

Occurrence of Phytoplankton in Stomach Content and Its Selectivity by Nile Tilapia (*Oreochromis niloticus* L.) Cultured in Fertilized Earthen Ponds

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التواجد الطحلي في معدات البلطي النيلي المستزرع في أحواض ترابية مسمدة

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قسم بيئة الأسماك بالمعمل المركزي لبحوث الثروة السمكية
العباسة - أبوحماد - الشرقية - مصر

أجرى هذا البحث بغرض دراسة التواجد الطحلي في معدات البلطي النيلي تحت تأثير كميات مختلفة من التسميد غير العضوي في أحواض سمكية ترابية . أظهرت نتائج فحص المحتوى الغذائي لمعدات سمك البلطي النيلي أنه يتغذى بشكل رئيسي على الهائمات النباتية (الفيتوبلانكتون) ثم المواد العضوية المتحللة (detritus) بينما كانت الهائمات الحيوانية (الزرووبلانكتون) قليلة ولا تزيد عن ١,٥% من المحتوى الكلي لمعدات السمك التي فحصت طوال فترة التجربة وعند كل الأحجام . اختلفت نسبة تواجد الأقسام الطحلية باختلاف حجم الأسماك و كانت الدياتومات هي السائدة في أحجام من ٣٠-٦٠ جم بينما سادت الطحالب الخضراء في أحجام ٦٠-٧٠ جم .

كانت أهم الأجناس الطحلية المتواجدة في معدات السمك هي *Anabaena*, *Merismopedia*, *Microcystis*, *Nodularia*, *Oscillatoria*, & *Spirulina* وهي تتبع الطحالب الخضراء المزرققة . و الأجناس الطحالب الخضرية *Cerasterias*, *Chlorella*, *Crucigenia*, *Pediastrum*, *Scenedesmus*, & *Tetraedron* وهي تتبع الطحالب الخضرية . والأجناس *Amphora*, *Cocconeis*, *Cymatopleura*, *Cymbella*, *Gyrosigma*, *Melosira*, *Navicula*, وهي تتبع الطحالب الخضرية . و الأجناس *Nitzschia*, *Pinnularia*, & *Synedra* وهي تتبع الدياتومات . و الأجناس *Euglena* & *Phacus* وهي تتبع الطحالب اليوجلينية .

أظهرت النتائج أيضا أن سمك البلطي النيلي له القدرة على اختيار غذاءه حيث أنه اختار الطحالب الخضرية المزرققة طول فترة التجربة بينما اختار الدياتومات والطحالب اليوجلينية في بعض شهور التجربة .

Keywords index: *Phytoplankton, zooplankton, detritus, selectivity, natural food, fish, stomach, Nile tilapia and inorganic fertilization.*

ABSTRACT

Nile tilapia (*Oreochromis niloticus* L.) was cultured in earthen ponds receiving 0, 20, 40, 60 and 100 kg/feddans/month of inorganic fertilizer (20:20:5 N:P:K). The obtained results showed that the composition percentage of food items in stomachs of Nile tilapia was ranked as phytoplankton > detritus > zooplankton at all fish sizes. Zooplankton did not exceed 1.5% of total stomach's contents. The main algal species found in fish stomach belonged to Cyanobacteria, Chlorophyta, Bacillariophyta and Euglenophyta. Detritus consisted mainly of scraps of macrophytes and mud, and its contribution to gut content decreased for increasing fish size, while phytoplankton contribution increased. Bacillariophyta represented the main phytoplanktonic division at small fish size (30-60 g/fish), while Chlorophyta is the dominant group at large fish size (60-70 g/fish). The most frequently genera represented in fish stomach in all treatments were *Anabaena*, *Merismopedia*, *Microcystis*, *Nodularia* and *Oscillatoria* (Cyanobacteria), *Cerasterias*, *Chlorella*, *Crucigenia*, *Pediastrum*, *Scenedesmus* and *Tetraedron* (Chlorophyta), *Amphora*, *Cocconeis*, *Cymatopleura*, *Cymbella*, *Gyrosigma*, *Melosira*, *Navicula*, *Nitzschia*, *Pinnularia*, *Serurella* and *Synedra* (Bacillariophyta) and *Euglena* and *Phacus* (Euglenophyta). Results revealed that Nile tilapia could select Cyanobacteria during the investigation period and sometimes select Bacillariophyta and Euglenophyta.

Introduction

Nile tilapia (*Oreochromis niloticus* L.) is one of the most known members of the tropical and subtropical freshwater fishes and is now globally distributed because of its importance in aquaculture. Tilapias in general are herbivores and detritivores, although they show ontogenetic shifts from zooplankton at young ages to phytoplankton, macrophytes, and detritus at advanced ages. In this respect, [1] and [2] reported that tilapia less than 35 g appear to be particulate feeders, selecting individual plankton especially crustaceans from the water column, and at about 35 g, tilapia make a shift to filter feeding and utilize mainly phytoplankton and smaller zooplankton such as rotifers. Furthermore, some investigators reported that Nile tilapia is phytoplanktivore and facultative detritivore [3-6], while others reported that it has also a very diversified diet with a dominant vegetable component (epilithic, epiphytic and filamentous algae, phytoplankton, vegetable debris and fine sediments) as well as animal component (insect larvae, crustaceans and small fish) [7,8]. That wide dietary breadth could have made it a more adaptable species in eutrophic environment [9-11]

Bowen [1] and Bowen *et al.* [12] also determined that tilapias are particularly adapted at assimilating energy from algal chlorophyll and other plant sources. This ability is based on the low pH generated in tilapia stomachs (as low as 1 to 1.25), compared to moderate values in other animals (2 to 2.2). Coupled with low stomach pH is a long intestine, which may reach from 7 to 10 times the fish's length. Both of these adaptations make tilapia particularly good at extracting energy from plant matter and allow inexpensive supplemental feeds to be useful in tilapia culture.

On the other hand, organic and/or inorganic fertilization of fishponds has been widely studied, with often conflicting results. Inorganic fertilizer has been promoted as favorable due to its lower loading rates due to higher nutrient contents and lower oxygen demand [13,14]. Fertilizers are usually added to fishponds to stimulate and maintain the production of natural food i.e. phytoplankton and zooplankton [15-17]. Phytoplankton was increased with increasing the applied doses of chemical fertilizer because of the increase of nutrients as a result of fertilizer increasing [16, 18-20]. The increase in fish production in fertilized ponds has been attributed to an increase in primary productivity [17, 21-33].

This work was carried out to study the contribution of phytoplankton to stomach contents and its selectivity by Nile tilapia (*O. niloticus* L.) in earthen ponds receiving only inorganic fertilizer (20:20:5 N:P:K) at different doses in Abbassa fishponds.

Materials and Methods

Eight earthen ponds (surface area 155 m²) at Central Laboratory of Aquaculture Research, Abbassa, Sharqia were used in this study. The ponds had been drained, cleaned and refilled with new freshwater from El-Wadi Canal derived from El-Ismailia Canal. The water level was adjusted at 80cm depth. Each application was represented by two replicates. The experiment was started on 3 July and continued for 125 days. Water temperature was 23.6-28.7 °C, Dissolved oxygen was 5.2-7.6 ppm, pH was 8.5-8.8 and ammonia 0.5-0.88 ppm.

The fertilizers were weekly applied to the ponds throughout the experimental period. The ingredient sources of fertilizer were urea (46.5% N), monosuperphosphate (15.5% P₂O₅) and potassium chloride (63.1% K₂O). The applied doses were 0, 20, 40, 60 and 100 kg/feddan/month (kg/f/m). The fertilizer was dissolved and splashed on the water surface of fishponds according to [39].

Cultured fishes were obtained from Abbassa nursery ponds and acclimatized in indoor tanks for 15 days. Nile tilapia was stocked at a rate of 150 fish/pond with average initial weight of 15-20 g/fish.

Water samples for chemical analyses were collected biweekly by a 90-cm water sampler between 08:30 and 09:30 at 30 cm depth from each pond. Dissolved oxygen and temperature were measured at 30cm depth with a YSI model 58 oxygen meter (Yellow Spring Instrument Co., Yellow Springs, Ohio, USA) and water conductivity was measured with a YSI model 33 conductivity meter (Yellow Spring

Instrument Co., Yellow Springs, Ohio, USA). The pH value and ammonia were measured colorimetrically by using Hach kits (Hach Co., USA). The chemical parameters were analyzed according to APHA [24].

Every two weeks, 25 fish from each pond were sampled by using pure seines, and individual weight was measured. Ten fish were monthly collected from each pond for stomach examination. The specimens were immediately placed in 10% formalin. The length of each fish and elementary canal was measured and the ratio of length was calculated. The degree of fullness was estimated according to Abdelghany [25]. Numerical count of organisms was carried out with Sedgwick Rafter counting cell under a binocular microscope using suitable magnification [25]. Selectivity value for different components of the food was calculated according to Ivlev (1961). Statistical analysis was conducted following Snedecor and Cochran [27] and Duncan's [28] multiple range test.

Results and Discussion

The average weight of fish samples in Fig. 1 shows that, fish growth increased with time till the end of experiment and also significantly ($P < 0.05$) increased with increasing fertilizer doses except that of 60 and 100 kg/f/m. This growth was due to fish activity in plankton grazing since artificial feed was not used. These results are in agreement with those reported by Hephher [29] and Schroeder [30] who stated that, fish yield of fertilized fishponds was greater than that of unfertilized ponds. Furthermore, Hall *et al.* [19], Batterson *et al.* [31] and Diana *et al.* [2] reported that, the yield of cultured fish had linearly increased with increasing the applied fertilizer.

It is worth mentioning that, phytoplankton flourishing and blooming at the dose 100 kg/f/m interfered with fish production and became limiting factor in fishponds causing problems with water quality. On the other hand, Melack [21], Almazan and Boyd [22], Boyd [23] and El-Ayouty *et al.* [17] attributed the increase in fish production in fertilized ponds to the primary productivity. Subsequently, the deposition of nutrients in fish tissues was achieved through fish grazing and accumulation of phytoplankton.

The analysis of stomach contents of Nile tilapia showed great diversity in the tested items. Fig. 2 shows that phytoplankton was the more abundant category in stomach, followed by detritus. Their percentages varied a little during the investigation period in all treatments. Also, it shows that detritus contribution to gut content decreased with increasing rearing time i.e. increasing fish size, while phytoplankton contribution increased. This trend was observed more or less in all treatments.

The main species of algae found in fish stomach belonged to Cyanobacteria, Chlorophyta, Bacillariophyta and Euglenophyta (Fig 3 and Table 1). Detritus consisted mainly of scraps of macrophytes and mud. Zooplankton was rarely found and did not exceed 1.5% of the total components in fish stomach. It consisted of parts of animals, especially cladocera, copepoda and rotifers. These results were in concomitant with Fish [3], Lowe-McConnell [4]. Tudorancea *et al.* [5] and Abdel-Tawwab [6]

who reported that, Nile tilapia is phytoplanktivore and a facultative detritivore fish. Contrary results were obtained by Moriarty [32] and Northcott *et al.* [33] who stated that, insects and crustaceans could also comprise a large portion of the diet of Nile tilapia.

Moreover, Batjakas *et al.* [34] reported that Nile tilapia has the ability to feed on either small or bulky particles in Lake Victoria and also it is the most efficient filter feeder and could utilize a broad range of particle sizes. The variation in fish stomach contents depends on numerous factors such as fish size, stocking, availability of different food items, light intensity and water temperature.

Results in Fig. 3 show that the abundance of phytoplankton divisions fluctuated from a treatment to another. Bacillariophyta followed by Cyanobacteria were dominant in fish stomachs at control and 20 kg/f/m while Euglenophyta was dominant at 100 kg/f/m during the investigation period. On the other hand, Cyanobacteria, Chlorophyta and Bacillariophyta were dominant in some months at 40 and 60 kg/f/m. These results indicate that phytoplankton cropping depended on fish weight and its availability in pond's water. Moreover, phytophagous fish consume great amounts of food and the intensity of feeding is affected by the filtration rate of food components, which depends on the density of phytoplankton in the water mass [35] and the condition of fish [36].

The most frequently species of Cyanobacteria represented in fish stomachs in all treatments were *Anabaena sp*, *Merismopedia eleganse*, *Microcystis aeruginosa*, *Nodularia harveyana* and *Oscillatoria sp*. The main Chlorophyta species are *Cerasterias sp*, *Chlorella spp*, *Crucigenia sp*, *Pediastrum spp*, *Scenedesmus spp* and *Tetraedron sp*. Also, the main species of Bacillariophyta are *Amphora ovalis*, *Cocconeis placentula*, *Cymatopleura solsa*, *Cymbella cistula*, *Gyrosigma attenuatum*, *Melosira granulata*, *Navicula spp*, *Nitzschia spp*, *Pinnularia spp*, *Serurella sp* and *Synedra sp*. However, *Euglena spp* and *Phacus spp* belonged to Euglenophyta (Table 1). Also, similar findings with Nile tilapia were reported by Abdel-Tawwab [6].

Regarding the complex nature of the feeding habit of Nile tilapia in fertilized earthen fishponds, it has been necessary to calculate the selectivity index, which might throw some light on fish's food preference. According to Ivlev's equation [26], values of selectivity index are between +1 and -1. Positive values indicate a positive selectivity of a certain kind of food while negative ones indicate a negative selectivity. Data in Fig. 4 show that, Nile tilapia selected Cyanobacteria at all treatments during the investigation period. It also selected Bacillariophyta at all treatments during the investigation period except during Oct. at 40 and 60 kg/f/m and July at 100 kg/f/m. The fish did not select Chlorophyta but it occurred incidentally in the stomach when it was mechanically swallowed together with other foodstuff. This result indicates that, Nile tilapia does not consume food at random but is able to select and choose the preferred foodstuff.

Correlation data in Fig. 5 showed that phytoplankton represented the main item in stomach content ($r^2 = 0.54990$) followed by detritus ($r^2 = 0.5032$), while the contribution of zooplankton was very rare ($r^2 = 0.028$). Otherwise, the composition percentage of natural food in fish stomach changed with increasing fish size, which ranged from 30-70 g/fish. On the other hand, the correlation data in Fig. 6 indicates that the composition percentage of phytoplankton in fish stomach is affected by fish size. It also indicates that Bacillariophyta represents the main phytoplanktonic division at small fish size (30-60 g/fish), while Chlorophyta is the dominant group at large fish size (60-70 g/fish). This difference in composition percentage of phytoplankton divisions in fish stomachs is due to the difference in the predatory pressure of fish on phytoplankton that depends on fish feeding and algal growth rates. On the other hand, evacuation time (rate) may affect the composition percentage of phytoplankton in fish stomach. Focken *et al.* [37] reported that the natural food is ingested for 4-5 hours in the morning and 5-7 hours in the afternoon, and the flow of natural food from the stomach is low and fast. Subsequently, it could be supposed that each phytoplanktonic division has its own evacuation rate.

Finally, the obtained results in this study indicate that Nile tilapia is a good biological filter for phytoplankton. In this concern, Landau [38] reviewed this role of tilapia stocked into reservoir ponds to reduce algal growth and improve water quality.

Table 1. The main taxa of phytoplankton found in stomachs of Nile tilapia cultured in earthen ponds received different doses of inorganic fertilizer.

	Control				20 kg/f/m				40 kg/f/m				60 kg/f/m				100 kg/f/m			
	J	A	S	O	J	A	S	O	J	A	S	O	J	A	S	O	J	A	S	O
Cyanophyta																				
<i>Anabaena sp</i>	-	-	-	+	+	-	-	-	-	-	-	-	-	-	+	+	-	-	+	+
<i>Merismopedia eleganse</i>	-	-	+	-	-	+	+	+	+	+	+	+	+	+	-	-	-	+	-	+
<i>Microcystis aeruginosa</i>	-	-	-	-	-	+	+	-	+	-	+	-	+	-	-	-	-	-	-	-
<i>Nodularia harveyana</i>	+	+	-	+	-	+	+	-	+	+	+	-	+	+	-	-	+	+	+	-
<i>Oscillatoria spp</i>	+	+	+	-	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+
Chlorophyta																				
<i>Cerasterias sp</i>	-	-	-	-	+	+	-	+	-	-	-	-	+	-	-	+	-	-	+	-
<i>Chlorella spp</i>	+	+	+	-	-	+	+	+	-	+	+	+	-	+	-	+	+	-	+	+
<i>Crucigenia sp</i>	+	-	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	-	-	-
<i>Pediastrum spp</i>	+	+	-	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+
<i>Scenedesmus spp</i>	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+
<i>Tetraedron sp</i>	+	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	+	-	-
Bacillariophyta																				
<i>Amphora ovalis</i>	-	-	+	+	+	-	+	-	+	-	-	-	-	-	-	-	+	-	-	+
<i>Cocconeis placentula</i>	+	+	+	+	-	+	+	+	-	+	-	+	-	+	+	-	+	+	+	+
<i>Cymatopleura solsa</i>	+	+	-	+	+	+	+	+	+	+	-	-	+	+	+	+	-	-	+	-
<i>Cymbella cistula</i>	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	+
<i>Gyrosigma attenuatum</i>	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+
<i>Melosira granulata</i>	-	-	-	-	+	-	+	+	+	-	-	-	+	-	+	-	-	+	-	-
<i>Navicula spp</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+
<i>Nitzschia spp</i>	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	+	-	-	+
<i>Pinnularia sp</i>	+	+	+	+	+	+	+	-	+	+	-	+	+	-	+	-	-	+	+	+
<i>Serurella sp</i>	-	-	+	+	+	-	-	-	+	+	-	-	+	-	-	-	-	+	-	-
<i>Synedra sp</i>	-	-	-	+	+	+	+	+	+	-	+	-	+	-	+	+	-	-	-	-
Euglenophyta																				
<i>Euglena spp</i>	+	+	-	+	-	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+
<i>Phacus spp</i>	+	+	-	+	+	-	+	+	-	+	+	-	-	+	+	+	+	+	+	+

+ present - absent

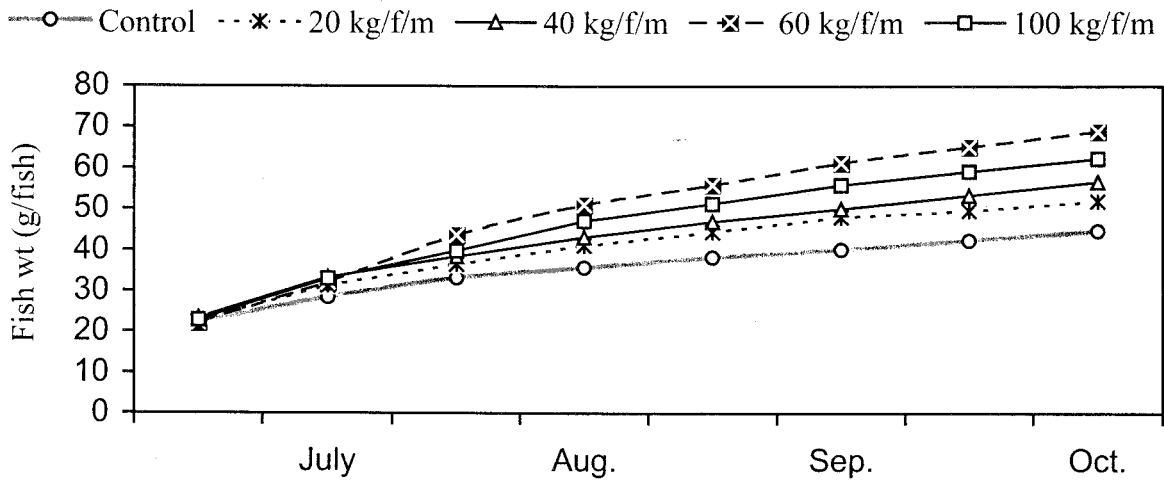


Fig. 1. Average weight of Nile tilapia (*O. niloticus*) cultured in Earthen ponds received different doses of inorganic fertilizer.

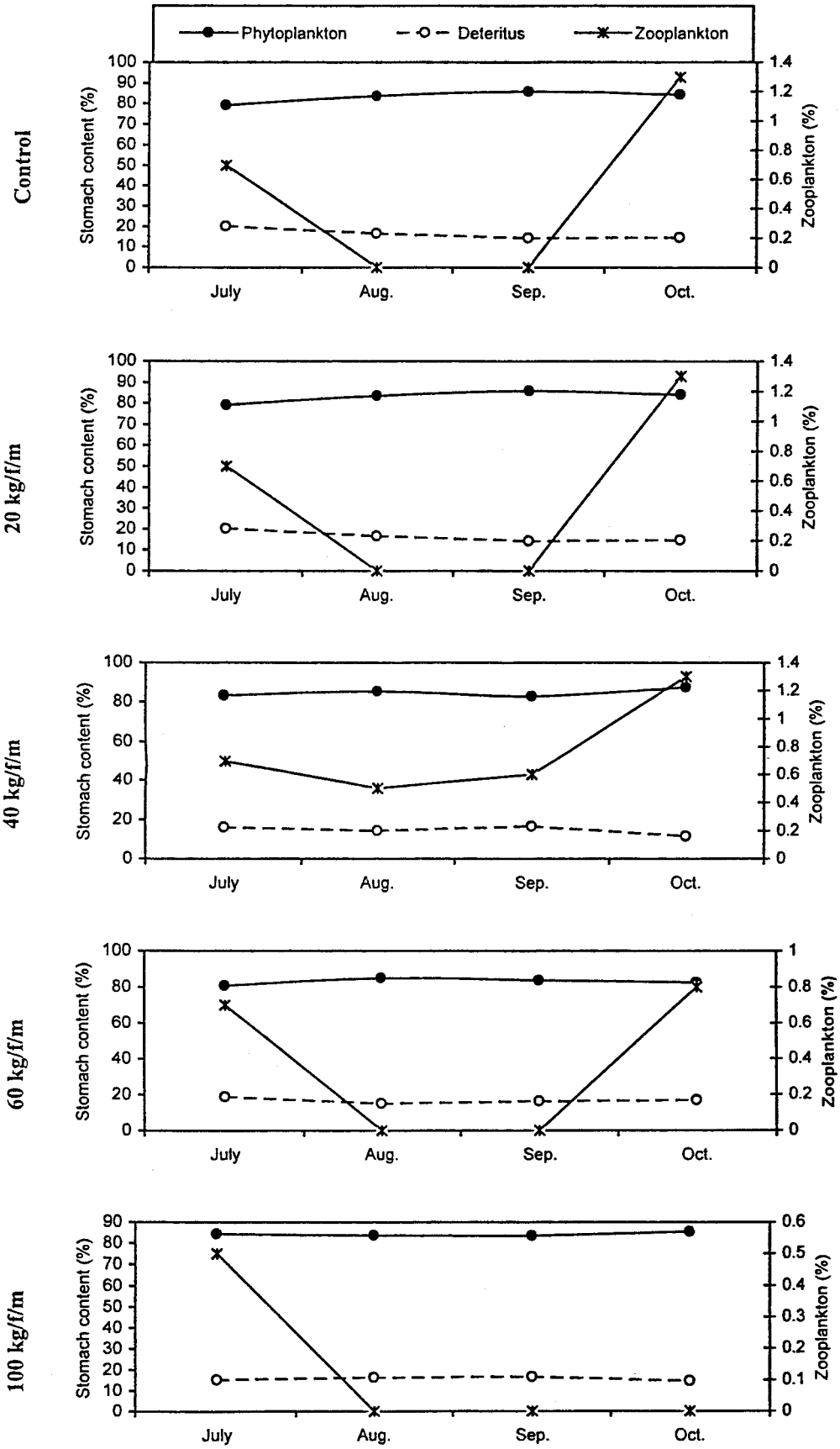


Fig. 2. Stomach contents of Nile tilapia (*O. niloticus*) cultured in ponds received different doses of inorganic fertilizer.

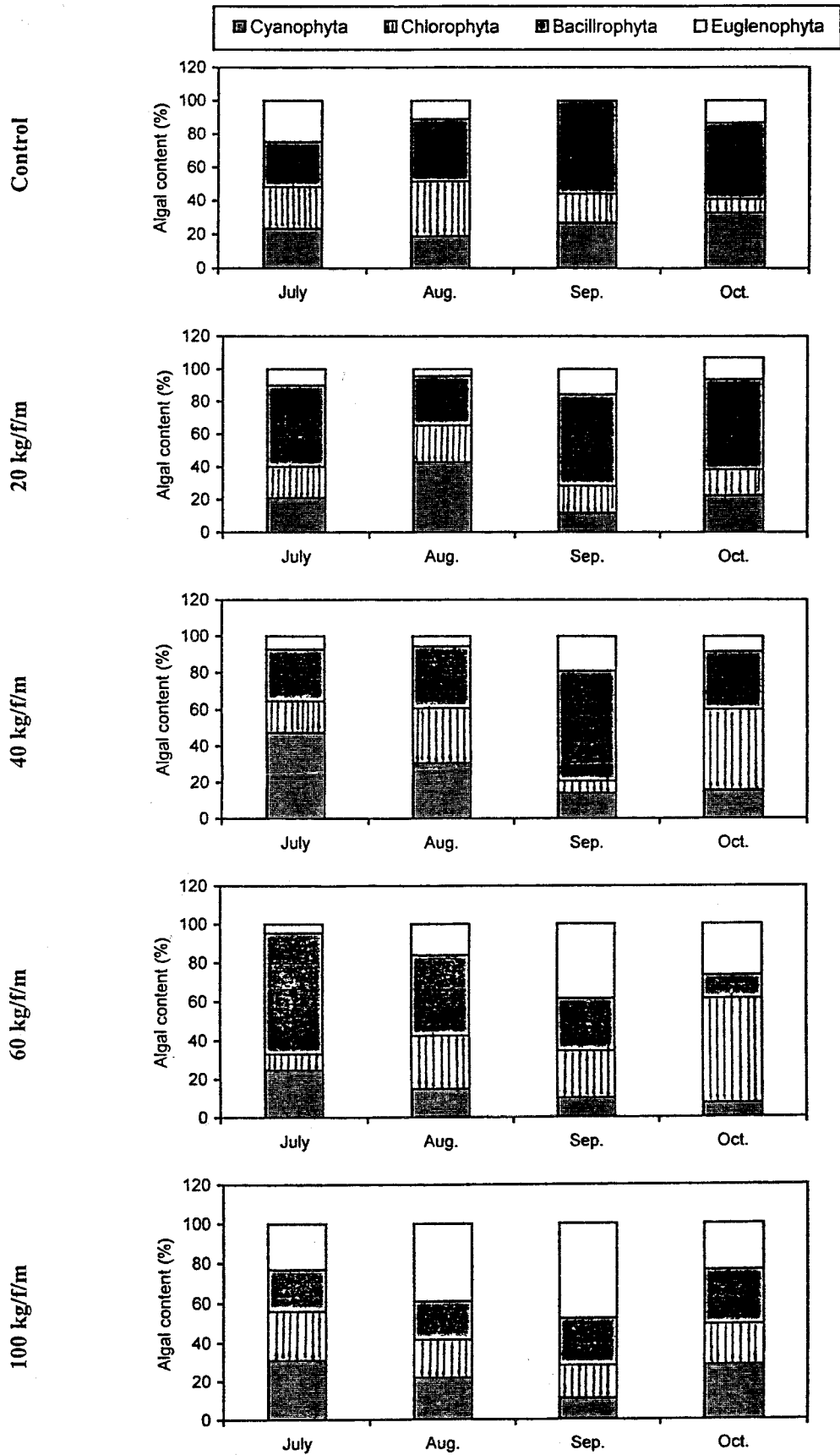


Fig. 3. Algal content (%) of stomach of Nile tilapia (*O. niloticus*) cultured in ponds received different doses of inorganic fertilizer.

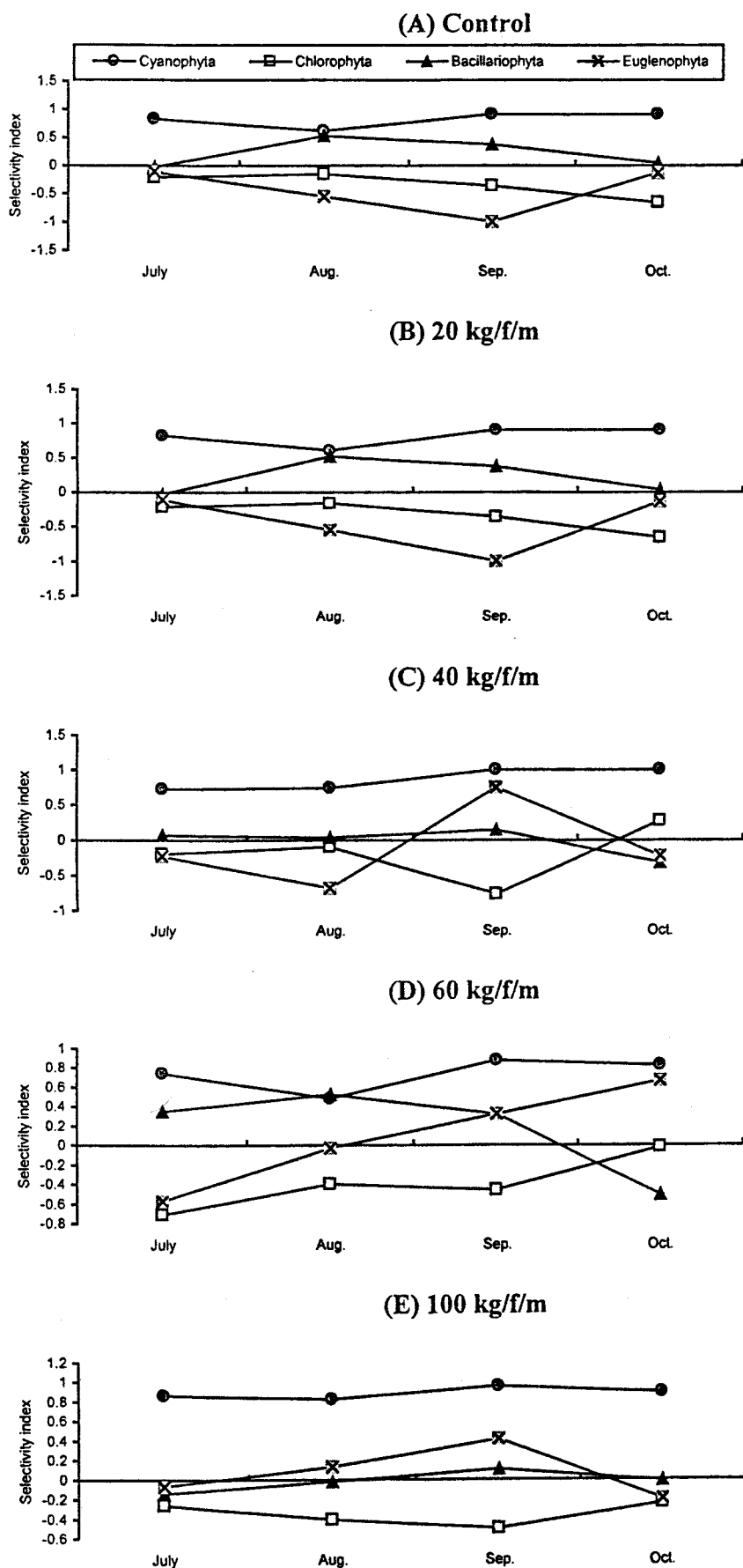


Fig. 4. Selectivity index of Nile tilapia (*O.niloticus*) for phytoplankton groups at the application of different doses of inorganic fertilizer in fishponds.

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