	**35**
57	*K. obesa* (W.West) Schmidle	1	0	0	0	0	**1**
58	*Lagerheimia ciliata* (Lagerh.) Chodat	2	0	0	0	0	**2**
59	*L. citriformis* (Snow) G. M. Smith**	4	5	4	3	8	**24**
60	*L. longiseta* (Lemmermann) Printz	1	1	1	0	2	**5**
61	*L.*sp	2	0	0	0	0	**2**
62	*Micractinium bornhemiense* (Conrad) Korshikov	1	0	0	0	1	**2**
63	*M. pusillum* Fresenius	6	8	7	4	6	**31**
64	*Monoraphidium arcuatum* (Korshikov) Hindák	0	0	1	0	0	**1**
65	*M. contortum* (Thuret) Komárková-Legnerová	2	0	2	0	3	**7**
66	*M. irregular* (G.M. Smith)Komárková-Legnerová	5	3	5	5	6	**24**
67	*M.minutum* (Näg.) Komárková-Legnerová	3	4	5	10	4	**26**
68	*M. nanoselene*	2	0	0	0	0	**2**
69	*M. pussillum* (Printz) Comb. Nov.	0	1	3	0	0	**4**
70	*M.saxatile* Komárková-Legnerová	0	0	0	1	0	**1**
71	*M.tortile*(W. et G. S. West) Komárková-Legnerová	1	3	0	0	1	**5**
72	*M.*sp	1	1	0	0	0	**2**
73	*Nephrocytium agardhianum* Nägeli	0	1	0	1	0	**2**
74	*N.*sp	0	0	0	1	0	**1**
75	*Oocystis borgei* Snow	1	0	1	0	0	**2**
76	*O. elliptica* West	0	5	0	2	2	**9**
77	*O. lacustris* CHODAT	0	1	0	0	1	**2**
78	*O. parva* W. &G. S. West.	2	0	1	0	0	**3**
79	*O.solitaria* Wittrock	2	0	2	1	0	**5**
80	*O.*sp	0	1	0	0	0	**1**
81	*Pandorina charkoviensis* Korschikov	1	0	0	0	0	**1**
82	*P. morum* (Muell.) Bory	3	0	0	0	0	**3**
83	*Pediastrum biradiatum* Meyen**	3	0	0	1	0	**4**
84	*P. duplex* Meyen	5	4	2	0	4	**15**
85	*P. simplex* Meyen**	10	11	8	10	8	**47**
86	*P.sturmii* Reinsch**	4	3	6	7	3	**23**
87	*P. tetras* var. tetradron (corda)Hansgirg	1	0	0	0	1	**2**
88	*Radiococcus nimbatus* (De Wildeman) Schmidle	0	1	1	1	0	**3**
89	*Scenedesmus abundans* (Kirchner) Chodat**	5	4	5	4	4	**22**
90	*S. acuminatus* (lagerheim) Chodat**	4	6	2	2	3	**17**
91	*S. acutus* Meyen**	1	1	1	0	0	**3**
92	*S. arcutus* var. capitatus G.M.Smith**	2	0	0	0	0	**2**
93	*S. asymmetricus* (Schröder) Chodat**	0	2	0	2	1	**5**
94	*S. bernardii* G.M.SMITH**	0	0	0	1	0	**1**
95	*S. bicaudatus* (Hansgirg) Chodat**	1	6	7	2	6	**22**
96	*S. bijugatus* (Turpin) Kuetzing.	5	4	6	9	7	**31**
97	*S. denticulatus* var. australis playfair	2	0	0	0	0	**2**
98	*S. dimorphus* (Turpin) Kuetzing.**	5	0	3	1	1	**10**
99	*S. disciformis* (Chodat) Fott & Komárek**	0	2	0	0	0	**2**
100	*S. ecornis* (Ehrenberg) Chodat	6	4	7	8	10	**35**
101	*S. incrassatulus* Bohlin**	0	0	0	1	0	**1**
102	*S. gutwinskii* Chodat**	0	1	0	0	0	**1**
103	*S. magnus* Meyen**	0	0	1	0	0	**1**

104	*S. nanus* Chodat	5	11	12	8	11	**47**
105	*S. obliquus* (Turpin) Kuetzing.**	2	2	0	1	0	**5**
106	*S.obtusiusculus* Chodat**	0	1	0	0	0	**1**
107	*S. opoliensis* P.G.Richter**	0	1	0	0	1	**2**
108	*S. pannonicus* Hortobágyi**	0	1	0	1	0	**2**
109	*S. quadricauda* var. bicaudatus Hansgirg.**	10	7	11	9	12	**49**
110	*S. subspicatus* Chodat**	0	0	0	0	1	**1**
111	*S.* sp	1	2	2	2	1	**8**
112	*Schroederia planctonica*(skuja) comb. Nov.	4	0	1	1	0	**6**
113	*S. robusta* Korshikov**	0	0	1	0	0	**1**
114	*S. setigera* (SCHROED.) LEMM.	0	4	1	5	7	**17**
115	*S.* sp	0	0	1	0	0	**1**
116	*Sphaerellopsis gloeosphaera***	0	1	0	0	0	**1**
117	*Tetraedron caudatum* (corda) Hansgrig.	1	0	0	0	0	**1**
118	*T. muticum* (A. Braun) Hansgrig.	1	0	0	0	0	**1**
119	*T. trigonum*(Nägeli) Hansgirg	1	1	0	0	1	**3**
120	*T.* sp	0	0	0	0	1	**1**
121	*Tetrastrum glabrum* (Y.V.Roll) Ahlstrom & Tiffany	0	0	1	1	0	**2**
122	*T. triangulare* (Chodat) Komárek.	1	0	0	0	0	**1**
123	*Trochiscia aciculifera* (Lagerheim) Hansgirg**	0	0	0	0	1	**1**
124	*Treubaria* sp	0	0	0	1	0	**1**
125	Un identified green cell	10	8	6	5	6	**35**
	Charophyta						
126	*Closterium pusillum* Hantzsch	0	1	0	0	0	**1**
127	*C.* sp	1	0	0	0	0	**1**
128	*Cosmarium contractum* O.Kirchner	0	0	0	1	0	**1**
129	*C. laeve* Rabenh.	2	1	1	2	0	**6**
130	*C. obliquum* Nordstedt	0	0	1	0	1	**2**
131	*C. portianum* Arch.	1	0	0	0	0	**1**
132	*C.*sp	3	1	1	2	3	**10**
133	*Staurastrum chaetoceras* (Schröder) G.M.Smith	1	0	0	0	0	**1**
134	*S. cingulum* var.obesum G.M.Smith	2	0	0	0	0	**2**
135	*S. floriferum* West & G.S.West	0	1	0	0	0	**1**
136	*S. longipes* (Nordstedt) Teiling	0	1	0	0	1	**2**
137	*S. pingue* Teiling	7	7	8	8	8	**38**
138	*S. tetracerum* Ralfs ex Ralfs	0	0	1	1	1	**3**
139	*S.* sp	0	2	2	0	0	**4**
	Cryptophyta						
140	*Chroomonas caudata* L.Geitler**	0	1	1	0	2	**4**
	Bacillariophyta						
141	*Achnanthes lanceolata* (Bréb.) Grun.**	2	0	0	0	0	**2**
142	*A. pyrenaica* Hust.**	2	0	0	0	7	**9**
143	*Amphora coffeaformis* Ag.**	1	0	2	0	0	**3**
144	*A. ovalis* Kütz.	2	0	0	1	1	**4**
145	*A.veneta* Kütz.**	0	3	0	0	0	**3**
146	*Anomoeoneis exilis* (Kützing) Cleve**	2	0	4	4	8	**18**
147	*Bacillaria paradoxa* J.F.Gmelin**	11	11	10	11	11	**54**
148	*Brebissonia boeckii* (Ehrbg.) Grun.	1	0	0	0	0	**1**
149	*Cocconeis pediculus* Ehrenberg	2	0	1	0	3	**6**
150	*C. placentula* Ehrenb.	11	11	12	11	9	**54**
151	*Cyclotella meneghiniana* Kütz.	12	12	12	12	12	**60**
152	*C. kuetzingiana* Thwaites**	12	12	12	12	12	**60**
153	*Cymbella affinis* Kütz.	3	0	2	1	0	**6**
154	*C. amphicephala* Näegeli**	0	0	0	0	3	**3**

155	*C. naviculiformis* Auersw.**	1	0	0	0	0	**1**
156	*C. sinuata* W.Gregory**	2	0	0	0	0	**2**
157	*C. ventricosa* Kütz.	0	0	4	0	0	**4**
158	*Diatoma vulgare* Bory	1	0	3	0	0	**4**
159	*Fragilaria crotonensis* Kitton	12	12	12	12	12	**60**
160	*F. brevistriata* Grunow	10	3	11	4	6	**32**
161	*F. construens* (Ehr.) Grun.	8	4	9	3	4	**28**
162	*F. leptostauron* (Ehrenberg) Hustedt**	9	10	10	12	10	**51**
163	*F. pinnata* Ehrenb.**	0	0	3	3	3	**9**
164	*F. virescens* Ralfs**	3	3	1	1	0	**8**
165	*Gomphonema augur* Ehrenberg	0	0	0	6	0	**6**
166	*G. constrictum* Ehrenberg**	0	0	0	3	2	**5**
167	*G. olivaceum* (Lyng.) Kütz.	0	2	0	3	2	**7**
168	*G. parvulum* (kütz.) Grun.	2	0	0	0	0	**2**
169	*Gyrosigma acuminatum* (kütz.) Rabenh.	1	0	0	2	2	**5**
170	*Hantzschia elongata* (Haxtzch.) Grun.	0	0	0	1	0	**1**
171	*H. spectabilis* (Ehrenberg) Hustedt	1	0	3	3	2	**9**
172	*Melosira italica* (Ehrenb.) Kütz.	5	0	2	0	0	**7**
173	*M. granulata* (Ehrenberg) Ralfs**	11	12	9	10	9	**51**
174	*Navicula affinis* Ehrenberg**	0	0	3	0	0	**3**
175	*N. anglica* Ralfs**	2	0	0	0	0	**2**
176	*N. cryptocephala* Kütz.	7	3	5	3	8	**24**
177	*N. cuspidata* kütz.**	2	0	3	0	3	**8**
178	*N. exigua* (Greg.) O.Müll	0	5	6	7	0	**18**
179	*N. hungarica* Grunow**	3	0	0	1	6	**10**
180	*N. lanceolata* (Ag.) kütz.**	1	2	6	9	2	**20**
181	*N. minuscula* Grunow**	0	0	0	0	3	**3**
182	*N. pygmaea* Kütz.**	2	2	0	0	0	**4**
183	*N. rhynchocephala* kütz.	3	0	0	0	2	**5**
184	*N. rostellata* Schmidt**	0	2	0	0	0	**2**
185	*N. tantula* Hustedt	0	0	0	0	1	**1**
186	*Nitzschia acicularis* (Kützing) W.Smith	1	3	6	3	0	**13**
187	*N. amphibia* Grunow	0	3	2	0	0	**5**
188	*N. filiformis* (W.Smith) Hustedt	0	0	0	0	2	**2**
189	*N. hantzschiana* Rabenhorst	0	0	0	3	0	**3**
190	*N. Kuetzingiana* Rabenhorst	0	0	7	0	0	**7**
191	*N. Linearis* (C.Agardh) W.Smith	0	0	1	0	0	**1**
192	*N. obtusa* W.Smith	0	0	0	1	2	**3**
193	*N. palea* (Kützing) W.Smith	3	7	4	6	3	**23**
194	*N. recta* Hantzsch	3	2	2	0	4	**11**
195	*N. scalaris* (Ehrbg.) W. Smith	0	3	0	0	0	**3**
196	*Synedra acus* Kützing**	0	0	0	2	0	**2**
197	*S. capitata* Ehrenberg**	0	3	0	0	0	**3**
198	*S. rumpens* Kützing**	0	0	0	5	0	**5**
199	*S. ulna* (Nitzsch) Ehrenberg	8	5	11	10	10	**44**
	Euglenophyta						
200	*Euglena acus* Ehrenberg	0	0	0	2	0	**2**
201	*E. caudata* Hübner**	0	0	0	3	0	**3**
202	*E. intermedia* (Klebs) Schmitz**	0	0	0	1	0	**1**
203	*E. limnophila* Lemmermann	0	0	1	1	0	**2**
204	*E. oblonga* Schmitz	0	0	0	1	0	**1**
205	*E. oxyuris* Schmarda**	0	0	0	1	0	**1**
206	*E. sanguinea* Ehrenberg	0	0	0	1	0	**1**
207	*E. variabilis* Klebs	1	4	5	9	4	**23**
208	*E. viridis* Ehrenberg	1	0	1	2	1	**5**
209	*E.* sp	0	0	1	2	0	**3**
210	*Phacus curvicauda* Svirenko	0	0	0	1	0	**1**

211	*P. longicauda* (Ehr.) Dujardin	0	0	0	0	1	**1**
212	*P. pleuronects* (O.F.Müller) Nitzsch ex Dujardin	0	1	0	1	0	**2**
213	*P. triqueter* (Ehrenberg) Perty**	0	0	1	7	2	**10**
214	*P.* sp	0	0	0	1	1	**2**

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ARABIC SUMMARY

المعاملات البيئية وتركيب مجتمع الهائمات النباتية كمؤشرات لجودة مياه نهر النيل بمصر"

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٢- قسم النبات – كلية العلوم - جامعة المنصورة – مصر.

نهر النيل هو المورد الرئيسي للمياه العذبة في مصر، والمصدر الرئيس لتلبية معظم متطلبات مياه الشرب والري والصناعة. تهدف هذه الدراسة إلي وصف وتقييم للمتغيرات البيئية المتنوعة وكذالك دراسة المجتمعات المتنوعة من العوالق النباتية (الفيتوبلانكتون) في منطقة الدراسة لعام ٢٠١١ لجزء من نهر النيل بالقرب من مدينة المنصورة ما بين مدينة اجا في الجنوب (31°03’41.34”N, 31°34’84.45”E) ومدينة المنصورة في الشمال (30°92’33.15”N, 31°22’25.57”E). تم تقدير عدد الأجناس المتواجدة من العوالق النباتية خاصة المحاصيل الدائمة. تم رصد ٢١٦ نوع من الطحالب الهائمة تنتمي الي ما يقرب من ٥٠ جنس . وكانت السيادة في عدد الأنواع للطحالب الخضراء (٩٨ نوع)، ثم الطحالب الدياتومية (٥٩ نوع)، تليها الطحالب الخضراء المزرقة (٢٩ نوع)، تليها الطحالب اليوجلينية (١٥ نوع) وأخيرا طحالب الكاروفيتا (١٤نوع) خلال فترة الدراسة. سجلت الدراسة زروة النمو القصوي في إبريل ٢٠١١ عند المحطة S2 حيث وصل العدد الي ١٠٦.٩*١٠٦ خلية/لتر كانت الطحالب الخضراء المزرقة الأبرز فيها من حيث العدد يليها الطحالب الخضراء وذلك في جميع المواقع.
تم إستخدام المعاملات البيولوجية لتقييم جودة المياه بمنطقة الدراسة وتحديد درجة؟ونوع التلوث حيث قدمت معظم المؤشرات المستخدمة، وخصوصا النعتمدة منها علي الدياتومات، دلالة علي جودة معقولة لنوعية المياه في هذا الجزء من نهر النيل مع وجود بعض الاختلافات المكانية. تم تسجيل انخفاض كبير في تنوع الاجناس في S4 خلال شهر يونيو مما يشير إلى مستوى كبير من تلوث المياه. ومع ذلك، فإن مؤشر التنوع ١.٠٦ أعطي اشارة بمستوي معتدل –الي- خفيف من التلوث. دلل مؤشر saprobic والذي اعطي متوسط قيمتة ١.٩٦ إلى حالة من التلوث (غالبا العضوي) تتراوح من الخفيفة الي المتوسطة esosaprobic - oligosaprobic مع وجود انواع من الطحالب الخضراء المزرقة مما سيير إلى وجود درجة من السمية في مياه النيل. بناء علي تكامل نتائج الدراسة (المقاسة والمحسوبة) تم توصف نوعية مياه نهر النيل بالمستوي المتوسط من حيث التلوث التي تقترب من المؤشرات القومية لمياه الشرب الا انه توجد بعض الحالات (سواء المكانية او الزمنية) التي تميزت بستوي منخفض الي منخفض جدا من جودة المياه. أكدت البيانات الزمانية والمكانية للدراسة على أهمية تعيين بعض السياسات البيئية وتقنين سبل الاستخدام لمياه نهر النيل لضمان جودنها والحفاظ علىها علي النحو الملائم مع تحديد القطاعات المختلفة للاستخدام.