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Feeding on phytoplankton profile of two African Cichlids in large reservoir, Lake Nasser, Egypt

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ABSTRACT

This study was carried out in 2016 to investigate the feeding on phytoplankton profile of the Nile tilapia (*Oreochromis niloticus*) and mango tilapia (*Sarotherodon galilaeus*) inhabiting Lake Nasser, and its relation to their fisheries biological parameters. Phytoplankton Preference index (PPI), Index of Relative Importance (IRI), and Straus Linear index were used to investigate the feeding patterns of the two species in the lake. Moreover, some fish biological parameters of the two species were determined in the lake different areas. The results showed that *O. niloticus* and *S. galilaeus* feed mainly on the same phytoplankton items. Bacillariophyceae was identified as the most desired phytoplankton item to *O. niloticus* (IRI = 12.53) and *S. galilaeus* (IRI=18.28). Both fish species were more selective to five species from Bacillariophyceae and five species from Chlorophyceae, while they were more avoidant to four species from Cyanophyceae at all lake's areas. The results also showed that the main fisheries biological parameters are varied significantly between the two species and through lake different areas. This study concluded that the variation in fisheries biological parameters in Lake Nasser is not related to the pattern of feeding on phytoplankton but is led by other factors (e.g. fishing practices).

INTRODUCTION

Lake Nasser is an extremely dynamic aquatic ecosystem which is an important source of fish for Aswan Governorate and the rest of Egypt. Although 75 fish species have been recorded in the Nile system (Bishai and Khalil, 1997), the fisheries sector of Lake Nasser depends on only a limited number of species, consequently, cichlids constituted 67 percent, 12315 tonnes, of the production of the lake which was 18352 tonnes in 2016 (GAFRD, 2018).

The natural aquatic habitats provide a vast diversity of organisms of different sizes and taxonomy groups that are utilised as food by fish (Gerking, 2014). The investigation of fishes diet in their natural habitats improves the understanding of their distribution, abundance, growth, and productivity (Ekpo *et al.*, 2014). Consequently, investigating the food and feeding habits of the commercial fish species is a very

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important concern since it establishes the basis for the development of effective fisheries management programmes (Oronsaye *et al.*, 2005). Food and feeding habits studies are mostly based on the analysis of gut contents of fish caught from their natural habitats, since the study of the gut content is not only a method to know the diet but also an excellent source of information on many characteristics of fish biology and ecology (Manko, 2016).

Fishes have been known to feed on a wide variety of items such as phytoplankton, detritus, higher plant material, chironomids, zooplankton and fish (Omondi *et al.*, 2011; Shalloof and Khalifa, 2009; YalÇIn *et al.*, 2001). The feeding habits of fish may be varying according to age and size (Tadesse, 1998), as the sizes of the fish increases, the consumption of large quantities of various phytoplankton evidently increased (Getachew, 1987).

Phytoplankton is the basic link in aquatic food chain, in addition to play an essential role as food material for fishes and its fry (Borowitzka and Borowitzka, 1988). Fish production in a lake depends directly on its productivity (Saiyida and Bari, 1982).

On the other hand, the main fisheries biological parameters such as length, weight and condition factor are used in order to compare the “condition”, “fatness” or wellbeing of fish. They are strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live (Anene, 2005).

Despite the importance of investigating the spatial variation of different biological factors affecting fish populations in such a huge water body like Lake Nasser, information about food and feeding habitats and fisheries biological parameters of fish species in Lake Nasser is outdated or completely absent. All available information on these aspects is more than decade old and on the lake as whole without considering any variation in the conditions through different regions of the lake (Halls *et al.*, 2015).

Therefore, this study aimed to contribute to the available information on food and feeding habitats of two of the most economically and ecologically important fish species inhabiting Lake Nasser, Nile tilapia (*Oreochromis niloticus)* and mango tilapia (*Sarotherodon galilaeus).* This study is focused on phytoplankton since they were ranked as the food items with the highest occurrence in the stomach of these fish species (Shalloof and Khalifa, 2009; Teferi *et al.*, 2000; Saiyida and Bari, 1982; Getachew, 1987). Moreover, this work investigates how feeding profile on phytoplankton is related to the main fisheries biological parameters of the two fish species in the Lake.

MATERIALS AND METHODS

Study Area

Lake Nasser is a huge man made reservoir located on the south border of Egypt with Sudan (Hussian *et al.*, 2015). Its surface area is 5237 km^2 at its highest water level and extends in Egypt for 291.8 km from South to North (Halls *et al.*, 2015). Lake Nasser could be divided to three main sectors: northern sector which shows full lake characteristics, middle sector which has both lake and river characteristics and southern sector which is dominated by riverine characteristics. There are 85 dendritic inlets in the lake, known as khors, which are significantly variable in size and shape, and greatly increase the shoreline length (Halls *et al.*, 2015).

Sampling

In the present study, sampling took place during December 2016. Six sites were selected to represent the different sectors of the lake: Elsag, Dihmit and Mirwaw in the north sector, Amda and ElMadiq in the middle sector, and Tushka in the south sector (Figure 1).

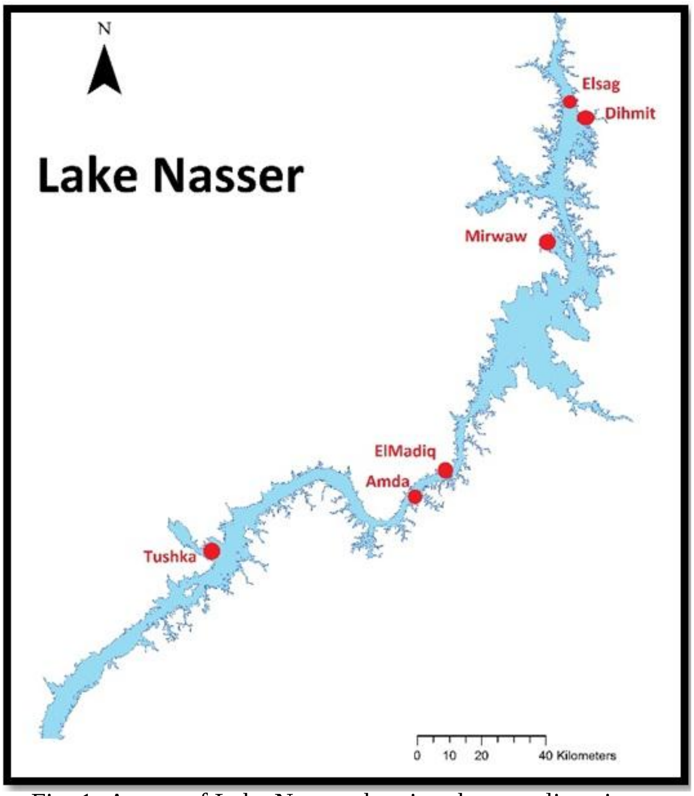

Fig. 1: A map of Lake Nasser showing the sampling sites.

Sampling of Phytoplankton

One litter of water was collected from the different sites and preserved in 4% formalin for quantitative and qualitative analyses of phytoplankton (Vollenweider *et al.*, 1974). In the laboratory, the preserved samples were transferred to a glass cylinder. Phytoplankton cells were allowed to settle for 5 days (APHA, 1998), siphoned and concentrated to a fixed volume and transferred to plastic vials for microscopic examination. The drop method was applied for counting and identifying phytoplankton species (APHA, 1998). Triplicate samples (5 μl) were taken and examined under an inverted microscope (ZEISS 1M4738) at magnifications of 400x and 1000x. Reference manuals were used for the identification (Compère, 1991; Bourrelly, 1981; Tiffany and Britton, 1952; Prescott, 1978; Starmach, 1974) and (Desikachary, 1959).

Sampling of Fish

A total of 275 fish belonging to the two fish species *O. niloticus* and *S. galilaeus* were collected from different sectors of the lake using commercial fishing gears (trammel nets). Total length of each fish was taken to the nearest millimetre from the tip of the snout (mouth closed) to the extended tip of the caudal fin using a measuring board. Body weight was measured to the nearest 0.1 gram using a top loading balance.

Stomach Content Examination

Fifty-seven fish were dissected and the guts were removed, transferred to labelled containers, and preserved in 4% formalin fixative then transported to laboratory for investigation. In the laboratory, the benches were cleaned and disinfected with hypochlorite solution. The stomach contents were emptied into Petri dish and the food composition was identified by microscope (Windell and Bowen, 1978). For the purpose of microscopic analysis, subsample was taken for phytoplankton enumeration using a teat pipette. This was placed in a Sedgewick rafter cell which carries a volume of 1 ml. The food items were then enumerated under a compound inverted microscope (magnification 10X to 400X). The phytoplankton in the stomach contents was counted by the transect method using the procedures outlined in (Lind, 1974).

The gut contents were analysed using frequency of occurrence and numerical methods as described by (Hyslop, 1980). In the frequency of occurrence method, the occurrence of food items was expressed as the percentage of the total number of stomach containing food. In the numerical method, the number of each food item was expressed as the percentage of the total number of food items found in the stomach.

Data Analysis

Phytoplankton Preference index (PPI)

For determine the phytoplankton preference index, percentage frequency of occurrence was obtained through the following equation described by (Chrisafi *et al.*, 2007): PP= (number of stomachs with a specific phytoplankton species/the number of non-empty stomachs from phytoplankton) ×100. The different values of this index, allow separation of phytoplankton preference to three categories: If PP >50%, the specific phytoplankton species is dominant and it is the main diet. If 50%> PP >10%, the specific phytoplankton species is secondary. If PP<10%, the specific phytoplankton species is eaten accidentally (Euzen, 1987).

Index of Relative Importance (IRI)

In the gut content, IRI for phytoplankton classes was calculated according to (Pinkas *et al.*, 1970), the following formula: IRI= (%N +%V) %O. Where, N, V, and O represent percentages of number, volume and frequency of occurrence of phytoplankton, respectively**.**

Straus Linear index

Phytoplankton was obtained from the gut samples and from the water samples then identified according to (APHA, 1998) for calculation of The Straus Linear index based on the following equation;

$L_i = r_i - p_i$ (Strauss, 1979)

Where: ri is the proportion of phytoplankton taxon i in the guts of predators and p_i is the proportion of the same taxon in the environment. The means of ri and pi evaluated by the number of phytoplankton in each sample will be used to calculate L_i

Fisheries biological parameters

A total of 275 individuals belonging to the two commercial fish species *O. niloticus* and *S. galilaeus* were used to calculate K in this study. Both species were represented by at least 15 individuals in each sector of the lake and with a relatively wide size range to carry out the ANOVA and Tukey's (HSD) tests. Extreme outliers attributed to data collection error were omitted from the analyses. Condition factor (K) was calculated by the formula: $K = 100W/ L^3$ (Pauly, 1983). Variations in total length, total weight, and K of the individual fish living in the lake’s different sectors were analysed with one-way analyses of variance (ANOVA) with subsequent Tukey's honestly significant difference (HSD) tests using Xlstat software. All the statistical analyses were considered at significance level of 5% ($p<0.05$).

RESULTS

In the present study, stomach content analysis of *O. niloticus* and *S. galilaeus* revealed a variation in the percentage of different phytoplankton classes (Figures 2 and 3). The dominant phytoplankton classes at the different lake sectors were Bacillariophyceae followed by Chlorophyceae. Also, Bacillariophyceae was the dominant class in the water column.

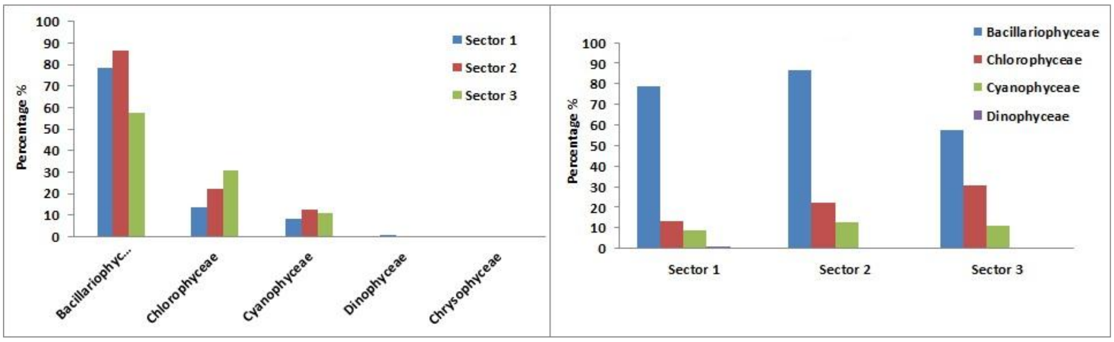

Fig. 2: Percentage of phytoplankton classes in gut of *Oreochromis niloticus* at the different sectors of Lake Nasser

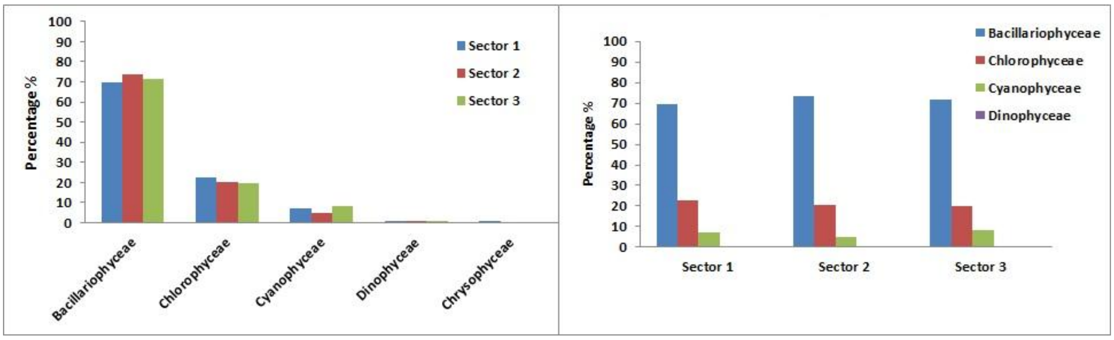

Fig. 3: Percentage of phytoplankton classes in gut of *Sarotherodon galilaeus* at the different sectors of Lake Nasser

Index of Relative Importance (IRI)

Calculating the Index of Relative Importance (IRI) for phytoplankton classes, that were recorded in the guts of *O. niloticus* and *S. galilaeus*, revealed that the highest IRI value was observed for Bacillariophyceae followed by Chorophyceae then Cyanophyceae with the mean IRI values of 12.53, 4.90, 2.10 and 18.28, 5.12, 1.90 for both *O. niloticus* and *S. galilaeus*, respectively, as shown in Table 1.

Table 1: Index of Relative Importance (IRI) for phytoplankton classes which examined in the gut of *Oreochromis niloticus* and *Sarotherodon galilaeus* at different sectors during December 2016.

Fish species	Sites	IRI				
		Bacillariophyceae	Chlorophyceae	Cyanophyceae	Dinophyceae	Chrysophyceae
O.n.	Sector 1	3.60	0.62	0.46	0.08	0.07
	Sector 2	14.57	3.76	2.15	0.06	0.00
	Sector 3	19.42	10.34	3.69	0.00	0.00
Mean IRI		12.53	4.90	2.10	0.05	0.02
S.g.	Sector 1	3.91	1.27	0.41	0.02	0.00
	Sector 2	14.84	4.12	1.01	0.05	0.00
	Sector 3	36.09	9.98	4.29	0.91	0.00
Mean IRI		18.28	5.12	1.90	0.33	0.00

The ANOVA with subsequent HSD tests of the IRI results showed that only the variation of IRI of *Chlorophyceae* between different lake sectors was statistically significant (Table 2).

Table 2: ANOVA with subsequent HSD tests of the Index of Relative Importance (IRI) for phytoplankton classes which recorded in the guts of *Oreochromis niloticus* and *Sarotherodon galilaeus*

	Bacillariophyceae	Chlorophyceae	Cyanophyceae	Dinophyceae	Chrysophyceae
Sector 3	27.756 a	10.158 a	3.986 a	0.456 a	0.000 a
Sector 2	14.703 a	3.939 b	1.579 a	0.057 a	0.000 a
Sector 1	3.755 a	0.943 c	0.432 a	0.053 a	0.038 a
Pr > F	0.181	0.005	0.082	0.622	0.486
Significant	No	Yes	No	No	No

Straus Linear food selectivity index for phytoplankton classes

Straus Linear index of selection showed that *O. niloticus* and *S. galilaeus* were preferential to Bacillariophyceae and Chlorophyceae (positive values) and avoidant to Cyanophyceae and Dinophyceae (negative values) in their diet at all lake sectors (Figs. 4 and 5).

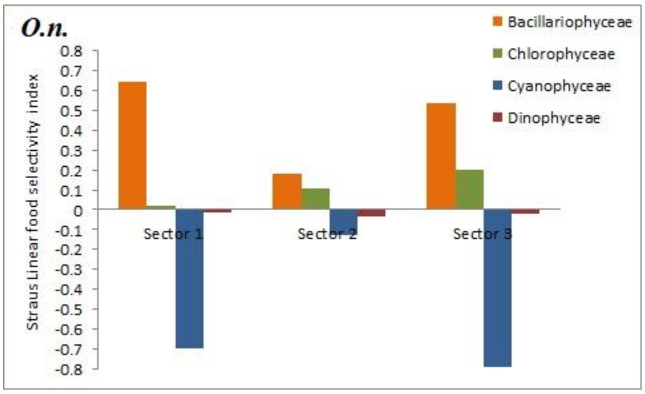

Fig. 4: Straus Linear food selectivity index for phytoplankton classes in gut content of *Oreochromis niloticus* at different sectors of Lake Nasser.

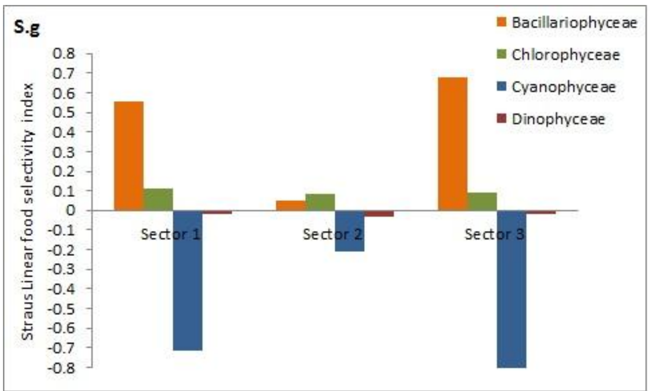

Fig. 5: Straus Linear food selectivity index for phytoplankton classes in gut content of *Sarotherodon galilaeus* at different sectors of Lake Nasser.

Straus Linear food selectivity index for phytoplankton species

The stomach content indicated that, *O. niloticus* in Lake Nasser is more selective to *Achnanthes lanceolata v.dubia*, *Cymbella parva*, *Synedra ulna* and *Tabellaria fenestrate* from Bacillariophyceae and *Chlorella vulgaris*, *Pediastrum simplex*, *Scenedesmus arvernensis* and *Staurastrum paradoxum* from Chlorophyceae and more avoidant to *Gomphosphaeria aponina*, *Merismopedia glauca* and *Microcystis wesenbergii* from Cyanophyceae at all lake sectors (Figure 6). Straus Linear food selectivity index for phytoplankton species in the gut content of *S. galilaeus* from different lake sectors showed that species of *Achnanthes lanceolata v.dubia*, *Cymbella parva*, *Fragilaria capunica* and *Tabellaria fenestrate* from Bacillariophyceae and *Chlorella vulgaris*, *Carteria multifilis* from Chlorophyceae are preferable by *S. galilaeus*, while species of *Aphanothece stagnina* and *Microcystis wesenbergii* are avoided at all lake sectors (Figure 7).

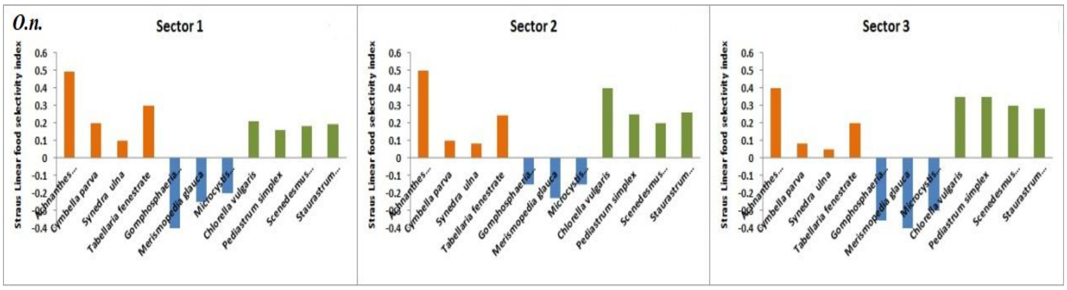

Fig. 6: Straus Linear food selectivity index for phytoplankton species in gut content of *Oreochro niloticus* at different sectors of Lake Nasser.

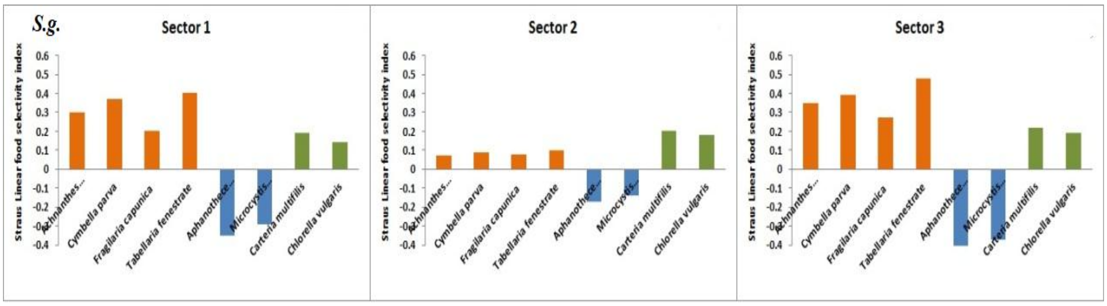

Figure 7: Straus Linear food selectivity index for phytoplankton species in gut content of *Sarotherodon galilaeus* at different sectors of Lake Nasser.

Table 3 shows the list of phytoplankton species which recorded in the gut contents of *O. niloticus* and *S. galilaeus*, with Phytoplankton Preference Index (PPI) at the different sectors.

Fisheries biological parameters

The number of specimens, condition factor, mean length, and mean weight of studied fish species are presented in Table 4. The sample size for the fish species varied from 118 in *O. niloticus* to 157 in *S. galilaeus*. The average condition factor (K) for *O. niloticus* was 2.152 while it was 2.117 for *S. galilaeus*.

An ANOVA revealed significant differences ($P<0.05$) in biological parameters among the two species and the three sectors (Table 4). As ANOVA has shown an overall statistically significant difference in species and sectors total length, total weight and condition factor means, Tukey's (HSD) tests were run to confirm where the differences occurred by pairwise comparisons for locations. The results of both statistical analyses are shown in Table 4. The Tukey's (HSD) test showed that sector 1 (north) of the lake was always significantly varied from sector 3 (south) in all tested parameter which reveals that there are geographical variations of the studied fisheries biological parameters in Lake Nasser. The average values of all investigated biological parameters were always higher in sector 3 (south).

Table 3: List of phytoplankton species in gut of *Oreochromis niloticus* and *Sarotherodon galilaeus* with Phytoplankton Preference Index (PPI) at the different sectors of Lake Nasser.

List of species	*Oreochromis niloticus*			*Sarotherodon galilaeus*		
	Sector 1	Sector 2	Sector 3	Sector 1	Sector 2	Sector 3
Bacillariophyceae	PPI	PPI	PPI	PPI	PPI	PPI
Achnanthes clevei v.rostrata	36.4	83.3	67.0	77.8	50.0	100.0
Achnanthes lanceolata v.dubia	91.0	100.0	100.0	100.0	83.3	100.0
Achnanthes microcephala	0.0	0.0	33.3	0.0	0.0	0.0
Amphipleura pellucida	0.0	0.0	0.0	38.9	0.0	100.0
Amphora ovalis	0.0	33.3	0.0	50.0	50.0	0.0
Anomoeoneis brachysira v.genuina	0.0	33.3	0.0	16.7	0.0	0.0
Anomoeoneis sphaerophora v.scalpata	0.0	16.7	0.0	5.6	0.0	0.0
Anomoeoneis vitrea	0.0	0.0	0.0	38.9	16.7	50.0
Cymbella parva	100.0	100.0	100.0	100.0	83.3	100.0
Fragilaria capunica	54.5	100.0	0.0	100.0	66.7	100.0
Fragilaria capunica	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria construens	0.0	100.0	0.0	0.0	0.0	50.0
Fragilaria crotonensis	0.0	0.0	0.0	0.0	50.0	0.0
Fragilaria pinnata	0.0	83.3	0.0	0.0	0.0	50.0
Gomphoneis herculeana	18.2	0.0	0.0	0.0	0.0	0.0
Gomphonema lanceolatum v.genuinum	0.0	0.0	0.0	5.6	0.0	0.0
Gomphonema parvulum v.genuinum	0.0	33.3	0.0	0.0	0.0	0.0
Gyrosigma scalproides	0.0	0.0	0.0	55.6	0.0	0.0
Mastogloia lacutris v. amphicephala	4.5	0.0	0.0	33.3	16.7	50.0
Melosira granulate	0.0	83.3	0.0	27.8	0.0	50.0
Melosira varians	18.2	100.0	75.0	88.9	0.0	100.0
Navicula accomoda	0.0	0.0	0.0	0.0	16.7	0.0
Navicula cocconiformis	45.5	100.0	0.0	100.0	66.7	100.0
Navicula cuspidate	4.5	33.3	0.0	44.4	0.0	100.0
Navicula radiosa	77.3	100.0	0.0	100.0	0.0	100.0
Navicula tripunctata	31.8	50.0	0.0	0.0	0.0	0.0
Nitzschia acicularis v. typical	0.0	0.0	0.0	27.8	0.0	50.0
Pinnularia borealis	0.0	0.0	0.0	0.0	0.0	50.0
Rhoicosphenia curvata	0.0	0.0	0.0	77.8	50.0	100.0
Rhopalidia gibba	27.3	33.3	0.0	0.0	0.0	0.0
Synedra ulna	95.5	100.0	100.0	11.1	0.0	50.0
Synedra acus	50.0	100.0	67.0	94.4	16.7	100.0
Tabellaria fenestrate	100.0	100.0	100.0	100.0	100.0	100.0
Chlorophyceae						
Ankistrodesmus fusiformis	0.0	0.0	0.0	38.9	0.0	50.0
Ankistrodesmus spiralis	0.0	33.3	0.0	61.1	0.0	0.0
Asterococcus superbus	0.0	0.0	0.0	0.0	16.7	0.0
Botryococcus braunii	0.0	0.0	0.0	44.4	0.0	50.0
Carteria multifilis	31.8	100.0	67.0	100.0	83.3	100.0
Chlamydomonas bicocca	13.6	100.0	33.3	61.1	66.7	0.0
Chlorella vulgaris	77.3	100.0	100.0	100.0	50.0	100.0
Chlorococcum humicola	0.0	0.0	0.0	11.1	66.7	0.0
Closterium venus	40.9	0.0	67.0	77.8	0.0	0.0
Coelastrum cambricum	0.0	0.0	0.0	5.6	0.0	0.0
Coelastrum microporum	54.5	66.7	0.0	0.0	0.0	0.0
Cosmarium botrytis	31.8	83.3	67.0	66.7	66.7	50.0
Cosmarium depressum	0.0	100.0	33.3	94.4	0.0	100.0
Cosmarium reniforme	0.0	16.7	0.0	61.1	50.0	0.0
Dictyosphaerium pulchellum	0.0	16.7	0.0	0.0	0.0	0.0
Elakatothrix biplex	9.1	83.3	0.0	5.6	0.0	0.0
Euastrum elegans	0.0	0.0	0.0	44.4	33.3	50.0
Eudorina elegans	4.5	16.7	0.0	0.0	0.0	0.0
Hyalotheca mucosa	0.0	0.0	0.0	55.6	0.0	0.0
Kirchneriella microscopica	0.0	66.7	0.0	0.0	0.0	0.0
Mesostigma viride	13.6	100.0	33.3	0.0	0.0	0.0
Nephrocytium limneticum	4.5	33.3	0.0	0.0	0.0	0.0
Oocystis lacustris	9.1	83.3	33.3	0.0	0.0	0.0
Pandorina morum	18.2	0.0	33.3	33.3	0.0	0.0
Pediastrum duplex	0.0	50.0	0.0	11.1	0.0	0.0
Pediastrum simplex	54.5	100.0	100.0	77.8	0.0	0.0

Scenedesmus arvernensis	68.2	100.0	67.0	72.2	0.0	100.0
Spirogyra dubia	0.0	0.0	0.0	27.8	0.0	0.0
Spirogyra sp.	4.5	0.0	0.0	0.0	0.0	0.0
Staurastrum paradoxum	72.7	100.0	100.0	94.4	0.0	0.0
Staurastrum uniseriatum	0.0	16.7	0.0	27.8	16.7	0.0
Staurodesmus triangularis	0.0	16.7	0.0	0.0	0.0	0.0
Teilingia granulate	0.0	16.7	0.0	0.0	0.0	50.0
Tetraedron caudatum	0.0	66.7	0.0	0.0	0.0	50.0
Tetraedron trigonum	0.0	16.7	0.0	0.0	0.0	0.0
Volvox globator	18.2	100.0	67.0	61.1	66.7	0.0
Cyanophyceae						
Aphanizomenon flos aquae	0.0	0.0	0.0	0.0	16.7	0.0
Aphanothece stagnina	36.4	100.0	33.3	94.4	100.0	100.0
Chaemesiphon carpaticus	0.0	50.0	0.0	66.7	66.7	50.0
Chroococcus limneticus	31.8	100.0	0.0	0.0	0.0	0.0
Coelosphaerium kuetzingianum	0.0	0.0	0.0	33.3	33.3	0.0
Gloeocapsa magma	0.0	0.0	0.0	0.0	16.7	0.0
Gloeocapsa turgida	0.0	0.0	0.0	22.2	16.7	0.0
Gomphosphaeria aponina	45.5	66.7	67.0	0.0	50.0	0.0
Merismopedia glauca	40.9	100.0	67.0	94.4	0.0	100.0
Merismopedia tenuissima	0.0	0.0	0.0	38.9	0.0	50.0
Microcystis incerta	0.0	83.3	0.0	11.1	0.0	0.0
Microcystis wesenbergii	54.5	100.0	33.3	77.8	100.0	100.0
Oscillatoria agardhii	18.2	100.0	0.0	0.0	0.0	0.0
Oscillatoria lauterbornii	0.0	0.0	0.0	0.0	16.7	50.0
Oscillatoria limnetica	27.3	83.3	0.0	0.0	0.0	100.0
Oscillatoria obliquaeacuminata	0.0	0.0	0.0	0.0	33.3	0.0
Oscillatoria planctonica	0.0	0.0	0.0	11.1	0.0	0.0
Stigonema ocellatum	0.0	0.0	0.0	22.2	16.7	0.0
Dinophyceae						
Ceratium hirundinella	13.6	16.7	0.0	0.0	0.0	0.0
Entzia acuta	27.3	66.7	0.0	0.0	0.0	0.0
Peridinium inconspicuum	0.0	16.7	0.0	0.0	0.0	0.0
Peridinium lomnicki	9.1	66.7	0.0	0.0	0.0	0.0
Peridinium palatinum	13.6	0.0	0.0	0.0	0.0	0.0

If PP >50%, the specific phytoplankton species is the main diet
If 50%> PP >10%, the specific phytoplankton species is secondary
If PP<10%, the specific phytoplankton species is eaten accidentally

Table 4: The results of ANOVA with subsequent HSD tests of studied biological parameters (Total Length (TL), Total weight (TWt), and condition factor (K)).

	T.L.	T.wt.	K
Sector 3	26.216 a	459.064 a	2.197 a
Sector 2	25.311 a	390.335 ab	2.126 b
Sector 1	23.423 b	331.181 b	2.080 b
Pr > F	0.000	0.000	0.000
Significant	Yes	Yes	Yes
O.n.	28.001 a	544.860 a	2.152 a
S.g.	21.966 b	242.194 b	2.117 a
Pr > F	0.000	0.000	0.000
Significant	Yes	Yes	Yes

DISCUSSION

This study shows that phytoplankton is the most common food items for both *O. niloticus* and *S. galilaeus* and that they could be considered as phytoplanktivorous or herbivorous feeders. Moreover, it reports that the most desirable food of plant origin for the two species were diatoms and green algae and states that they favour diatoms than the green algae, despite the latter being more abundant in the aquatic environment. Phytoplankton appeared to be the dominant plant material in gut contents of herbivorous fish (Saiyida and Bari, 1982). Some studies classified *O. niloticus* as herbivorous that favourite to phytoplankton species such as diatoms, green and blue green algae (Assefa and Getahun, 2015; Abdulhakim *et al.*, 2015; Bwanika *et al.*, 2004; Teferi *et al.*, 2000) or obligatory herbivore (Gwahaba, 1973). Also, earlier studies in various lakes showed that *O. niloticus* is capable of using a wide range of food resources including algae (Njiru *et al.*, 2004; Shalloof and Khalifa, 2009; Getabu, 1994) , in addition to *O. niloticus* able to shifting feeding behaviour according to the availability of natural foods as well (Njiru *et al.*, 2004; Canonico *et al.*, 2005; Abidemi-Iromini, 2019).

The study also found that *O. niloticus* and *S. galilaeus* fed on the same food items. Both fish species favour Bacillariophyceae, this result supported by (Abidemi-Iromini, 2019; Abdel-Tawwab, 2003) who mentioned that Bacillariophyceae the most prevailing food items and the high desired by *O. niloticus,* and also Chlorophyceae, this could be attributed to the fact that Chlorophyceae have pleasant cell walls that are easier to digest (Otieno *et al.*, 2014) and they are avoid to Cyanophyceae may be return to Cyanophyceae are filamentous and hence more difficult to handle during feeding and can lead to clogging of fish gills and some Cyanophyceae are also known to produce toxins (Vasconcelos, 2001). Data on diel feeding regime indicated that O. *niloticus* is a diurnal feeder (Otieno *et al.*, 2014). While (Shalloof and Khalifa, 2009; Abidemi-Iromini, 2019) mentioned that the most preferable food of plant origin for *O. niloticus* were diatoms, represented about 68.0% from the total gut content. (Otieno *et al.*, 2014) stated that the major diet of fish <10 cm total length were zooplankton and algae. Moreover, the result of this study agree with (Shallof and El-Far, 2009) findings where they mentioned that diatoms in the fish stomachs were represented mainly by *Cyclotella spp*. and *Achnanthes spp*. while green algae were represented mostly by *Scenedesmus spp.* and *Coelastrum spp.* (Wakil *et al.*, 2014) stated that *O. niloticus* preferred to Chlorella, Scenedesmus and Pediastrum from cholorophyceae.

On the other hand, the average condition factors (K) of the two fish species were generally lower than that reported by (Adam, 2004) for the years between 1984 and 2000. This suggests that the current condition of Lake Nasser, in comparison to its former status, may be becoming unfavourable to fishes.

The length, weight and condition factor data reflect, through its variations, information on the physiological state of the fish in relation to its welfare. From a nutritional point of view, there is the accumulation of fat (Le Cren, 1951). From a reproductive point of view, the highest K values are reached in some species depending on gonad development (Angelescu *et al.*, 1958). K also gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonad maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherly, 1972).

Both investigated species showed significant difference in mean total length, mean total weight and mean condition factor in different geographical areas of the lake. These differences could be related to spatially different environmental and biological factors and also to the characteristics of the fishing area. The environmental and biological factors include temperature, salinity, food (quantity, quality and size), habitat, gonad development, spawning period, season, sex, small individuals' absence and health (Froese, 2006; Pauly, 1984; Safran, 1992). Fishing time, fishing gear and area may be additional causes of such variation (Ricker, 1973). As the average values of all investigated biological parameters were always higher in southern sector of the lake, this could be an indication that the environmental and biological factors are more favourable in this part of the lake. Nevertheless, the results of this study showed that *O. niloticus* and *S. galilaeus* prefer and also avoid the same phytoplankton in their diet at all sectors without any statistical significant difference which indicates that the species and spatial variation in their fisheries biological parameters in Lake Nasser are not related to their feeding activity.

CONCLUSION

This study shows the importance of phytoplankton as food items for *O. niloticus* and *S. galilaeus* in Lake Nasser**.** They fed mainly on Bacillariophyceae followed by Chlorophyceae. The feeding on phytoplankton profiles of the two fish species were similar in all lake sectors while the fisheries biological parameters of the two fish species varied significantly among species and lake sectors. Therefore, it could be concluded that the variation in fisheries biological parameters of the studied fish species in Lake Nasser is not related to their pattern of feeding on phytoplankton but is led by other factors (e.g. fishing practices).

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