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Biochemical evaluation of phytoplankton and microbial load in water, sediments, macrophytes and fish during drought and high flooding season in Dahmeit and Tushka khors, Lake Nasser, Egypt

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ABSTRACT

After building the High Aswan Dame (HAD), flood water is stored in Lake Nasser. The biochemical composition of the phytoplankton community and microbial load are considered as biomarkers of the ecosystem including water, sediments, plant and fish in different khors of Lake Nasser. So the present study investigated the variation of chlorophyll a in water of Dahmeit and Tushka Khors during high flood and drought seasons. Also, the total protein, carbohydrate and lipid contents of phytoplankton and the microbial load in water, sediment, macrophytes and fish in these Khors during high flood and drought seasons were investigated. Data of this study indicated that Tushka khor recorded higher yield of all biochemical contents of algae than Dahmeit khor during the two seasons. In addition, higher chlorophyll a and protein contents were recorded in surface layer than bottom one. Microbial analyses indicated that the total bacterial counts and the total diazotrophs were present in high population densities in all water samples at different seasons. Higher flooding season recorded higher autochthonous and allochthonous as well as higher diazotrophic bacteria than drought season for Tushka khor. Furthermore, Tushka Khor recorded higher nitrogen-fixing bacteria than dahmiet khor. Also, Tushka khor recorded slightly higher total sediment bacterial counts than Dahmeit khor. On the other hand, the highest bacterial load of various fish organs was recorded in Dahmeit khor compared to Tushka khor. Microbial analyses of macrophyte species included total bacterial counts, as well as total diazotrophs were present in high population densities in all sample at deferent seasons. This study provides evidence that the biochemical composition of phytoplankton as well as water and sediment quality and fish healthy and distribution of macrophytes is affected by the flood. Thus, great efforts and cooperation between different authorities are needed to regular evaluation and study Lake Nasser and its khors to protect them from pollution and reduce environmental risk.

Key words: Phytoplankton community, microbial load, Dahmeit khor, Tushka Khor, drought season, high flooding season.

INTRODUCTION

Building of High Dam caused the formation of Lake Nasser to store flood water. Lake Nasser lies between 22º 00\` N and 23º 58\` N in Egypt, and extends southward in Sudan to 20º 27N\` as Lake Nubia. The lake shoreline is very irregular, with numerous side channels known as khors. Lake Nasser is considered the main source for drinking and irrigation water for the Egyptian people. So, study of water quality is very important for the management of water.

The biochemical contents of phytoplankton, microorganisms and fish can be used as monitoring tools for the quality of the aquatic environment. Boëchat and Giani (2008) found that the seasonal and regional variation effect on the biochemical contents of phytoplankton, so affecting the aquatic system. The biochemical contents of phytoplankton are important indicator of their nutritional quality (Müller-Navarra *et al*., 2000). The phytoplankton nutrition quality and chlorophyll a - nutrient relationships in Lake Nasser were studied by Abd El-Karim and Mahmoud (2016). The relationship between environmental variables and elemental, biochemical composition of phytoplankton species in Lake Nasser were studied by Hussian *et al*. (2016).

Flood management of Lake Nasser is subjected to different complicated conditions including inflow flood variations, operation conditions and the expected future scenarios (Nahla and Medhat, 2005). Hassan and Salem (2015) studied the effect of flooding on distribution and mode of transportation of Lake Nasser sediments.

Microorganisms in aquatic environment play an important role in organic matter turnover as well as in quality determination of water (Pomeroy and Wiegert, 1981). Organisms reside in the gastrointestinal tracts of humans and animals are used as indicators to assess the microbiological safety of drinking water. Evidence from a number of studies suggests that *E. coli* and enterococci may multiply in warm subtropical waters (Anderson *et al.*, 2005).

Also, fish can be used as an indicator of environmental stress, where it provides a definitive biological end-point of historical exposure (Begum, 2004).

Nitrogenase activity by diazotrophic prokaryotes occurs in a wide variety of freshwater systems and habitats (Howarth e*t al*., 1988b; Paerl, 1990). Underwater surfaces of aquatic vascular plants support epiphytic populations of microorganisms, including nitrogen-fixing species (Silver and Jump, 1975).

Aquatic macrophytes are important sources of organic matter for aquatic ecosystems, especially for aquatic bacteria (Stepanauskas *et al*., 2000; Huss and Wehr, 2004). Macrophyte leachates are mainly composed of labile compounds that favor bacterial growth, such as carbohydrates and amino acids (Anesio *et al*., 2000).

So the present study investigated the variation of chlorophyll a, total protein, carbohydrate and lipid contents of phytoplankton and the microbial load in water, sediment, plant and fish in Dahmeit and Tushka Khors, during high flood and drought seasons.

MATERIALS AND METHODS

1. Sites of work

In this study five sites from each of Dahmeid and Tushka Khors were studies (Figure 1).

2. Sampling

2.1. Phytoplankton samples:

Water samples were collected in plastic bottles, then filtered 25 ml by Whatman GF/F fiber circles to separate phytoplankton.

2.2. Water samples:

Water samples were aseptically collected in sterile brown bottles (500 ml), stored at 4 ^{0}C until bacteriological analysis completed within 24 h of sampling.

2.3. Sediment samples:

Sediment samples were collected using Ekman grab to estimate microbial content.

2.4. Plant samples:

The existing plant species were collected from 5 sites from each of the two Khours.

2.5. Fish samples:

Various groups of microorganisms were enumerated in gills, skin, muscles, gut and gonads of *Oreochromis* sp.

3. Phytoplankton biochemical analysis

The total protein, carbohydrate and lipid were determined by the methods of David and Hazel (1993), Dubois *et. al*., (1956) and Chabrol and Castellano (1961), respectively. Chlorophyll-a was measured according to APHA (2005).

4. Bacteriological analyses

4.1. Preparation of samples for analysis

Dilutions of plant samples were prepared by blending sufficient portions of phyllospher with 90 ml sterile peptone water (0.1 % w/v) in Warring blender for 2-3 min. Another portion of phyllospher was carefully washed with tap water and treated with 95% ethanol for 30 seconds followed by 3% sodium hypochlorite for 1 h. Surface sterilized phyllospher was washed with sterile water and prepared as previously mentioned above. Further dilutions were prepared for enumerating bacterial groups in the endo-phyllospher. Sediment samples were prepared by transferring 10 g sediment into sampling bottles containing sterile peptone water. Bottles were shaken for 60 min. and further serial dilutions were prepared. Dry weights of soil (105°C) were determined. Dilutions of water samples were also prepared.

Bacteriological analysis for representative water, sediment, plants and fish sample was carried out as follows:

4.2. Total bacteria count

The pour plate technique and the plate count agar (APHA, 2005) were used for the enumeration of the total bacterial counts at 30 ºC incubation temperatures.

4.3. Total spore-forming bacteria

Successive dilutions were pasteurized, for 15 min at 80ºC, prior to plating using plate count agar and incubation at 30ºC (APHA, 2005).

4.4. Bacterial indicators of pollution

The total and faecal coliforms were counted using MacConkey broth and faecal streptococci using azide-dextrose broth media (APHA, 2005).

4.5. Total diazotrophs

The total diazotrophs were counted using the surface inoculated plate method and N-deficient combined carbon sources agar medium, CCM (Hegazi *et al*., 1998).

4.6. Spore-forming diazotrophs

Successive dilutions were pasteurized, for 15 min at 80ºC, prior to plating using CCM agar medium and incubation at 30ºC (Hegazi *et al*., 1998).

4.7. *Salmonella* sp.

Salmonella and Shigella agar was used for detection of *Salmonella* sp.

Statistical analysis

Data obtained were statistically analyzed using STATISTICA 10 (StatSoft, Inc., Tulsa, USA). Analysis of variance (ANOVA) was used to examine the independent effects as well as possible interactions. Correlation statistical analysis was carried out.

RESULTS

Biochemical contents of phytoplankton

Investigation of biochemical contents of phytoplankton in Dahmeit and Tushka Khors during high flooding season (December 2015) and drought season (May 2015) at the surface and the bottom layers were illustrated in Figure 2 (A & B). The results showed that the total biochemical contents varied according to the sites and seasons in each khor (Fig. 2 A & B).

In Dahmeit Khor during high flood, the maximum protein and carbohydrate contents of phytoplankton were detected at the surface in stations 2 & 1, respectively (26.36 & 0.92 mg/l), while the maximum chlorophyll a and lipid content were detected at the bottom in stations 2 & 5 (0.064 & 0.18 mg/l), respectively. While, during drought season, the maximum protein, carbohydrate and lipid contents were detected at the surface in stations 1, 5 & 2 (17.05, 0.48 & 0.43mg/l), respectively. The maximum chlorophyll a content detected at the bottom in station 1 (0.059 mg/l).

In Tushka Khor during high flood, the maximum protein and lipid contents were detected at the surface in stations 2 & 1 (39.09 & 0.32 mg/l), respectively. The maximum chlorophyll a was detected at the bottom in station 2 (0.078 mg/l). While, the maximum protein and lipid contents during drought season were detected at the surface in stations 1 & 3 (16.59 & 0.43 mg/l), respectively. Also, the maximum chlorophyll a and carbohydrate at the same season were detected at the bottom in stations 4 &5 (0.022 & 0.96 mg/l), respectively.

In general, in the surface samples, Tushka khor recorded maximum yield of all biochemical contents compared to Dahmeit Khor (mean, for Tushka khor : 0.025, 23.0, 0.67 and 0.232 mg/l; for Dahmeit khor: 0.015, 11.6, 0.29 and 0.217 mg/l for chlorophyll a, protein, carbohydrate and lipid, respectively). The same observation was also noticed in the bottom samples (mean, 0.035, 17.5, 0.55 and 0.29 mg/l for chlorophyll a, protein, carbohydrate and lipid, respectively for Tushka khor and 0.029, 6.5, 0.35 and 0.24 mg/l for those from Dahmeit khor).

With respect to flooding effect, in surface level, the maximum chlorophyll a and carbohydrate were recorded during high flooding season (mean 0.02 and 0.34 mg/l in Dahmeit Khor and 0.04 and 0.85 mg/l in Tushka Khor, respectively) compared to those collected during the drought season (mean 0.01 and 0.23 mg/l in Dahmeit Khor, and 0.01 and 0.49 mg/l in Tushka Khor, respectively).

The maximum protein yield (mean 14.0 mg/l) was obtained during the drought season compared to 9.2 mg/l during high flooding season in Dahmeit Khor. However, during the high flooding season in Tushka Khor the mean was 33.7 mg/l, compared to 12.3 mg/l during high drought season.

The maximum yield of lipid content was recorded during the drought season (mean 0.36 and 0.33 mg/l in Dahmeit and Tushka Khors, respectively), while it was 0.08 and 0.13 mg/l during high flooding season for Dahmeit and Tushka Khors, respectively.

On the other hand, in bottom level, the maximum protein yield was obtained during the drought season (mean 10.5 mg/l, compared to 2.5 mg/l during high flooding season) in Dahmeit Khor; but it was 28.7 mg/l during the high flooding season in Tushka Khor 28.7 mg/l, compared to 6.3 mg/l during drought season. The maximum carbohydrate was yield obtained during the high flooding season (mean 0.5 mg/l, compared to 0.2 mg/l during drought season) in Dahmeit Khor. Tushka Khor recorded little variation in carbohydrate yield during the two seasons (mean 0.54 and 0.56 mg/l during high flooding and drought seasons, respectively). While, the maximum yield of lipid content was recorded during the drought season (mean 0.32 and 0.38 mg/l in Dahmeit and Tushka Khors, respectively), compared to high flooding season (mean 0.16 and 0.19 mg/l for Dahmeit and Tushka Khors, respectively).

Bacteriological analyses for water

Bacteriological analyses for water samples included total bacterial counts at 22 or 37 °C, bacterial indicator of pollution and total diazotrophic bacteria. The results are shown in Figure (3).

The total bacterial counts growing at 22 or 37°C (autochthonous or allochthonous, respectively) ranged from 1.8 - 4.2 and 1.3 - 4.1 Log No/ ml for Dahmeit and Tushka khors, respectively at drought season; and from 1.3- 3.1 and 3.1 - 4.5 Log No/ ml at high flooding season (Fig. 2). In addition, the ratio of the total bacterial counts at 22 to 37 °C ranged from 0.6 to 2.1 during drought season and 0.5 to 1.3 during high flooding season. In general, Tushka khor recorded higher bacterial load than Dahmeit (mean 3.1 and 2.7 Log No/ ml for autochthonous and 2.9 and 2.4 Log No/ ml for allochthonous). Furthermore, high flooding season recorded higher autochthonous and allochthonous for Tushka khor (mean 3.9 and 3.8 Log No/ ml, respectively) compared to 3.1 or 2.3 Log No/ ml at drought season; while high flooding season recorded higher allochthonous not autochthonous for Dahmeit khor (mean 2.5 and 2.2 Log No/ ml, respectively) compared to drought season (mean 2.3 and 3.1 Log No/ ml, respectively).

The associative nitrogen-fixing bacteria (diazotrophs) were present in high population density in all samples during high flooding and drought seasons (range 3.0 to 5.7 Log No/ ml). Tushka khor recorded higher nitrogen-fixing bacteria than dahmeit khor (mean 4.5 and 4.1 Log No/ ml, respectively). Also, higher flooding season recorded higher populations of diazotrophic bacteria (mean 4.6 Log No/ml) than drought season (mean 4.4 Log No/ ml) for Tushka khor and dahmeite khor (mean 4.8 and 3.4 Log No/ ml, respectively).

In both Khors, MPN of indicator bacteria ranged from 0 - 240, 0 - 23 and 0 - 29 MPN/100 ml for total coliforms, faecal coliforms and faecal strepotocci, respectively in high flooding season, while they respectively ranged from 0 - 240, 0 - 21 and 0 - 460 MPN/100 ml in drought season. In general, faecal streptococci showed highly count comparing with faecal coliform in all samples except in sample one for Tushka Khor, where, faecal coliform: Faecal streptococci ratio varied from 0 to 0.8 in all samples except in site one for Tushka Khor recorded 5.3.

Bacteriological analyses for sediment

Dahmeit and Tushka Khors sediment microbiological analyses indicated differences attributed to the sample sites and sampling collected time (during high flooding and drought seasons) as shown in Figure (4). In general, Tushka khor recorded slightly higher total bacterial counts than Dahmeit khor (mean 7.3 and 7.1 Log No/g, respectively). Also, drought season recorded higher bacterial load than higher flooding season for Tushka khor (mean 7.3 and 6.3 Log No/ml, respectively) and Dahmeit Khor (mean 7.4 and 6.8 Log No/ ml, respectively).

The number of spore-forming bacteria during drought season was minimal than those during higher flooding season in Dahmeit Khor (mean 4.4 and 5.8 Log No/g, respectively); while they were minimal in Tushka khor during higher flooding season than drought season (mean 3.8 and 4.3 Log No/ ml, respectively).

The total *Enterobacteriaceae spp* count ranged from 4.7 - 7.9 Log No/g and the minimal count varied between Dahmeit and Tushka khors (mean 6.3 and 6.7 Log No/ g, respectively). Also, drought season recorded higher total Enterobacteriaceae count than in higher flooding season for Tushka khor (mean 6.7 and 5.8 Log No/ ml, respectively) and Dahmeit Khor (6.8 and 5.7 Log No/ ml, respectively).

Bacteria indicator of pollution was detected in all samples with different density (Fig.3). With the higher load of for total coliform and faecal coliform in Tushka khor (mean10198 and 7768 MPN/g, respectively) than Dahmeit Khor (mean 2440 and 2241 MPN/g, respectively), while the mean minimal count for faecal streptococci was 995 and 2386 MPN/g for Tushka and Dahmeit, respectively. Also, the results showed increasing in total count of coliform bacteria, faecal coliform bacteria and faecal streptococci during drought season than those in higher flooding season either in Tushka Khor or Dahmeit Khor. Their respective mean count was 15147, 15147 and 1972 MPN/g during drought season, and 5249, 389 and 18 MPN/g during higher flooding season, in Tushka Khore and 4372, 4372 and 4689 MPN/g during drought season, and 508, 110 and 83 during higher flooding season in Dahmeit Khor.

From the present study, it was obvious that bacteria capable of growth on N–deficient combined carbon source medium, CCM (Hegazi *et al*., 1998) were detected in all samples collected (ranged from 4.5 to 8.0 log No/ g). In general Dahmeit khor recorded slightly higher load than Tushka khor (mean 6.7 and 6.4 log No/ g, respectively). Also drought season recorded higher diazotrophic bacterial count than higher flooding season in Tushka khor (mean 6.4 and 6.2 log No/g, respectively), with minimal difference in Dahmeit khor (mean 6.6 and 6.7 log No/g during drought and higher flooding season, respectively).

The total spore forming diazotrophic bacteria ranged from 1.0 to 5.6 log No/ g (Fig 3). In general, Dahmeit khor recorded higher spore forming diazotrophs than Tushka khor (mean 4.6 and 4.0 Log No/g, respectively). Also drought season recorded higher spore forming diazotrophic bacteria than higher flooding season in Tushka khor (mean 4.0 and 3.0 log No/g respectively), but in Dahmeit khor higher flooding season recorded higher spore forming diazotrophic bacteria than drought season (mean 5.1 and 4.0 log No/ g, respectively).

Bacteriological analyses for various organs of *Nile tilapia*

In general, the highest bacterial load of various fish organs was recorded in Dahmeit khor (12-1715294 cfu×10^3/g) compared to Tushka khor (53-1440000 cfu×10^3/g) as shown in Table (1). Also, drought season recorded higher bacterial load (2×10^7- 2×10^9 cfu/g) than higher flooding season (1×10^4- 5×10^6 cfu/g) for both khors (Table 1). The total spore forming bacterial (TSF) count is higher in Tushka khor (2-9×10^4 cfu/g) compared to that in Dahmeit khor (1-4×10^4

cfu/g). As well as drought season recorded higher TSF load than higher flooding season (range $1×10^3$- $9×10^4$ cfu/g and 1- $3×10^4$ cfu/g, respectively) for both khors (Table1). Also *Enterobacteriaceae spp*. recorded higher numbers during drought season (range $5×10^6$- $8×10^7$ cfu/g) than higher flooding season (range $3×10^3$ - $8×10^5$ cfu/g respectively). *Salmonella* sp was detected in 50% of tissue samples collected from Dahmeit and Tushka khors.

Macrophyte analyses

Two macrophytes, *Myriophyllum spicatum* L. and *Najas marina* subsp. *armata* were observed in Lake Nasser Khors. *Myriophyllum spicatum* L. was dominated submerged macrophytes communities in Lake Nasser and Khors. *Najas marina* was collected from only one site (Tu 5) in drought season. Site Tu 5 showed low value of ammonia (79.3µg/l) compared to other sites in drought season. Table (2) of Goher and Madbouly (2016) shows the range of physico-chemical parameters

Microbial analyses indicated that the total bacterial counts and total diazotrophs were high in their population densities in all sample at different seasons (Table 3).

The total bacterial count and diazotrophs ranged from 10^6 to 10^8cfu g^{-1} and 10^4 to 10^6 g^{-1} for high flooding season and drought season, respectively. No significant differences can be attributed to the plant species.

A large amount of bacteria was encountered in endo-phyllosphere which proves much greater bacterial infection of the inner tissues. The endo-phyllosphere accommodated populations ranged from 10^2-10^4 and 10^2-10^3 cfu / ml for the total bacteria and total diazotrophs, respectively. generally, These findings, support the possibility of significant contribution of diazotrophs bacteria closely associated and/or localized within the inner tissues of various macrophytes (Table 4).

DISCUSSION

Actually, Nile flooding is greatly affecting the conditions of Nasser Lake (Mageed and Heikal, 2006), and it carries nutrients and organic matter which are important for growth of fauna and flora. In the present study, it was clearly noticed that higher flooding season causes increasing in microbial load in Phyllospher and endo- Phyllospher of macrophytes, as well as increasing in autochthonous and allochthonous and in diazotrophic bacteria especially in Tushka khor. Also, Tushka khor recorded higher yield of all biochemical contents of phytoplankton than Dahmeit khor during the two investigated seasons. This is may be due to the presence of high nutrients in Tushka khor which is located southern Dahmeit khor (Toufeek and Korium, 2009). Also, flooding causes increase in the most biochemical contents studied in phytoplankton, such as chlorophyll a, carbohydrates, protein and not for Lipids in Tushka khor. While in Dahmeit khor drought season caused increasing in proteins and lipids, and decreasing in carbohydrates; and no significant change was observed in chlorophyll a, this is may be due to environmental condition such as light and temperature, also sedimentation effect as well as level and water current (Abd El-Karim and Mahmoud, 2016). In addition, higher chlorophyll a and protein contents recorded in surface layer than bottom layer may be due to the effect of light, nitrates and phosphates concentrations (Abd El-Karim and Mahmoud, 2016).

On the other hand drought season causing increased in bacterial load in fish organs from two investigated khors. This can be related to the effect of evaporation rate, current, and amount of water (Mageed and Heikal, 2006).

Dahmeit khor recorded higher bacterial load for various fish organs compared to Tushka khor, which may be related to the effect of tourism and fisheries activities (Ali *et al*., 2016).

There are correlation between fauna and flora in aquatic system, where Othman *et al.*, (2016) demonstrated the role of diazotrophic bacteria in increasing water productivity and fish biomass. In the present study for surface water layer, there were significant positive correlation between TBC and chlorophyll a, protein, carbohydrates, (r= 0.52, 0.69 and 0.47, respectively n=20, $p<0.05$), and, there were significant negative correlation between lipid content and TSF, FS and TD (r=0.45, 0.5 and 0.52 respectively n=20, $p<0.05$). While, there are significant positive correlation between lipid contained in bottom layers and some bacterial groups in sediment such as FC, FS and *Enterobacteriaceae spp*. (r= 0.47, 0.59 and 0.45, respectively n=20, $p<0.05$).

Furthermore, in Dahmeit Khor, according to ANOVA statistical analysis, the total lipid showed high temporal significant difference $p< 0.001$, and the total protein showed temporal significant difference $p< 0.05$. In Tushka Khor, the total protein, showed spatial significant difference $p< 0.05$, however, there were no differences between high flood and drought seasons.

According to the concentration of nutrients; nitrates and phosphates (Goher and madbouly, 2016), the correlation statistical analysis in Dahmeit Khor, showed negative correlation between lipid & nitrates, and lipid & phosphates [r = -0.8 and r = -0.38, respectively]. In Tushka Khor, chlorophyll a showed high positive correlation with the total protein, nitrates and phosphates [r = 0.77, 0.7 and 0.43, respectively], and high negative correlation with the total lipid [r = -0.65]. The total protein showed high positive correlation with nitrates [r = 0.74], and high negative correlation with total lipid [r = - 0.87]. The total lipid showed negative correlation with nitrates [r = -0.58].

Generally, the maximum yield of biochemical contents was obtained during the high flooding season. The biochemical composition of phytoplankton is influenced by the seasonal, regional variations, environmental parameters and nutrients. Also, the present data illustrated the lowest concentration of chlorophyll a and biochemical contents in Lake Nasser Khors during high flooding and drought seasons (2016), with respect to data of Autumn (2014) and Spring (2015) given by Abd El-Karim and Mahmoud (2016). Also, the microbial load in sediments was higher in the period before the flood than after the flood, while the opposite was recorded for water; this is may be due to the amount of water and the current speed.

Myriophyllum spicatum is considered an invasive species (Madsen, 1998) and it was found to spread in almost all sites of the investigated Khors. *Najas marina* subsp. *armata* was recorded only in site 5 of Tushka Kore. Ali and Soltan (2006) reported that, *N. marina* subsp. *armata* dominated the submerged macrophytes communities in Lake Nasser in the period (1988–1990). In almost all sites *N. marina* was eliminated and replaced by *M. spicatum*. Similar findings were reported by Agami and Wise (1985) who explained *M. spicatum* caused reduction of growth of *N. marina* subsp. *armata*. Many authors reported that *M. spicatum* may release allelopathic substances (Nakai *et al*., 2000; Gross *et al*., 1996). Anderson and Kalff (1986) suggested that the length and biomass of *M. spicatum* are increasing by addition of nitrogen. Similarly, in the present study, the increase in water nitrogen and nitrogen fixing bacteria was associated with the increases of *M. spicatum*, which, in turn, reinforces its invasive capacity into Lake Nasser.

Conclusion

This study indicated that the biochemical composition of phytoplankton as well as water and sediment quality and fish healthy and distribution of macrophytes are affected by the flood.

Thus, great efforts and cooperation between different authorities are needed to carry out monitoring program and regular evaluation for Lake Nasser and its khors to protect them from pollution and to reduce environmental risks.

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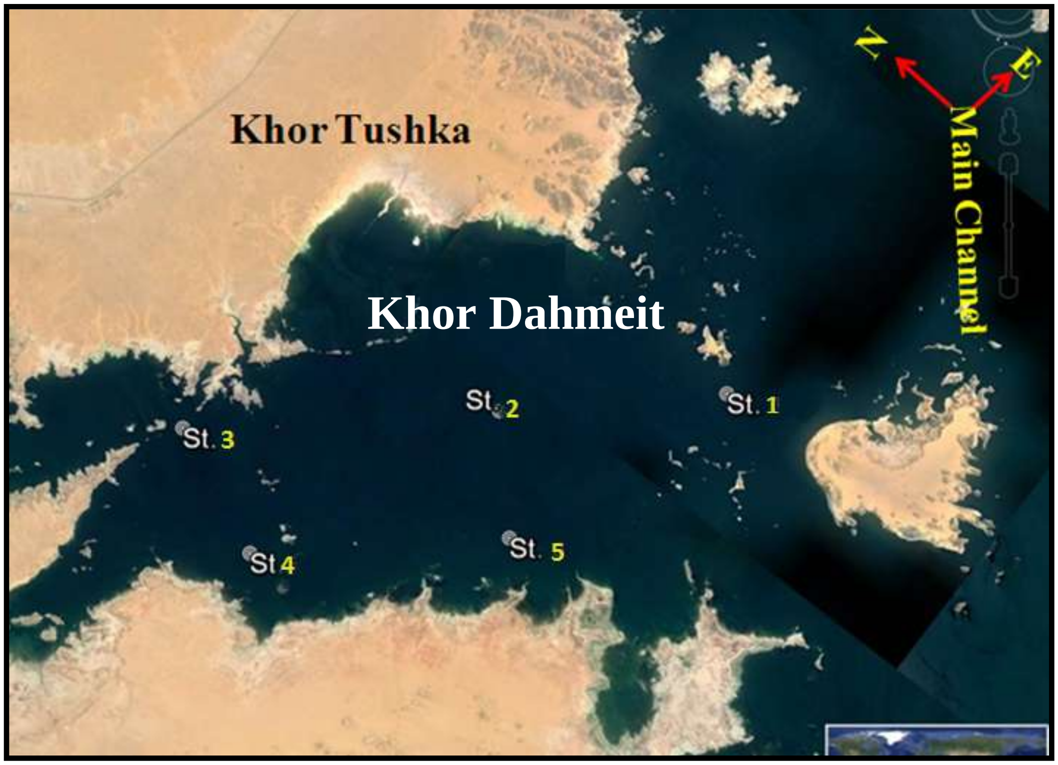

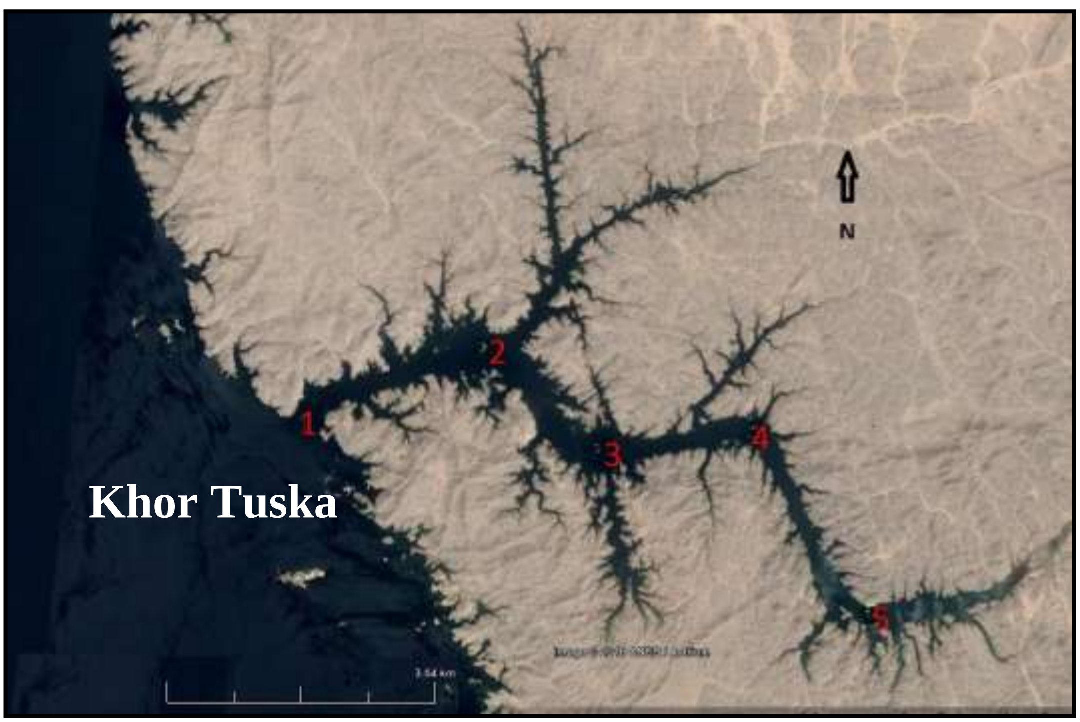

Fig. (1): Stations of Tushka and Dahmeit Khors of Lake Nasser.

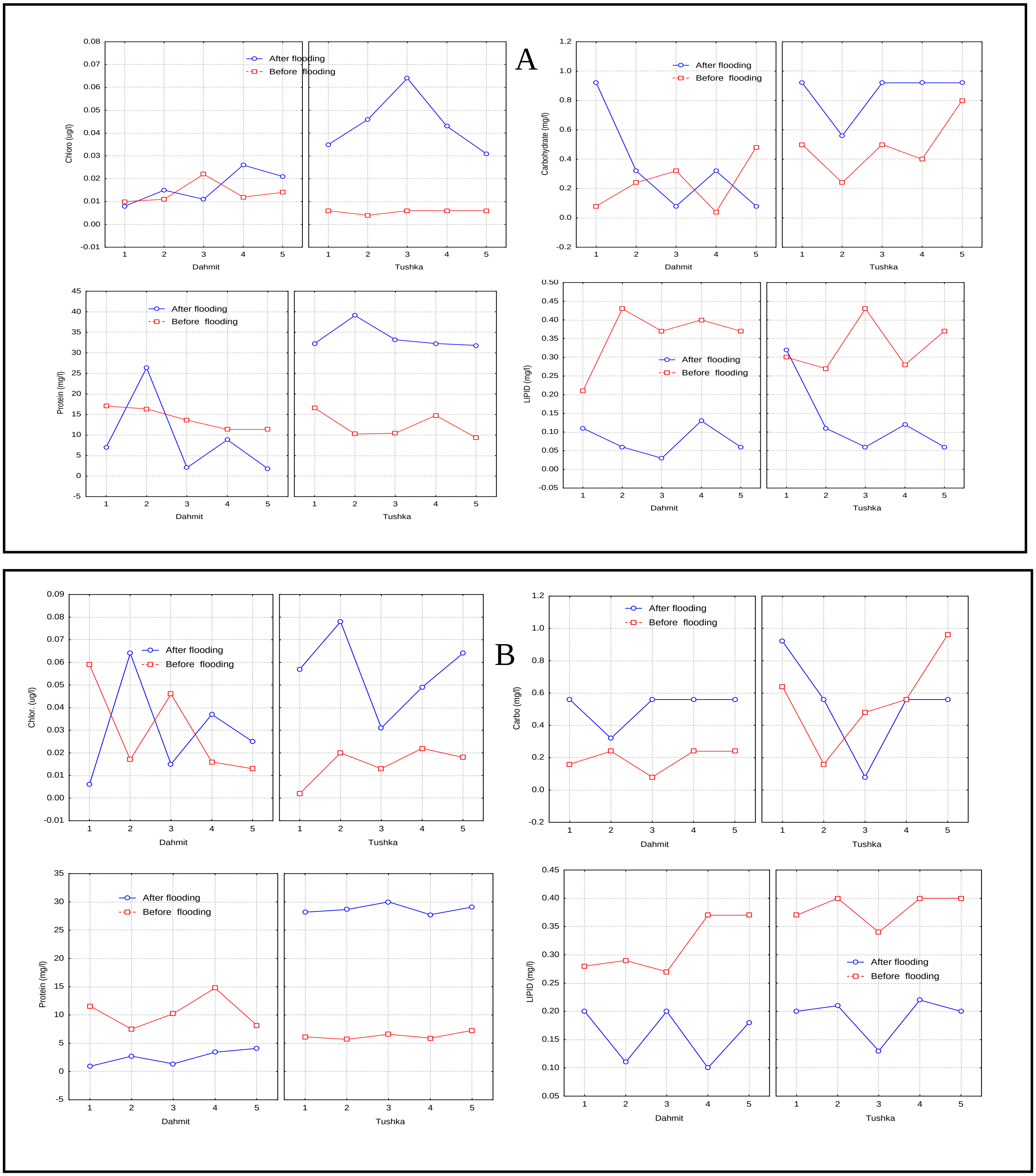

Fig. (2): Biochemical contents of phytoplankton in Dahmeit and Tushka Khors Lake Nasser during high flooding season and drought seasons of at the surface (A) and the bottom (B) levels.

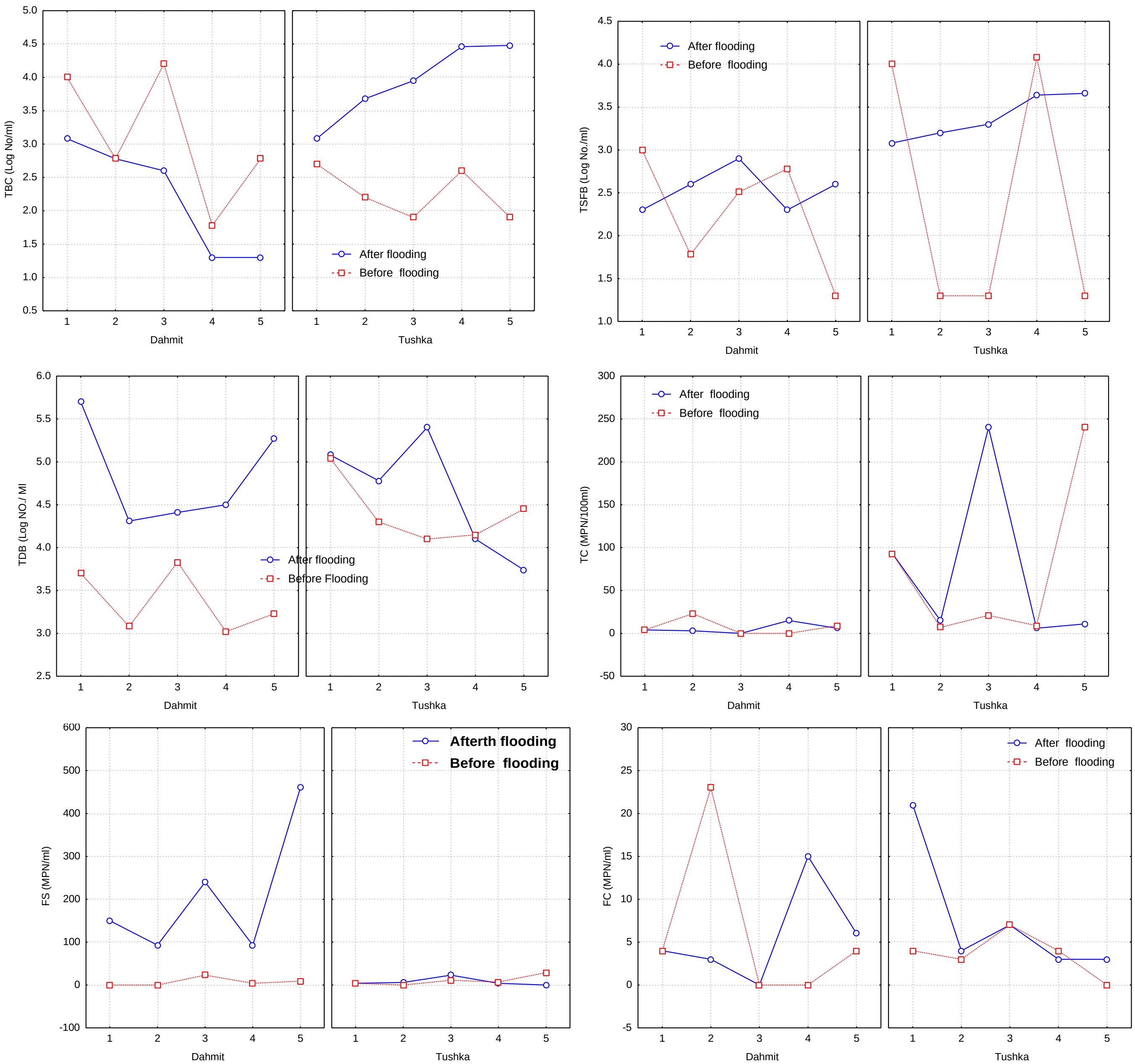

Fig. (3): Bacterial load fluctuations in water samples along Dahmeit and Tushka Khors of Lake Nasser during high flooding and drought seasons.

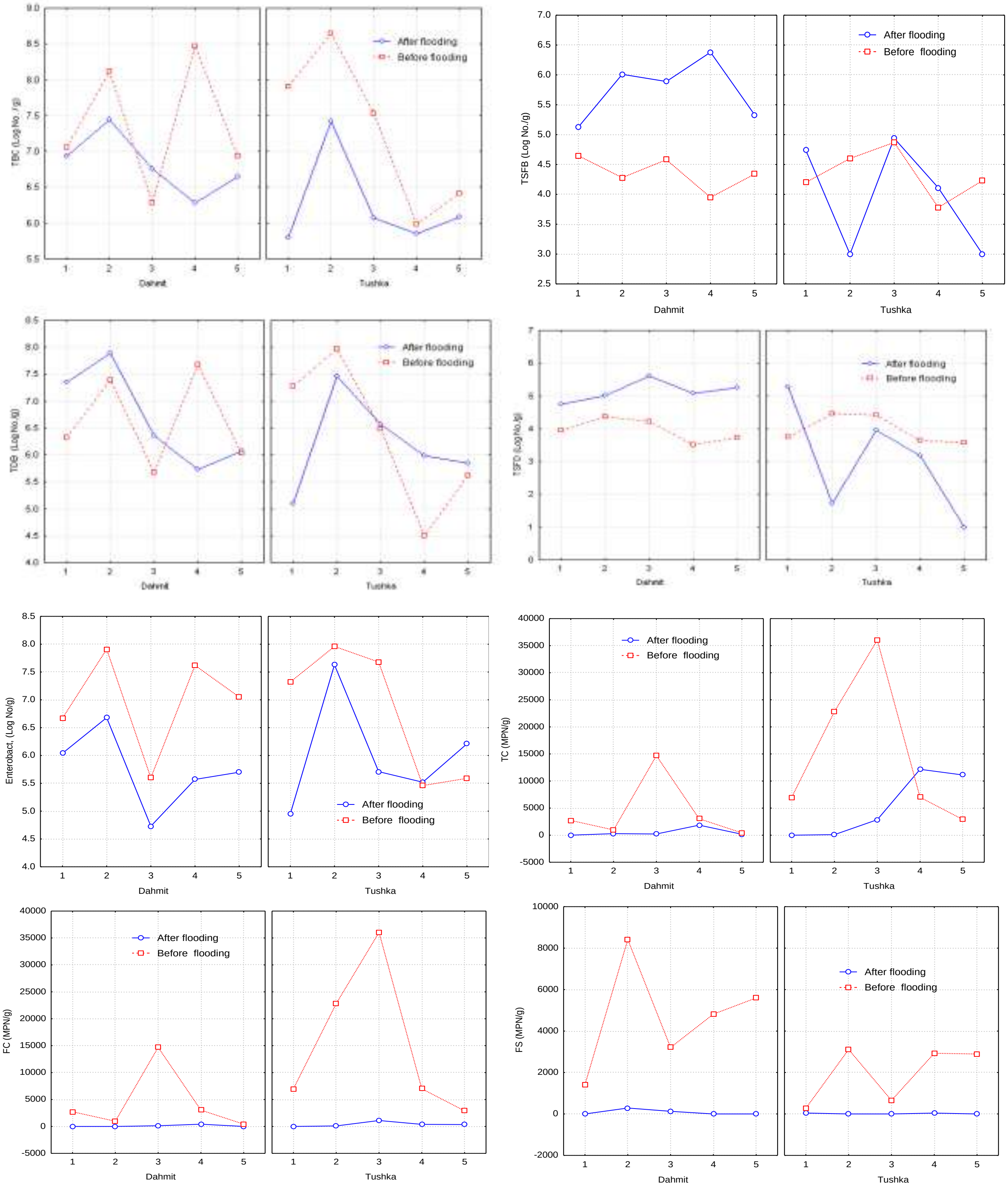

Fig. (4): Bacterial load fluctuations in sediments samples along Dahmeit and Tushka Khors of Lake Nasser during high flooding and drought seasons.; Rao R (20,120)=107.23; p<0.000.

Table (1): Microbial load in various organs of *Oreochromis niloticus* collected from Dahameit and Tushka khors of Lake Nasser during high flooding and drought seasons.

Organs	TBC (cfu x10^3/g)	SFB (cfu /g)	*ENT* (cfu x 10^3/g)	TBC (cfu x10^3/g)	SFB (cfu/g)	*ENT* (cfux 10^3/g)
	Dahmeit Khor					
	Drought season			**Higher flooding season**		
Skin	1715294	38779	84044	4664	29493	820
Gills	734470	1800	84800	1539	899	281
Muscles	65322	1408	15142	512	411	3
Gut	18000	1508	5000	12	1	11
	Tushka Khor					
	Drought season			**Higher flooding season**		
Skin	1440000	33188	21206	1749	792	23
Gills	102619	25206	83146	540	199	92
Muscles	344127	30952	71365	53	146	56
Gut	33600	95707	10185	774	2	535

TBC, Total bacteria counts; SFB, Spore-forming bacteria; *ENT*, *Enterobacteriaceae* spp.

Table (2): Average values of physico-chemical parameters of Dahameit and Tushka khors of Lake Nasser during high flooding and drought seasons (Goher and Madbouly, 2016).

Seasons / Parameters	Dahameit Khor		Tushka Khor	
	high flooding	**drought seasons**	**high flooding**	**drought seasons**
Temp. ^{0}C	26.0-28.1	18.1-20.2	27.7-30.4	19.2-20.7
pH	8.6-8.9	7.8-8.6	8.4-8.9	8.5-8.8
EC mS /cm	236.2-257.2	258.0-268.0	240.7-259.8	250.0-253.0
NO_2-N µg /l	0.84-4.20	0.0-76.2	0.84-2.90	1.60-3.52
NO3- N µg /l	12.8-18.4	24.0-354.5	16.0-72.8	94.6-511.1
NH_4 -N µg /l	159.8-491.3	137.9-568.6	205.7-317.9	75.6-179.5
PO_4 (µg/l)	3.15-5.12	0.0-198.4	4.74-7.13	12.4-19.5

Table (3): Population density (Log No/ g dry weight) of various groups of microorganisms in Phyllospher of macrophytes of Lake Nasser.

Sites	Plant species		Total bacteria count		Total sporformers		Total diazotrophs		Spore forming diazotrophs	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Dah.3	*M. spicatum*	*M. spicatum*	7.62	6.98	3.74	4.46	7.41	5.82	2.47	3.12
Dah.4	*M. spicatum*	*M. spicatum*	7.74	5.02	3.88	3.81	7.39	5.36	2.35	3.20
Dah.5	*M. spicatum*	*M. spicatum*	8.1	5.00	3.47	3.11	8.03	5.16	1.42	3.01
TU.4	NC	*M. spicatum*	ND	5.55	ND	3.10	ND	5.56	3.19	3.18
TU.5	*M. spicatum*	*M. spicatum*	6.79	4.74	3.47	2.22	6.19	5.00	3.19	1.99
TU.5	NC	*N. marina*	ND	5.71	ND	2.92	ND	5.07	ND	2.33

S1, Drought season; S2, Higher flooding season; NC, not collected; ND, not determined

Table (4): Population density (Log No/g dry weight) of various groups of microorganisms in endo- Phyllospher of macrophytes of Dahmeit and Tushka khors.

Sites	Plant species		Total bacteria		Total diazotrophs	
	S1	S2	S1	S2	S1	S2
Dah.3	*M. spicatum*	*M. spicatum*	3.71	3.46	2.35	2.12
Dah.4	*M. spicatum*	*M. spicatum*	4.12	3.81	3.82	2.20
Dah.5	*M. spicatum*	*M. spicatum*	4.15	3.31	2.11	2.30
TU. 4	NC	*M. spicatum*	ND	3.10	ND	2.18
TU. 5	*M. spicatum*	*M. spicatum*	3.84	2.22	2.56	1.99
TU. 5	NC	*N. marina*	ND	2.92	ND	2.33

S1, Higher flooding season; S2, Drought season; NC, not collected; ND, not determined.

Biochemical evaluation of phytoplankton and microbial load in water, sediments, plant and fish during drought and high flooding season in Dahmeit and Tushka khors, Lake Nasser, Egypt

التقيم الكيميائي الحيوي للعوالق النباتية والميكروبات في المياه والتربة والنباتات والاسماك اثناء موسمي الفيضان والجفاف في خوري دهميت و توشكى ببحيرة ناصر – مصر

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المستخلص

بعد بناء السد العالي كانت مياه الفيضان تخزن في بحيرة ناصر والاخوار التابعة لها. ويعتبر التركيب البيوكيميائي لمجموعة العوالق النباتية والميكروبية من العلامات البيولوجية الهامة للنظام البيئي من مياه وتربة ونباتات واسماك الاخوار المختلفة لبحيرة ناصر. لذلك تم دراسة اختلاف محتوي الكلوروفيل أوالمحتوي الكلي للبروتين والكربوهيدرات والدهون للعوالق النباتية كما تمت دراسة المحتوي الميكروبي للمياه والتربة والنباتات والاسماك اثناء موسمي الفيضان والجفاف في خوري دهميت و توشكى.

سجل خور توشكى أعلي محتوي بيوكيميائي للطحالب اثناء الموسمين كما سجل أعلي محتوي من صبغ الكلوروفيل أ والمحتوي الكلي للبروتين في الطبقات السطحية دون السفلية. كما أظهر التحليل الميكروبي للمياه تواجد كثيف لكل من اعداد البكتيريا الكلية والبكتريا المثبتة للنتروجين الجوى في كلا الموسمين. وسجل خور توشكى خلال موسم الفيضان اعلي محتوي من البكتريا الموجودة طبيعيا فى المياه وايضا البكتريا الدخيلة على البيئة المائية بالاضافة الى البكتريا المثبتة للنتروجين الجوي وذلك بالمقارنة بموسم الجفاف. كما سجل خور توشكي اعلي محتوي من البكتيريا المثبتة للنيتروجين واعلي محتوي من البكتريا في التربة بالمقارنة بخور دهميت. ومن ناحية اخري كان اعلي محتوي من البكتيريا في اعضاء السمك المختلفة في خور دهميت.كما اظهر التحليل الميكروبى للنباتات المائية تواجد البكتريا الكلية والبكتريا المثبتة للنتروجين الجوى بكثافة عالية فى كلا الموسمين.

ولذلك فان نتائج هذه الدراسة تقدم دليل علي ان الفيضان يؤثر بشكل كبير في المحتوي البيوكيميائي للعوالق النباتية وجودة المياه والتربه وتوزيع النباتات المائية وصحة الاسماك. ويوصى بضرورة التعاون بين السلطات لوضع برامج للرصد والمتابعة والتقييم المستمر لدراسة بحيرة ناصرواخوارها لحمايتها من التلوث وتقليل المخاطر البيئية.