A STUDY ON PHYTOPLANKTON DISTRIBUTION, ABUNDANCE AND COMMUNITY STRUCTURE IN FISH PONDS OF AL- ABBASSA FISH FARM IN RELATION TO PHYSICO-CHEMICAL PROPERTIES OF WATER

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Abstract:

This study aims to investigate the phytoplankton dynamics (distribution, composition) and their relation to water quality parameter in Ismailia canal and Abbassa fish farm (inlet, outlet and the fish ponds).The study was carried out from April, 2014 to May, 2015. Physical, chemical parameters and phytoplankton estimation were measured in situ and laboratory. The results showed that, the physico- chemical parameters of water were significantly varied among different seasons and the studied sites. Phytoplankton communities are represented by eight phyla namely; Chlorophyta, Cyanophyta, Euglenophyta, Bacillariophyta, Chrysophyta, Dinophyta, Cryptophyta and Xanthophyta. Their major number (22724 Org./ml) was detected at the fishponds (site C), while their minor number (9374 Org./ml) was detected at the main feeder (MF), (site A). Chlorophyceae was the predominant class at all studied sites except at (MF) where; Bacillariophyceae occupied the first predominant position. Results demonstrated that occurrence of 247 taxa of phytoplankton at (MF), 273 taxa at (inlet), 304 taxa at fishponds and 292 taxa at outlet. Also, Shannon and Weaver diversity index (H^-) was studied and the results showed that the mean range of the phytoplankton diversity index (H^-) was low ($<$ 2.0) at all the studied sites and this is indication of moderate pollution. It is concluded that, both seasonal variations and physico-chemical parameters of water have great impact on phytoplankton dynamics and its biological diversity.

Key words: Chlorophyll "a", diversity indices, fishponds, phytoplankton dynamics, water quality, water supply.

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Introduction

Phytoplankton organisms (composition and density) are affected by both physical and chemical characteristics of fish pond water which lead to changes in both aquatic environment and dynamics of fish ponds.

The artificial shallow systems, their productivity and profitability are highly determined by human activities (**Lukaw *et al.*, 2013**). The interactions of both the physical and chemical properties of water play a significant role in composition, distribution, abundance, movements and diversity of aquatic organisms (**Mustapha and Omotosho, 2005**).

Managing successful aquaculture processes vary from pond to pond even under similar ecological conditions and in turn affect quality and quantity abundance of phytoplankton communities in fishponds (**Bhuiyan *et al*., 2008**).

Study of planktonic diversity as biological indicator contributes to understanding of the environmental status of a water body (**Rani and Sivakumar, 2012**).

Most of the published references in Egypt are generally based on the relationship between fish production and composition of major phytoplankton groups (**Mageed and Konsowa**, **2002; Abdel-Tawwab *et al*., 2007; Saeed and Al-Nagaawy, 2013; Saeed and Batran, 2014**). However, no investigations were carried out dealing with the impact of pond management (nutrient additions) and climatic conditions (all year around) on phytoplankton dynamic (abundance and composition), phytoplankton biomass and diversity in fish farms. So, the results have been generally poor understanding of the dynamics of phytoplankton in aquaculture ponds.

So, this study is carried out to investigate the impact of the physico-chemical parameters on the species composition, structure and distribution of the phytoplankton community to give an understanding of the dynamics of phytoplankton in aquaculture ponds and help in maintaining water quality in fish farms to ensure optimal growth of fish and get non-polluted environment.

Materials and Methods

Study sites

Water samples were collected from four sampling sites at Al-Abbassa fish farm (the World Fish Center) and Ismailia canal including four sites namely; 1- Ismailia canal site A, which is the main feeder (MF) for the area and the fish farm; 2- the irrigation canal (Inlet), site B, which supplies fish ponds with mixed water (Nile and underground water); 3- the fish ponds (site C) which receive different inputs as feed and organic fertilizers and 4- the drainage canal (Outlet), site D, where water is discharged from the fish farm as shown in Figure (1).

Figure (1): **Map demonstrates the location of Al-Abbassa fish farm at the World Fish Center and Ismailia canal.**

Sampling and water analysis

Water samples were taken monthly (from April, 2014 to May, 2015) at different sites to analyze physico-chemical properties and phytoplankton estimation. Water temperature and pH were measured directly at the sampling site by portable Multi-parameter (pH/EC/TDS/Salt), PCSTestr 35 (Singapore). Dissolved oxygen concentration was determined by modified Winkler method (**APHA, 2005**). Water transparency (cm) was measured by using a Secchi Disc (SD) 30 cm in diameter crossed by white and black color. Water samples were taken with a water sampler constructed from a PVC pipe (5-cm diameter, 1.5-m long) from at least five spots between 10.00 am and 12.00 pm at a depth of 30 cm below the water surface and mixed together in a plastic container according to **Boyd and Tucker (1992)**. Then water samples were put in two plastic bottles, one liter each. One bottle is used for chemical analysis and the other preserved in a Lugol's solution at a ratio of 3.0 ml Lugol's solution to 1000 ml sample for quantitative and qualitative analysis of phytoplankton.

The concentration (mg/l) of alkalinity (carbonate and bicarbonate as $CaCO_3$), total ammonia (NH_4^+-N+NH_3-N), nitrite (NO_2-N), nitrate (NO_3-N), orthophosphate (PO_4-P) and chlorophyll"a" content (µg/l) were measured by the methods described by **Boyd and Tucker** (**1992**).

Phytoplankton were identified up to the species level according to the key of freshwater algae (**Prescott, 1970**).The population density was expressed as (Org./ml).Three indices were used to estimate the community structure; diversity; Shannon and Weaver diversity index (H^-) and Simpson's Reciprocal Index as well as evenness or equitability (**Pielou, 1975**).

Statistical analysis

Statistical analysis was performed using the analysis of variance (ANOVA) and Duncan's Multiple Range Test to determine differences between spatial and seasonal means at significance level of $p < 0.05$. Standard errors were also estimated (**Dytham, 1999**).

Results and Discussion

The seasonal variations of water quality parameters at different sites are illustrated in Figures (2- 8). The fluctuations in temperature, pH and dissolved oxygen at different studied sites are presented in Figure (2 A, B and C). Temperature was not significantly different among different sites, where it ranged between 17.5^{O}C (in winter) at site A and 30.3^{O}C (in summer) at site D. Temperature is one of the most important and essential parameter of aquatic habitats because almost it controls all the physical, chemical and biological properties (Fig. 2A). A temperature of about 35^{O}C is generally considered as threshold for survival of aquatic life (**ICAR, 2011**).

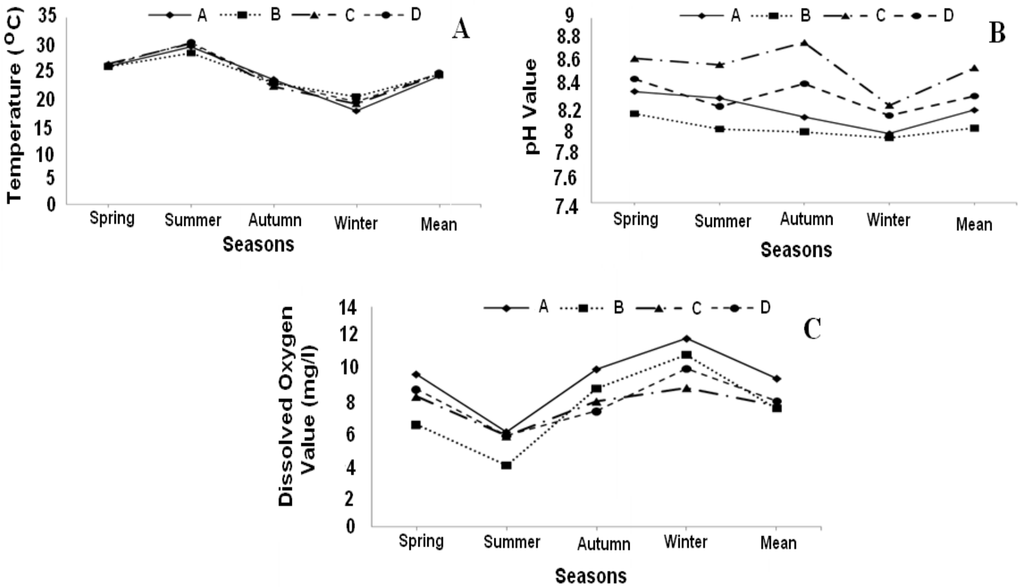

Figure (2): Seasonal variations of A- temperature (^{O}C), B- pH and C-dissolved oxygen (DO) at the studied sites.

The pH recorded for all sites was in the alkaline side (Fig. 2B). Values of pH fluctuated between 7.9 in winter at sites (A and B) and 8.78in (autumn) at site (C), while the total annual means were 8.2, 8.04, 8.56 and 8.32 at sites A, B, C and D, respectively. These findings may be corresponding to phytoplankton count, where the highest total count was observed during autumn season and the lowest one was detected during winter season. High pH may be resulted from high photosynthetic activity of phytoplankton and other aquatic plants causing decrease in the levels of free carbon dioxide (**Shiddamallayya and Pratima, 2008**). Also**, Boyd** (**1998**) stated that decrease in pH level is due to excessive respiration of microorganisms as well as fish excretion, while photosynthesis increases pH. The seasonal variations in pH were mainly affected by temperature, carbonate and bicarbonate system and the photosynthetic activity of the primary producers (**Abdo, 2005**).

It is observed that dissolved oxygen is inversely proportional to temperature, where it ranged between (3.9 mg/l) at site B in summer and (11.9 mg/l) at site A in winter, while the total means were 9.44, 7.53, 7.72 and 8.0 mg/l at sites A, B, C and D, respectively, (Fig. 2C). These results are in agreement with **Niusha *et al*.** (**2014**). They mentioned that dissolved oxygen was high at all sites during the winter season. They refer it due to the cumulative effect of heavy rainfall and higher wind velocity which is good condition to produce freshwater mixing. On the other hand, relatively lower values were observed during summer and this may be due to the increased surface water temperature, which reduces the dissolution of O_2 in the surface waters (**Viijayakumar *et al*., 2000**).

Figure (3 A, B and C) shows the fluctuations in transparency (SD), total alkalinity and total dissolved solids. Seasonally, Secchi Disc (SD) readings ranged between (12.4 cm) in autumn at site D and (94.4cm) in winter at site A. The decrease in SD (14.6-15.6 cm) at site C (Fish ponds) is mainly caused by the abundance of phytoplankton populations and suspended matter (clay and organic materials) that result from sediment turbulence by fish (Fig. 3 A). Perhaps, the transparency was lower in the autumn season at sites (B, C and D) due to high planktonic population. The maximum transparency recorded in Ismailia canal (site A) may be attributed to the increase of water level in the canal. The annual averages of SD readings showed that there are significant differences ($P<0.05$) among the studied sites, where the total means were 88.9, 20.1, 15.3 and 13.8cm at sites A, B, C and D, respectively. The important of transparency is to point out the absence or presence of food materials as well as the productivity of the water body that effect by suspended particles such as silt or microorganisms our results were in accordance with the results found by (**Ferdoushi *et al*., 2008; Sipaúba-Tavares *et al*., 2011**).

Alkalinity in most natural water is the function of bicarbonate and carbonates. It is also used as a measure of productivity (**Hulyal and Kaliwal, 2011**). Seasonally; there are significant differences among different seasons, where total alkalinity fluctuated between 159.8 mg/l at site A in summer and 265.7 mg/l at site D in autumn (Fig. 3 B).

The annual mean values of total alkalinity demonstrated that there are significant differences among the studied sites, where the highest values were recorded at sites C and D, while the lowest values were detected at sites A and B. **Saeed and Batran** (**2014**) mentioned that higher total alkalinity values in polyculture ponds might be due to the high rate of CO_2 production resulted from the decomposition of increased organic material released from sediment as well as fish excretion. **Boyd (1998**) mentioned that the changes of alkalinity were influenced by climatic factors such as temperature as well as fish culture practices such as fertilization.

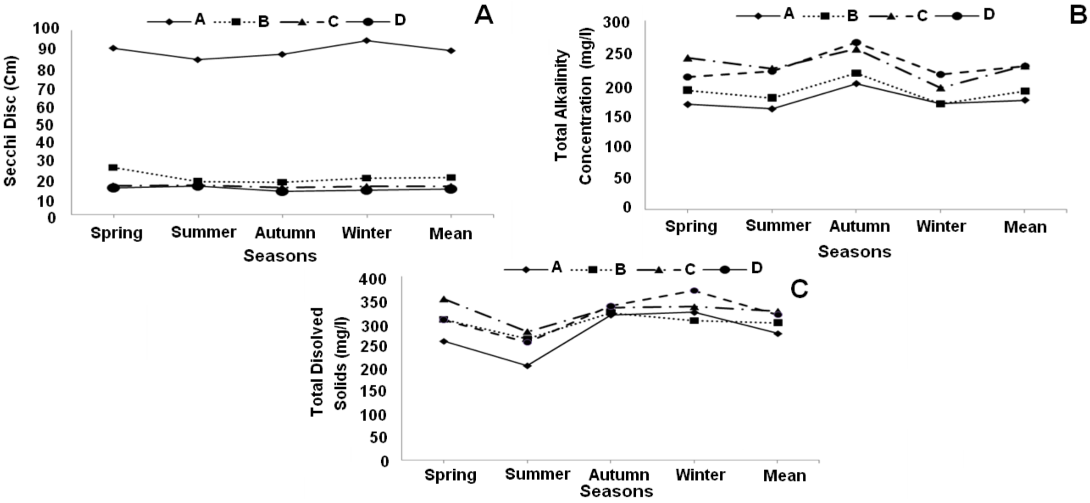

Figure (3): Seasonal variations of A-transparency (SD), B-total alkalinity and C-total dissolved solids at the studied sites

Seasonally, the results of total dissolved solids showed significant differences ($P<0.05$) among seasons, where the values ranged between 205.7 mg/l at site A during summer and 369.2 mg/l at site D during winter. The annual averages of total dissolved solids showed that there are no significant differences among the studied sites. The TDS of a freshwater pond should be in the range of 50-2000mg/l for optimum fish production (**Boyd, 1998**).

Figure (4 A) shows the fluctuations in total ammonia. Ammonia is introduced into the pond through dead phytoplankton, uneaten feeds, dead and decaying organic matter. Seasonally, there are significant differences among seasons. The annual averages of total ammonia follow the order: C>D>B>A. Low ammonia concentration at site C during September associated with the cyclic feeding regimes (periods of feed deprivation) (**Turano *et al*., 2008**).

Meanwhile, the results showed significant differences among seasons when concerning to the nitrite. The values of nitrite ranged between 0.014 mg/l at sites A and B during spring and 0.11mg/l at site C during autumn as shown in Fig. (4

B). **Boyd (1998)** recommended nitrite concentration in aquaculture pond water should not exceed 0.3mg/l.

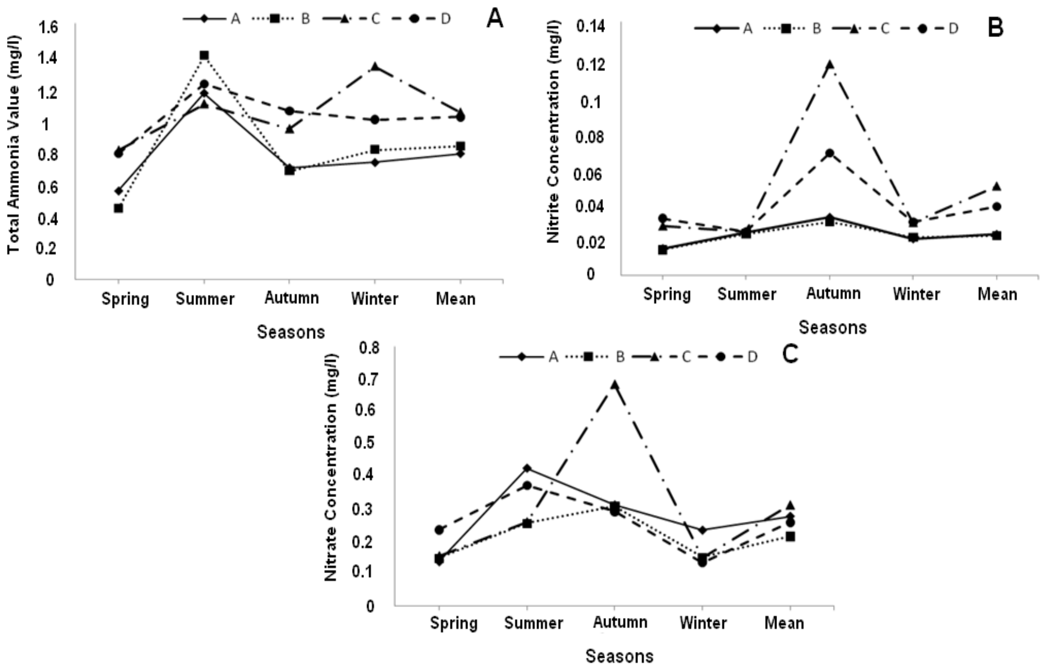

Figure (4): Seasonal variations of: A- total ammonia, B- nitrite and C- nitrate at the studied sites.

The values of nitrate ranged between 0.13mg/l at sites (A during spring and D during winter) and (0.68mg/l) at site C during autumn. There is a positive correlation between nitrate and phytoplankton abundance in this study and this agrees with the finding of **Nassar and Shams El-Din** (**2006**). In the present investigation it was observed that at site A (MF) the high density of diatoms coincides with high nitrate concentrations while diatoms reached its minimum density at spring season. These finding agree with **Sipaúba-Tavares *et al.*** (**2011**) who speculated that alkaline pH (between 7.2 and 8.8) and high nitrate concentrations supported a high population of diatoms. The annual means of nitrate were 0.27, 0.21, 0.31 and 0.25 mg/l at sites A, B, C and D, respectively, as shown in Fig. (4 C).

Figure (5) show the fluctuations in orthophosphate. Seasonally, orthophosphate ranged between 0.03 mg/l at site A during winter and 0.14mg/l at site C during summer. These findings are in agreement with **Yadav *et al*.** (**2013**) who stated that phosphate concentration in fishponds was more in summer followed by a decline in winter season. Higher phosphate content during summer is due to high temperature **(Patil *et al.*, 2013).** PO_4-P levels recorded at fishponds showed a remarkable increase compared to the main feeder (Site A) and this may be related to different inputs as feed and organic fertilizers in fishponds as well as fish feces. Also, **Stickney *et al.*** (**1979**) stated that a large proportion of phosphorus in the feces is orthophosphate. The annual averages of orthophosphate were 0.04, 0.07, 0.10 and 0.09 mg/l at site A, B, C and D, respectively.

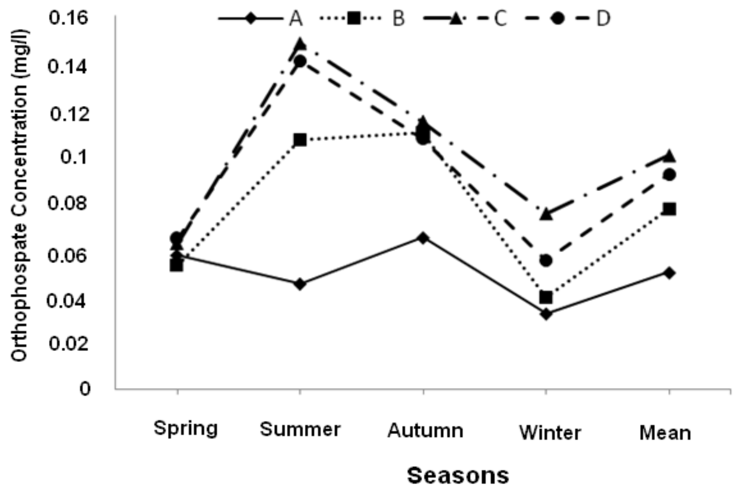

Figure (5): Seasonal variations of orthophosphate at the studied sites

Figure (6) clarified the fluctuations in chlorophyll "a" content. Seasonally, data showed that there are significant differences among different seasons, where chlorophyll "a” contents ranged between 20.9 µg/l at site B during winter and 311.06 µg/l at site C during autumn.

It was observed that the maximum concentration of chlorophyll "a" at sites (B, C and D) was detected during autumn season while, the minimum concentration was recorded during winter season. These results correlated with total phytoplankton count, where Chlorophyceae was the most dominant class. Chlorophyll "a" and phytoplankton follow the following order: autumn > summer > spring > winter. It is thought that the chlorophyll content is 4–6 times in green algae higher than that in Cyanophyta and Bacillariophyta. A predominance of Chlorophyta in phytoplankton is responsible for high relative content of chlorophyll "a" in the total biomass of phytoplankton (**Mineyeva, 2004**).

On the other hand, at site A (MF) chlorophyll "a" didn't correlate with phytoplankton abundance, where chlorophyll "a" follows the following order: autumn > summer > winter> spring, while phytoplankton count follows the following order: winter >autumn > summer >spring. These results are supported by **Primmer** (**2010**) who detected that samples containing the highest chlorophyll "a" concentration and phytoplankton count were not strongly correlated. This demonstrates that chlorophyll "a" concentration and phytoplankton abundance may not always be directly related.

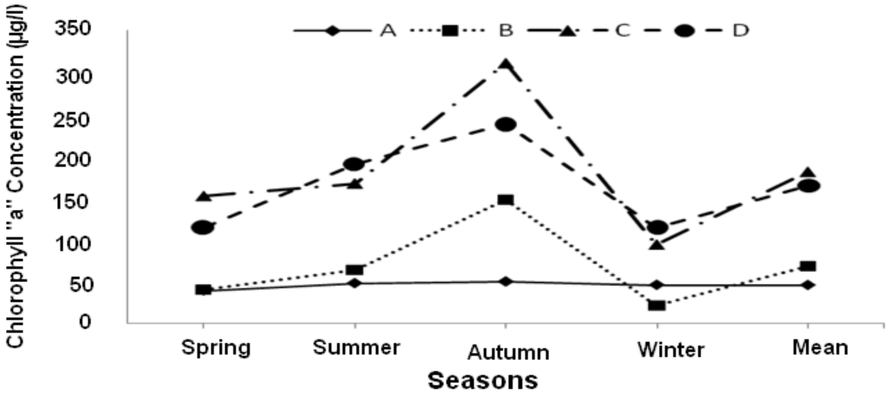

Figure (6): Seasonal variations of Chlorophyll "a" at the studied sites.

The annual averages of chlorophyll "a" concentrations showed that there are significant differences (P<0.05) among the studied sites, where the highest values were observed at sites C and D, while the lowest values were recorded at sites A and B. **El-Otify** (**2015)** stated that phytoplankton biomass in terms of chlorophyll "a" concentrations were always of relatively higher values in the fish pond than its water supply thus, chlorophyll-*a* concentrations appeared to be promoted by sufficient nutrients.

Phytoplankton

The present study revealed that the algal communities belonged to Chlorophyta, Cyanophyta, Euglenophyta, Bacillariophyta, Chrysophyta, Dinophyta, Cryptophyta and Xanthophyta. As shown in Table (1) Chlorophyceae individuals achieved the first order of abundance at all sites except at site A, where Bacillariophyceae occupy the first order of distribution during most of the study period.

It was observed that, site A (MF) was represented by 247 taxa and takes the following order: Bacillariophyta> Chlorophyta> Cyanophyta> Euglenophyta> Cryptophyta> Dinophyta> Chrysophyta> Xanthophyta as shown in Table (1). The most abundant species belonged to Bacillariophyta were *Synedra ulna*, *Cyclotella ocellata*, *Surirella ovate* and *Aulacoseira ganulata*. Also, *Tetrastrum triangulare*, *Actinastrum hantzschii, Scenedesmus ecornis* and *Tetradron minimum* were the most abundant species belonged to Chlorophyta. The most abundant species of Cyanophyta were *Merismopedia minima*, *Merismopedia convolute* and *Merismopedia ferrophila*. Besides, *Euglena geniculata, Eutreptia viridis* and *Euglena obtuse* were the most abundant species belonged to Euglenophyta. At site A, Bacillariophyceae reached maximum ratio (46.4%) in winter and minimum one (44%) in spring from the total population. The dominance of diatoms might be attributed to the recognized occurrence of iron and silicon in Nile water (**Shehata *et al*., 2009; Shehata and Badr, 2010**).

Chlorophyceae reached its maximum ratio (49.4%) in spring and minimum ratio (3.6%) in winter from the total population, while Cyanophyceae reached its maximum density (19.6%) during summer. These results agree with **Shehata *et al*.** (**2009**) who mentioned that the increase in total phytoplankton number in Nile water mainly attributed to diatoms which represents 75 - 97.8% of total algal counts and dominated by centric form and secondarily by pinnate form while, green algae restricted their growth to the spring season and comprise about 20% of total algal counts. They also mentioned that blue-green algae had its maximum density in summer season constituting 8% of total algal counts.

Site B (Inlet) represented by 273taxa and follow the following order: Chlorophyta> Bacillariophyta> Cyanophyta> Euglenophyta> Cryptophyta> Chrysophyta> Dinophyta> Xanthophyta as shown in Table (1). The most abundant spesies belonged to Chlorophyta were: *Scenedesmus ellipsoidus,* *Closterium pronum*, *Scenedesmus communis and Lagerheimia ciliata.* In addition, the most abundant species belonged to Bacillariophyta were *Pinnularia viridis*, *Cyclindrotheca closterium*, *Nitzschi apalea and Cyclotella ocellata.* Besides, *Merismopedia convoluta*, *Merismopedia ferrophila*, *and Cylidrospermopsis curvispora* were the most abundant species belonged to Cyanophyta. Also, *Euglena acus*, *Euglena oxyuris* and *Distigma gracile* were the most abundant species belonged to Euglenophyta.

Fishponds (Site C) represented by 304 taxa which take the following order: Chlorophyta> Bacillariophyta> Euglenophyta> Cyanophyta> Cryptophyta> Dinophyta> Xanthophyta> Chrysophytaas shown in Table (1). The most abundant species belonged to Chlorophyta were *Closterium pronum*, *Palmellococcus miniatus* and *Scenedesmus ecornis*. Also, *Cyclotella meneghiniana*, *Nitzschia rostellata* and *Navicula decusis* were the most abundant species belonged to Bacillariophyta. In addition, *Euglena oxyuris*, *Euglena gracilis*, *Phacus suecius* and *Euglena sanguinea* were the most abundant species belonged to Euglenophyta. Besides, *Cylidrospermopsis raciborskii*, *Cylidrospermopsis curvispora* and *Merismopedia tenuissima* were the most abundant species belonged to Cyanophyta.

Site D (Outlet) represented by 292 taxa and follow the order of: Chlorophyta> Euglenophyta> Bacillariophyta> Cyanophyta> Cryptophyta> Dinophyta> Chrysophyta> Xanthophyta as shown in Table (1). The most abundant species belonged to Chlorophyta were *Closterium pronum*, *Kirchneriella contorta* and *Palmellococcus miniatus.* Also, *Strombomonas fluviatilis*, *Euglena oxyuris* and *Euglena acus* were the most dominant species belonged to Euglenophyta. The most abundant species belonged to Bacillariophyta were *Aulacoseira* Sp, *Nitzschia palea* and *Cyclotella meneghiniana*. Besides, *Merismopedia minima* and *Anabaena variabilis* were the most abundant species belonged to Cyanophyta**.**

Saeed and Batran (**2014**) studied phytoplankton composition in polyculture ponds (Nile tilapia with catfish) and found that Chlorophyceae occupy the first order of abundance followed by Bacillariophyceae then Cyanophyceae and Euglenophyceae. **Hossain *et al*.** (**2013**) stated that Chlorophyceae dominated the phytoplankton groups, followed by Bacillariophyceae. This may be attributed to high temperature and other favorable water quality parameters as well as high levels of total alkalinity. The dominance of Chlorophyceae and Bacillariophyceae at the expense of Cyanophyceae and Euglenophyceae may be as a result of decrease in dissolved iron Fe^{+2} (**Khan and Bhat, 2000**).

Table (1): Annual means of phytoplankton divisions and species numbers (Org./ml) at the studied sites.

Site	Site A (Main feeder)		Site B (Inlet)		Site C (Fish ponds)		Site D (Outlet)	
Division	**Algae count**	**Species number**	**Algae count**	**Species number**	**Algae count**	**Species number**	**Algae count**	**Species number**
Chlorophyceae	**3665**	**106**	**4755**	**91**	**10734**	**108**	**6992**	**109**
Cyanophyceae	**1276**	**23**	**1285**	**31**	**2171**	**29**	**2244**	**24**
Euglenophyceae	**327**	**28**	**574**	**36**	**4647**	**67**	**4377**	**70**
Bacillariophyceae	**4064**	**86**	**3367**	**108**	**4700**	**90**	**3665**	**81**
Chrysophyceae	**7**	**1**	**39**	**2**	**0**	**0**	**8**	**1**
Dinophyceae	**14**	**2**	**12**	**2**	**88**	**5**	**47**	**3**
Cryptophyceae	**19**	**1**	**90**	**3**	**367**	**4**	**203**	**4**
Xanthophyceae	**0**	**0**	**0**	**0**	**17**	**1**	**0**	**0**
Total	**9374**	**247**	**10122**	**273**	**22724**	**304**	**17536**	**292**

Gledhill and Van den Berg (**1994**) have shown that about 99.0 % of the dissolved iron in surface water is organically bound and that the concentrations of organic iron chelators far exceed the concentration of dissolved iron. Both laboratory and field studies has linked the availability of Fe to N_2-fixation in cyanobacteria (**Paerl *et al.*, 1994**) as iron deficiency causes a decrease in heterocyst formation in the nitrogen-fixing freshwater cyanobacterium *Anabaena catenula*. Since iron is a key component of chromophore synthesis (**Straus, 1994**), most photoautotrophs, including cyanobacteria, are highly vulnerable to iron deficiency. Also, **De Wever *et al*.** (**2008**) stated that Chlorophytes and diatoms appeared to be stimulated by N and P rather than by Fe in contrast to cyanobacteria and Euglenophyta.

Euglenophyceae showed maximum count (8304 Org./ml) during autumn at site C (Fish Ponds), 8037 Org./ml at site D (Outlet), 865 Org./ml at site B (Inlet) and 674 Org./ml at site A (Ismailia canal). This result agrees with **Affan *et al*.** (**2005**) who stated that Euglenophytes showed their higher proportion in late autumn. They explained their finding by presence of some factors like, moderate temperature and accumulation of organic loads from surface run-off and clear sun-shine. **Sen and Sonmez** (**2006**) stated that Euglenophyceae increase synchronize with high total phosphorus, orthophosphate concentrations and high pH levels, as well as high levels of organic matter. Seasonally, as shown in Figure (7), the highest (42183 Org./ml) and the lowest (3301 Org./ml) total phytoplankton counts were obtained in autumn and winter at site C and B, respectively.

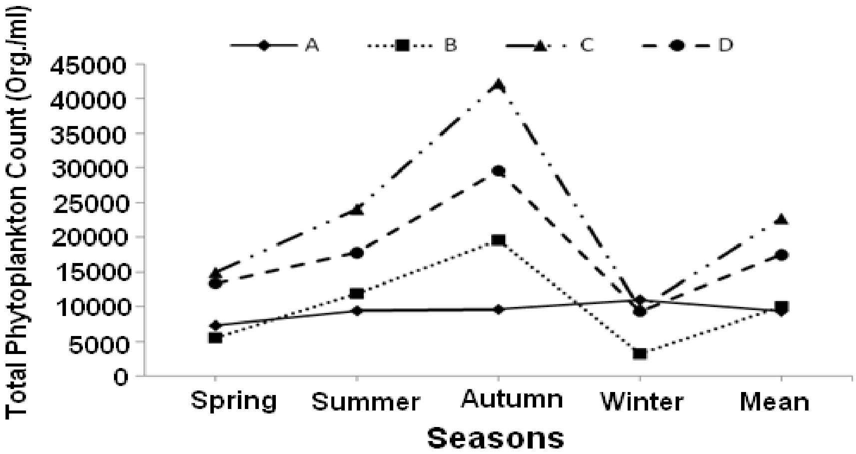

Figure (7): Seasonal variations of total phytoplankton (Org. /ml).

The locations ordered according to their annual mean of total phytoplankton count as follows: C > D > B > A, with the values 22724, 17536, 10122and 9374 Org./ml, respectively and represent 38 %,29%,17% and 16% at site C, D, B and A respectively as shown in Table (1), Figure (7) and Figure (8). Increase of phytoplankton biomass in fishponds may result from the increase of re-suspension of sediments by fish as well as fish excretion which lead to release more nutrients that increase phytoplankton and water productivity (**Garcia *et al.*, 2012**).

Adamovich and Zhukova (**2014**) showed that in fish ponds, the intensity of phytoplankton development was essentially higher than that in the Smerdiya River (the main source of its water supply) and this agrees with our results. **Veronica et *al*.** (**2014**) mentioned that high phytoplankton abundance in the pond could result from good range of total phosphate concentration in the pond promoting the phytoplankton growth, while limited phytoplankton abundance in the river is due to river current and current velocity dependence.

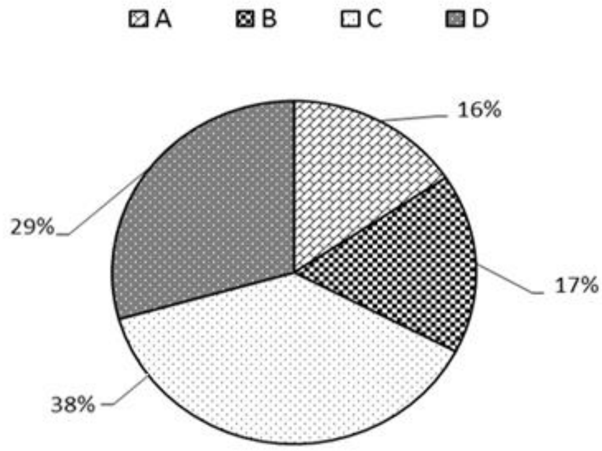

Figure (8): Annual mean of phytoplankton abundance as percentage (%) in water at the whole studied sites.

Affan *et al*. (**2005**) mentioned that phytoplankton abundance was appeared to decrease gradually in the winter; this may be related with lower temperature, shorter day length, low pH and low concentration of nutrients. These findings are in agreement with our finding, since the lowest count of phytoplankton was observed during winter season at sites B, C and D.

Biodiversity indices:

The biological diversity was measured by three biodiversity indices namely; Shannon and Weaver diversity index (H^-) and Simpson's Reciprocal Index as well as evenness or equitability. They are related to each other and showed which environment more diverse than the other. Shannon's index (H^-) encompasses species richness and species evenness components as overall index of diversity. Diversity is dependent on key ecological processes such as competition, predation, and succession. Therefore changes in these processes can alter the species diversity index through changes in evenness (**Stirling and Wilsey, 2001**). A community dominated by one or two species is considered to be less diverse than one in which several different species have a similar abundance. Seasonally, the values ranged between 0.9 at site A during spring and 1.33 at site B during winter. The annual averages of phytoplankton diversity index (H^-) were 1.02, 1.13, 1.251 and 1.258 at sites A, B, C and D, respectively, as shown in Table (2). The higher values of Shannon's Index (H^-) indicated the greater species diversity. A scientist concluded that the normal values range from 0-4.

Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4.The present study revealed that mean range of phytoplankton diversity index (H^-) in the studied sites was low (< 2.0).These findings coincide with **Veronica et *al*. (2014**) who found that the mean range of the phytoplankton diversity index (H^-) in the river and ponds was low (<2.3). However, a low species diversity index showed that there is domination by a few species in the area (**Margalef, 1978**), which is evident in the present investigation that several species were present but at the same time dominated by a small number of species. The lower the H^- value the lower the phytoplankton diversity, and this condition may highly influence the water stability and living environment. It will easily change with relatively small environmental influence.

Table (2): Range and mean of Shannon and Weaver diversity, evenness of species, and Simpson's Reciprocal index at the studied sites.

Parameter	Site A (Main feeder)	Site B (Inlet)	Site C (Fish ponds)	Site D (Outlet)
Shannon and Weaver (H^-)	0.9-1.1 (1.02)	0.91-1.33 (1.13)	1.07-1.32 (1.251)	1.17-1.29 (1.258)
Simpson's Reciprocal Index (1/D)	2.2-2.7 (2.53)	2.16-3.22 (2.7)	2.69-3.37 (3.05)	2.92-3.34 (3.16)
Species Evenness (E)	0.1-0.2 (0.14)	0.1-0.17 (0.12)	0.1-0.14 (0.12)	0.12-0.13 (0.12)

So, the diversity changed from site to another in the following order: site D < C < B< A. Phytoplankton population in nutrient rich waters is more diverse than those in nutrient deficient waters **Margalef** (**1964**).

The species diversity index can serve as an indicator that the ecosystem is under the influence of pollution stress or eutrophication **Telesh** (**2004**). Lower species Shannon-Wiener diversity Index values indicated that the water body is under the influence of pollution. An increasing in diversity values means that the water quality is recovered.

Shannon- Weiner diversity index ranged from 1.02 to 1.258 showed that the studied sites have moderate pollution level. So, phytoplankton study is very important because it acts as primary producers and an efficient bio-indicator for water quality. **El Sheekh *et al*.** (**2010**) studied the water quality of river Nile at different locations and found it moderately polluted on the basis of biological assessment through diversity and sapropic indices that were less than three throughout the study period.

Simpson's Reciprocal Index:

The Simpson's Reciprocal Index is often used to quantify the biodiversity of habitats. It takes into account the number of species present as well as the abundance of species. The annual averages of Simpson's Reciprocal Index were 2.53, 2.7, 3.05 and 3.16 at sites A, B, C and D respectively. Seasonally, the values ranged between 2.16 at site B during spring and (3.16) at site D during winter as shown in Table (2). The higher the value, is the greater the diversity. It was observed from this index that, the studied sites follow the following order: site D < C < B < A.

Evenness:

The evenness index is a measure of the evenness with which individuals are divided among the taxa present. The values ranged between 0-1. The closer the value to 1 the more even is the distribution of phytoplankton. **Pirzan and Pong-Masak** (**2008**) reported that if evenness index approaches to zero, the species evenness in the community is low and inversely if the evenness index approaches to 1 the species evenness in the community is the same. The annual averages of evenness index (E) were 0.14, 0.12, 0.12 and 0.12 at sites A, B, C and D, respectively, as shown in Table (2). From the annual average, it was observed that the entire evenness index values approach to zero, so the species evenness at all sites is low. It indicates that there are few species dominating the studied sites.

Conclusion

From this study, it can be concluded that phytoplankton composition and abundance are varied at the studied sites. No single factor is responsible for this variability. However, temperature, transparency, water pH, seasonal variations, nutrient enrichment may be responsible for the variable changes in the phytoplankton distribution, composition and their abundance. The present study demonstrated that phytoplankton diversity index (H^-) at the studied sites was low and this is indication of moderate pollution. Also, the diversity to some extent increase with increase nutrients.

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دراسة توزيع، وفرة وتركيب الهائمات النباتية فى الأحواض السمكية لمزارع العباسة وعلاقتها بالخواص الفيزيائية والكيميائية للمياه

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**قسم الليمنولوجى – المعمل المركزى لبحوث الثروه السمكيه – مركز البحوث الزراعية – مصر*
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تهدف هذه الدراسه لتقييم حركة الهائمات النباتيه (التوزيع والتركيب) وعلاقتهم بجودة المياه فى ترعة الاسماعيلية ومزرعة العباسة السمكية (الرى، الأحواض السمكية والصرف). أجريت الدراسة لمدة عام كامل ابتداء من ابريل عام 2014 وحتى مايو 2015 حيث تم قياس الخواص الفيزيائية والكيميائية والبيولوجية فى مكان أخذ العينه وفى المعمل.

أوضحت النتائج ان الخواص الفيزيائية والكيميائية للمياه تظهر اختلافا معنويا بين المواسم والمواقع محل الدراسه. تم تمثيل الهائمات النباتية بثمانى مجموعات وهى مجموعة الطحالب الخضراء، الطحالب الخضراء المزرقه، اليوجلينات، الدياتومات، الطحالب الخضراء المصفره، الدينوفلاجيلات،الكريبتوفايت والطحالب الصفراء الذهبيه. كان أكبر عدد للهائمات النباتية 22724 كائن فى المللى فى الأحواض السمكية، بينما أصغر عدد كان 9374 كائن فى المللى فى مصدر الرى الرئيسى (الموقع أ). كانت مجموعة الطحالب الخضراء هى السائده فى كل المواقع محل الدراسه ماعدا فى الموقع أ، حيث احتلت مجموعة الدياتومات المركز الأول به. أظهرت النتائج وجود 247 نوع من الطحالب فى الموقع أ، 273 نوع فى الموقع ب، 304 نوع فى الموقع ج (الأحواض السمكيه) و 292 نوع فى الموقع د (المصرف). بدراسة معامل التنوع للهائمات (شانون ويفر)، أوضحت نتائج المتوسطات السنويه ان قيم المعامل قليله حيث انه كان اقل من 2 وهذا استدلال لوجود تلوث بدرجه متوسطه فى كل المواقع محل الدراسه. استنتج ان التغيرات الموسميه، الخواص الفيزيائية والكيميائية للمياه لها تأثير كبير على حركة الهائمات النباتيه وتنوعها.