LENGTH-WEIGHT RELATIONSHIP, NATURAL FOOD AND FEEDING SELECTIVITY OF NILE TILAPIA, *Oreochromis niloticus* L. IN FERTILIZED EARTHEN PONDS

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Abstract

Nile tilapia, *Oreochromis niloticus* (L.) was stocked in fertilized earthen ponds and received both organic and inorganic fertilizers. Fish samples were collected for growth determination and were categorized into different sizes, i.e. <25g, 25-50g, 50-75g, 75-100g and 100-125g. Every two weeks, fish samples were collected and individual weight and length were measured. Samples for stomach content analysis were taken. The obtained results showed that the L ratio was approximately similar in all fish sizes and ranged from 2.9 to 3.4. The composition percentage of food items in stomach contents of Nile tilapia was ranked as phytoplankton>detritus>zooplankton at all fish sizes. Detritus consisted mainly of scraps of macrophytes and mud, and its contribution to gut content decreased by increasing fish size, while phytoplankton contribution increased. Zooplankton did not exceed 1% of total stomach's contents. The main algal species found in fish stomach belonged to *Cyanobacteria, Chlorophyceae, Bacillariophyceae and Euglenophyceae. Bacillariophyceae* represented the main phytoplanktonic division at small fish size (<75 g/fish), while *Chlorophyceae* is the dominant group at large fish size (>75 g/fish). Results revealed that Nile tilapia could select *Cyanobacteria* and *Euglenophyceae* at all sizes. Chlorophyceae and Bacillariophyceae were eaten with slight selectivity at large sizes.

Introduction

Nile tilapia, *Oreochromis niloticus* (L.) is one of the most known members of the tropical and subtropical freshwater fishes. It is recommended by the FAO as a culture fish species because of its importance in aquaculture and its capability in contributing to the increased production of animal protein in the world. Therefore, it is now globally distributed and has become very popular through the advances in the cultivation techniques.

One of the key factors to successful fish culture is the understanding of some biological fundamentals especially food and feeding behavior. Juvenile and adult Nile tilapia are reported to filter phytoplankton (Northcott *et al.* 1991). Since Nile tilapia use algal protein raising tilapia for food at lower trophical level can be a cost-efficient culture method. Fish food consumption might be influenced by many environmental factors such as water temperature, food concentration, stocking density, fish size and fish behaviour (Houlihan *et al.* 2001).

The feeding rate relative to the body weight decreases as fish size increases; however, the rate of food consumed increases per individual (Wang *et al*. 1989). Small *Tilapia rendalli* consumed significantly more diatoms than larger individuals (Brummett 1995). Saha and Dewan (1979) observed that the amount of phytoplankton in Nile tilapia stomachs decreased as fish size increased.

Stocking of Nile tilapia with mixed sex at the beginning of the production season facilitates the subsequent reproduction increasing the number of small fish in the pond. The wide variation in fish sizes in the pond would effectively influence the phytoplankton management. This work was carried out to study the length-weight relationship, and feeding selectivity of Nile tilapia at different sizes in earthen ponds received organic and inorganic fertilizers.

Materials and methods

This study was conducted in four earthen fishponds (1000 m^2 surface area each) located at Central Laboratory for Aquaculture Research, Abbassa, Sharqia, Egypt. These ponds were firstly drained and cleaned, then supplied with freshwater from Ismailia canal throughout El-Wady canal to a depth of 0.8-1.0 m. The experimental period started on 3 May 2001, which continued for 6 months.

Fishponds were initially fertilized with 150 kg/feddan of cattle manure two weeks before fish stocking. Organic manure at a rate of 100 kg/acre/month, and the inorganic fertilizers at the rate of 5 kg/acre urea (46.5% N) and 15 kg/acre monosuperphosphate (15.5% P_2O_5), were added to the pond at biweekly interval. The inorganic fertilizers were dissolved and splashed on the water surface of ponds. Nile tilapia was stocked at a rate of 1.5 fish/m^2 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 30 cm 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., Loveland, Colorado, USA). Total alkalinity and total hardness were analyzed by titration according to APHA (1985). Orthophosphate was colorimetrically determined by stannous chloride method and nitrate was colorimetrically determined by phenoldisulphonic acid method (Boyd, 1984).

Water samples (1 liter bottle) were collected for phytoplankton determination at the same depth and time, then preserved by adding 1 ml of 4% formalin. Samples were allowed to settle for 15 days and the supernatant was siphoned to 50 ml. Samples for zooplankton determination was collected by plankton net (50 µm) through filtering 20 liters and soon preserved by adding 1 ml of 10% formalin. The counts of phytoplankton and zooplankton were performed using Sedgwick-Rafter cell under a binocular microscope using suitable magnification up to x100. The means of the different parameters were expressed per liter per month throughout the investigation period.

Every two weeks, 50 fish from each pond were sampled by using pure seine. The individual weight and length were measured and were categorized into different sizes, i.e. <25g, 25-50g, 50-75g, 75-100g and >100g. Fish specimens were immediately placed in 10% formalin. Fish were dissected and the length of alimentary canal was measured and the ratio between length of digestive tract to total fish length (L ratio) was calculated. The stomach fullness degree was estimated. Fullness degree of fish stomachs was categorized to empty, ¼ full, ½ full, ¾ full, full and gorged as described by Abdelghany (1993). The stomach contents were transferred to a fixed volume of distilled water. Three sub samples were then transferred to Sedgwick-Rafter counting cell and phytoplankton was identified and counted. The phytoplankton in samples was identified to genus according to Prescott (1961). The composition of the phytoplankton community in the stomach was then compared with that of fishpond to evaluate grazing selectivity, which was calculated according to Ivlev (1961). The obtained data was conducted to analysis of variance and Person correlation was done by using SPSS software program (ver. 8) as described by Dytham (1999).

Results

Water quality remained within the acceptable limits for tilapia growth as described by Boyd (1984). Average measurements for the following parameters were: water temperature: 26.7 C (range 24.2-27.7), dissolved oxygen: 5.7 mg/L (range 5.2-6.0), pH: 8.7 (range 8.5-8.8), free ammonia: 0.59 ppm (range 0.50-0.71), water conductivity: 0.985 mS/cm (0.89-1.05), total alkalinity: 294 mg/L as $CaCO_3$ (range 237-347), total hardness: 202 mg/L as $CaCO_3$ (range 172-243), PO_4: 1.15 mg/L (range 0.81-1.82), NO_3: 1.74 mg/L (range 1.31-2.15).

The relationship between fish size, length and L ratio is indicated in Fig 1. It is noticed that the L ratio was approximately similar and ranged from 2.9 to 3.4, and did not change from one size to another. Data in Fig. 2 did ensure the occurrence of natural food in fish stomachs with variable stomach fullness degrees. All fullness degrees were represented in all fish size except 75-100 g fish size that had no gorged stomach and 50-75 g fish size had no empty stomach.

The analysis of stomach contents of Nile tilapia showed great diversity in the found items. Fig. 3 shows that zooplankton sharing to gut content was generally inconsiderable, and the high zoo content was obtained at small fish sizes, and completely disappeared in large sizes. Whenever zooplankton occurred, it did not exceed 1.0% of the total components in fish stomach, and it consisted of parts of animals especially cladocera, copepoda and rotifers. Sometimes, parts of insects and zoobenthos were found. Detritus consisted mainly of scraps of macrophytes, organic particles and mud**.**

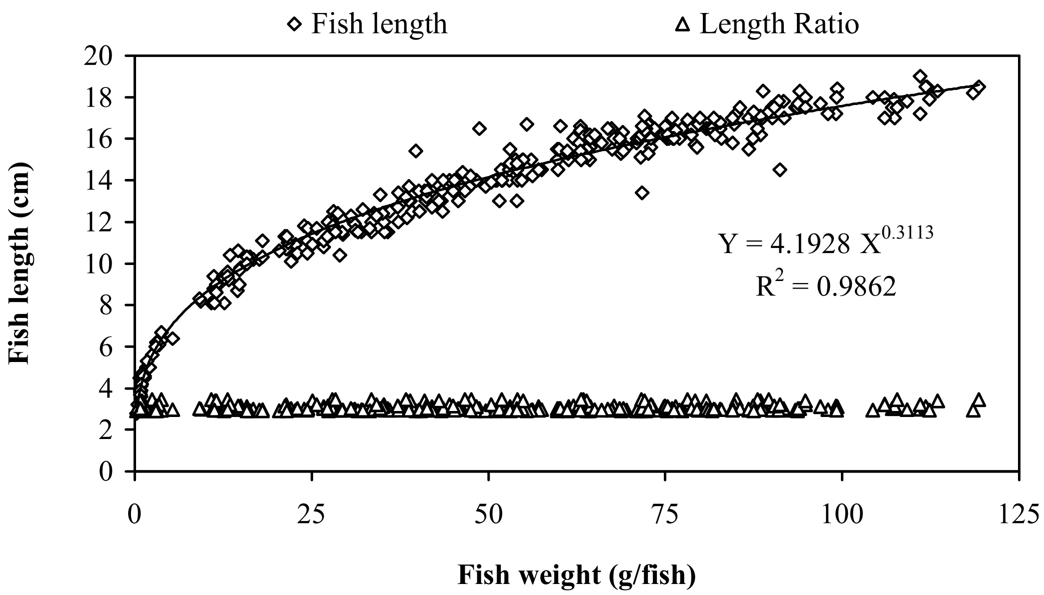

Fig. 1. Relationship between total length (cm), body weight (g/fish) and length ratio of Nile tilapia (*O. niloticus* L.) reared in fertilized earthen ponds in Abbassa fish farm, Sharqia.

* Length ratio = length of digestive tract/fish length.

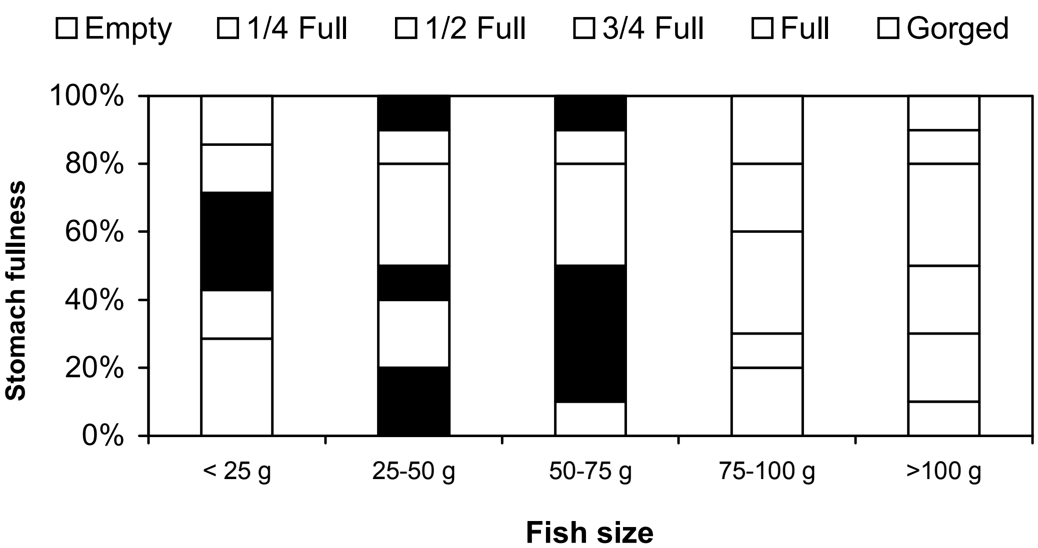

Fig. 2. Stomach fullness degree of Nile tilapia (*O. niloticus*) with different sizes in fertilized earthen ponds in Abbassa.

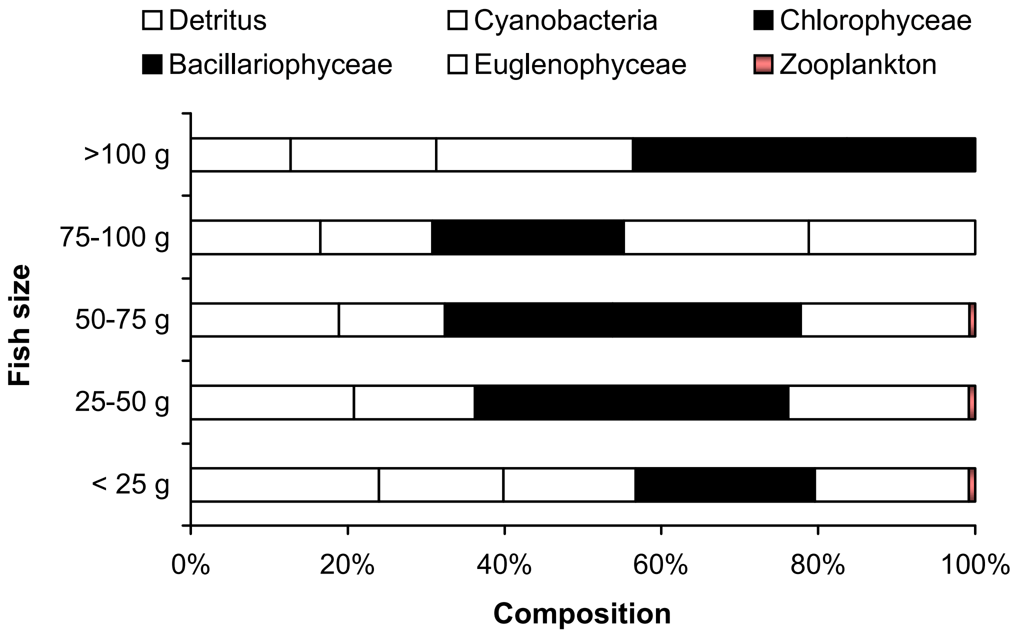

Fig. 3. Food items composition in stomach of Nile tilapia (*O. niloticus*) with different sizes in fertilized earthen ponds in Abbassa.

The main phytoplankton genera found in fish stomach belongs to *Cyanobacteria, Chlorophyceae, Bacillariophyceae and Euglenophyceae* (Fig. 3). Results in Fig. 3 show that the abundance of phytoplankton divisions fluctuated from size to size. *Bacillariophyceae* represented the main phytoplanktonic division at small fish size (<75 g/fish), while *Chlorophyceae* is the dominant group in large fishes (>75 g/fish). The most frequent genera represented in fish stomach in all sizes were *Anabaena, Anabaenopsis, Coleospharium, Merismopedia, Microcystis, Nodularia, Oscillatoria, Spirulina* (Cyanobacteria), *Actinostrum, Chlorella, Closterium, Coelastrum, Eudrina, Pandorina, Pediastrum, Scenedesmus, Shereoderia, Staurastrum* (Chlorophyceae), *Amphora, Cocconeis, Cymatopleura, Cymbella, Gyrosigma, Melosira, Navicula, Pinnularia, Synedra* (Bacillariophyceae) and *Euglena, Phacus* (Euglenophyceae).

Regarding the complex nature of the feeding habit of Nile tilapia in fertilized earthen fishponds, it is necessary to calculate the selectivity index, which might throw some light on fish's food preference. According to Ivlev's equation (Ivlev, 1961), 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. Figure 4 shows that Nile tilapia selected *Cyanobacteria* and *Euglenophyceae* at studied sizes, meanwhile they did not select *Chlorophyceae* and *Bacillariophyceae*, which were gut interred with water and mechanically swallowed together with other foodstuffs. This result indicates that, Nile tilapia did not consume food at random but have the ability to select and choose the preferred foodstuff.

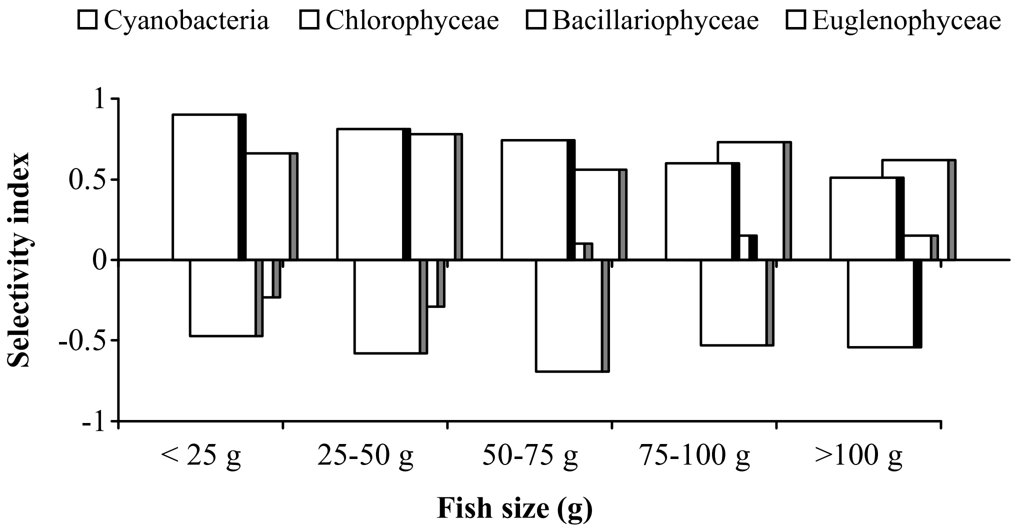

Fig. 4. Selectivity index of Nile tilapia (*O. niloticus*) with different sizes for phytoplankton groups in fertilized earthen ponds in Abbassa.

Correlation data in Fig. 5 show the composition percentage of natural food in fish stomach significantly changed by increasing fish size. However, phytoplankton sharing percentage to stomach contents curvilinearly increased with increasing fish size ($r^2 = 0.6749$; $P<0.05$). On the other hand, detritus and zooplankton were curvilinearly decreased with increasing fish size ($r^2 = 0.6307$ and 0.647, respectively; $P<0.05$).

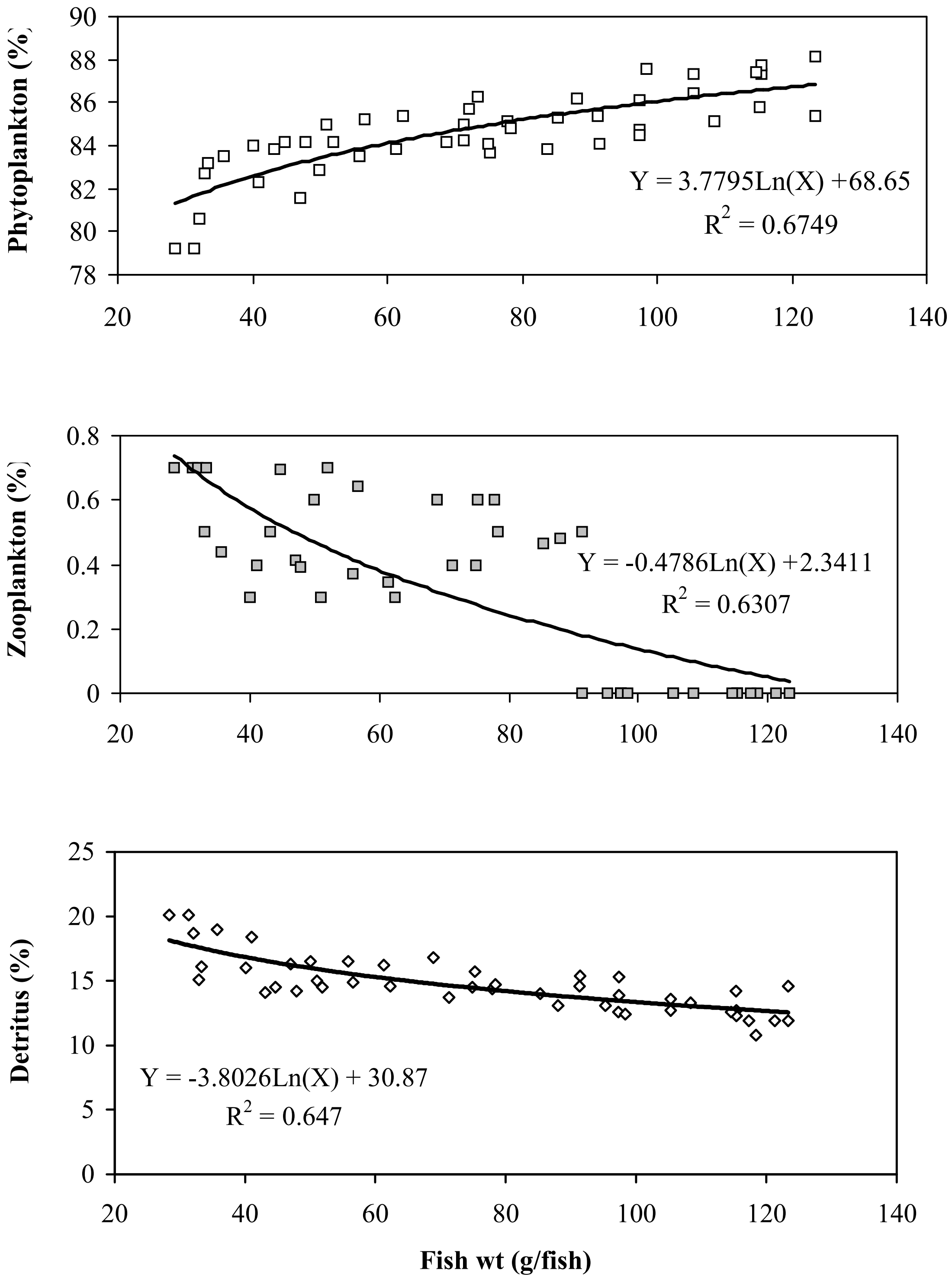

Fig. 5. The relationship between fish weight and different food groups in the stomach content of Nile tilapia (*O. niloticus*) cultured in fertilized earthen ponds at Abbassa.

Discussion

The L ratio herein indicates to the herbivorous behavior of Nile tilapia. This adaptation makes tilapia particularly good for extracting energy from plant matter and allows inexpensive supplemental feeds to be useful in tilapia culture.

The grazing behavior is varied from size to size, time to time, and actually it positively correlated to the occurrence and the richness of nature food components. So, the fullness degree insignificantly differed. On the other hand, plankton is quickly digested and passed to the mid-gut and subsequently to hind-gut. Also, evacuation time (rate) may affect the composition percentage of phytoplankton in fish stomach. In this concern, Yada (1982) stated that the feeding behavior of Nile tilapia begins at sunrise, continues during the daytime and becomes most active during sunset. He also reported that Nile tilapia could change its feeding periodicity according to the fluctuation of phytoplankton concentrations. Moreover, Focken *et al*. (2000) 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 phytoplankton organism has its own evacuation rate.

The analysis of stomach contents of Nile tilapia showed great diversity in the found items where zooplankton sharing to gut content was considerable at small fish sizes, and completely disappeared in large sizes. However, phytoplankton biomass in gut content increased, while detritus content decreased with increasing fish size. In this regard, Fernando (1994) stated that the necessity of zooplankton for young fishes is considered universal, and planktivorous fish may consume zooplankton. Also, Yada (1982) found that the ingestion ratio of zooplankton decreased with increasing fish total length. He found that the turning point from zooplankton to phytoplankton in Nile tilapia was found around 30-40 mm in fish TL, and no zooplankton was observed in fish with TL 70 mm. Moreover, Moriarty and Moriarty (1973) stated that Nile tilapia was phytoplankton feeder when TL is longer than 60 mm, and zooplankton feeder when TL is shorter than 50 mm. Also, Teferi *et al*. (2000) studied the food and feeding habit of Nile tilapia in Lake Chamo, (Ethiopia) from the stomach contents of adult (29-57 cm TL) and juvenile (6.1-11.5 cm TL) fish. They found that Nile tilapia was essentially phytoplanktivorous, and the composition of the phytoplankton diet varied seasonally. The diet of both adult and juvenile fish consisted of 10 genera of Cyanobacteria whereas green algae and diatoms each contributed 8 genera. Zooplankton occurred on rare occasions in the stomach contents of both adult and juvenile fish.

The obtained results were in concomitant with Tudorancea *et al*. (1988) and Abdel-Tawwab (2000) who reported that Nile tilapia is phytoplanktivore and a facultative detritivore fish. Also, Anibeze (2001) found that Nile tilapia in Agulu Lake basin in Nigeria subsisted mainly on a wide variety of plankton, however, considerable quantities of phyto- and zooplankton were presented in the food. Contrasting results were obtained by Northcott *et al*. (1991) who stated that, insects and crustaceans could also comprise a large portion of the diet of Nile tilapia. Moreover, Piyasiri and Perera (2001) found that *Oreochromis* hybrids is an opportunistic feeder where the fry feed mainly on larger zooplankton, whereas the adults prefer detritus and sedimented diatoms in most months. The intensive feeding hours of the fish occurred between 12:00 and 18:00, and most fish consumed over 3% of their body weight during that time. He also found that *Oreochromis* hybrids filter the plankton, converting them directly into fish flesh, which can be readily harvested out the water body. However, the variation in fish stomach contents is depending on numerous factors such as fish size, stocking, availability of different food items, light intensity and water temperature.

The obtained results indicated that phytoplankton cropping depended on fish size and its concentration in the pond water. However, the 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. In this regard, Caulton 1976; Saha and Dewan 1979; Brummett 1995; Turker *et al*. 2003) found that small tilapia filtered significantly more phytoplankton than larger individuals. Moreover, Azim *et al.* (2003) investigated the effect of periphyton quantity and fish size (7 and 24 g) on the ingestion rate by Nile tilapia and they found that the ingestion rate among small fish increased significantly with periphyton density, but not for medium size fish.

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