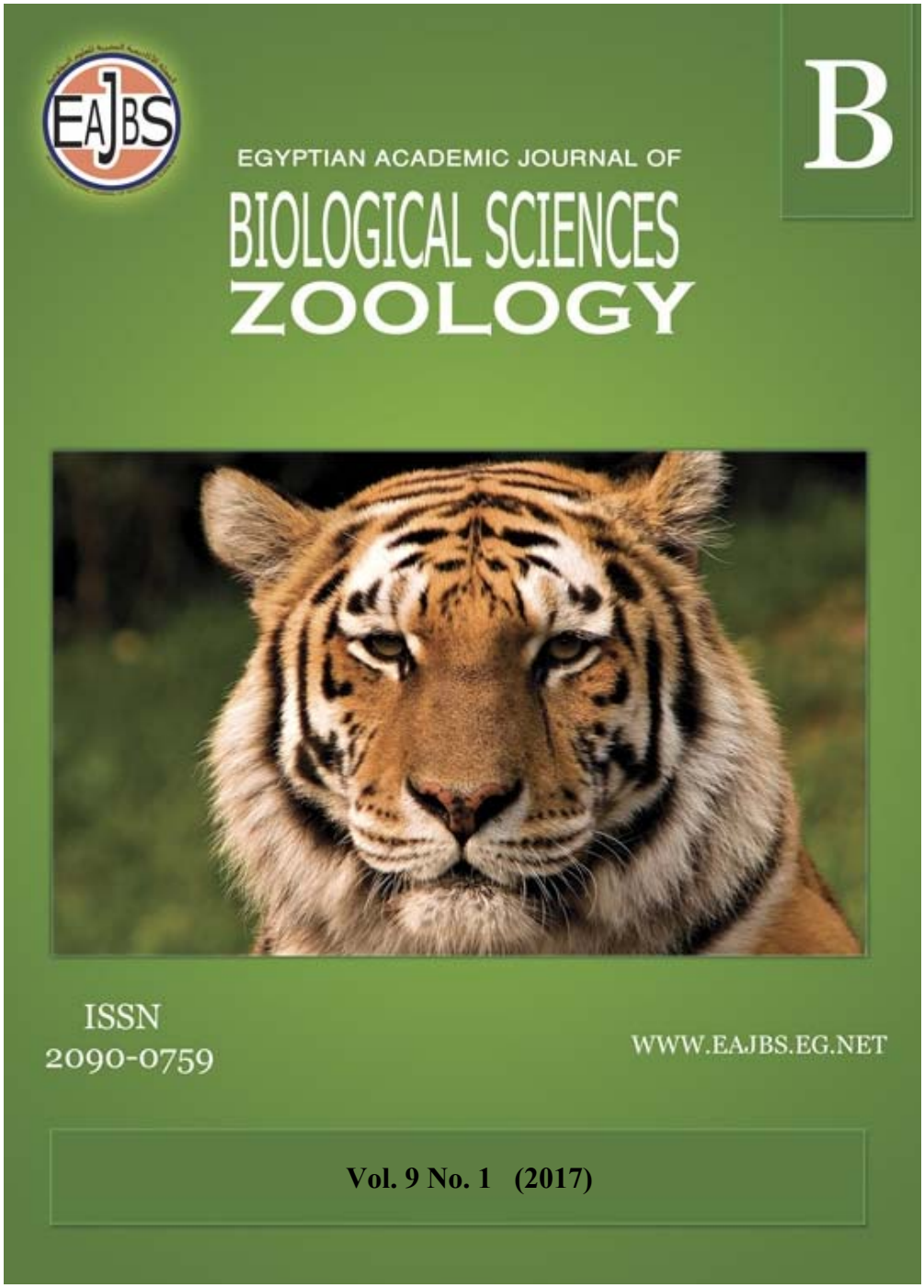

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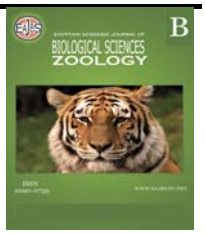

Effect of Some Environmental Factors on the Food and Feeding Habits of the Cichlid Fish, *Tilapia zillii*, Inhabiting Lake Qarun, Egypt.

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ABSTRACT

The present work aims to study the effect of the environmental factors (temperature, salinity and PH) on the food and feeding habits of *Tilapia zillii*caughted from Lake Qarun. A total of 126 specimens of *T. zillii* were collected seasonally from the different localities of Lake Qarun, during the period from June, 2014 to July, 2015**.** Results showed that, the highest value of surface water temperature was recorded at Village 8 Station during summer (32.67±2.31 ºC) and the lowest (16.93±1.79 ºC) at Nema Island Station during winter**.** The maximum value of water salinity was recorded at Village 8 Station during summer (40.10±3.46 ‰) and autumn (40.47±2.73 ‰) and the minimum value (29.17±3.52 ‰) was observed at Kahk Village Station during winter. The highest values of hydrogen ion concentrations were recorded at Village 8 Station during summer (8.67±0.15) and autumn (8.76±0.02) and the lowest values were detected at Ezbet Abd El-Alim Station during spring (7.96±0.09) and winter (7.96±0.12). The maximum values of feeding activity were recorded during autumn and summer and the minimum activity was observed during spring. The feeding activity is relatively larger in the younger fish than in the older one; being 41.63% in the former and 25.60% in the latter. Results showed that, the fish is mainly omnivorous and consumed a wide range of animal and plant foods. The plant food includes plant tissue, algae and diatoms while, the major animal food includes molluscs, polychaets, insects, pisces, nematods, crustaceans, Protozoa, Foraminifera and Rotifera. The relative amount of plant food increases with the increasing length of the fish. However, the relative amount of animal food and sand granules decreases with the increasing length of this fish.

INTRODUCTION

Lake Qarun constitutes a very important sector in the Egyptian fisheries, for both significant total catch and a large number of economically important species. The lake is located in the Western Desert, between latitudes 29°24` and 20°33` North and longitudes 30°25` and 30°50` East. The lake has an area of about 55000 feddans (22000 hectares), or approximately 107 square kilometers. The lake is bounded by the cultivated lands to the South and West Desert to the north. The southern border of the lake forms the north boundary of El-Fayoum Governorate (El-Zarka, 1961; Hassan, 2002; Ghanem, 2006 & 2011 and Khalaf-Allah, 2014). The lake is presumed to have

resulted from the accumulation of water in low laying lands (El-Fayoum Depression) where it now occupies.

Several drains (El-Bats, El-Wadi and El-Berkah Drains) of El-Fayoum irrigation systems terminate and pour highly amounts of fresh or brackish water into the lake. Such water is loaded with wastes, salts and nutrients that may accumulate and contaminate the aquatic environment (Hassan, 2002; Ghanem, 2006 & 2011 and Khalaf-Allah, 2014).

Temperature plays an important role in the physical, chemical and vital properties of any water mass. Chemical and biological reactions are doubled for every 10 °C increasing in temperature. The inhabiting fauna usually migrates vertically by influence of water temperature (Shehata *et al*., 1996a & b; Shehata *et al*., 1998 and Ghanem, 2006 & 2011). Salinity is an important factor affecting the biota of the lake. It is generally affected by three main factors: total amount of drained water entering the lake, rate of evaporation and meteorological parameters of the area (winds, humidity, rain…etc.) (Khalaf-Allah, 2001; Hassan, 2002 and Ghanem, 2006 & 2011).

Knowledge of the natural diet of animals is important in understanding the feeding habits and nutritional requirements of the species and is essential in fundamental community analysis for studies of food webs, tropho-dynamics, and resource partitioning and ecological energetic (Ladeberger, 1968 and Shehata, 1993). Moreover, the food and feeding habits of the fish is important for cultivating a group of fish in ponds (Stephen, 2007; Mugisha & Dumba, 2007 and Oliveira *et al*., 2007).

Little information is known about the accurate status of the obtainable food content, trophic levels and effect of the environmental factors on the fish food status at Lake Qarun. So it was found necessary desirable to study the effect of the environment factors o food ad feeding habits of the commercial fish, *T. zillii*, commonly found in the lake waters. Such investigation may lead to a better understanding of some biological aspects like food chains, growth rates, productivity, mortality and nutrional value as well as their trophic levels of this species.

Fig. 1: Map of Lake Qarun showing the selected stations in the study area.

MATERIALS AND METHODS

Environmental factors:

The environmental factors considered here were surface water temperature, water salinity and hydrogen ion concentrations (pH).

Surface water temperature (^{o}C): It was measured by using alcoholic thermometer graduated to 100^{o} C and recorded along the study period.

Salinity (S ‰): It was determined by using the gravimetric method suggested by **APHA (1992)** according to the following equation:

$$\text{Total dissolved solids (g / L)} = \frac{(A - B) \times 1000}{\text{Volume of sample (ml)}}$$

Where:

A= Weight of dried residue plus dish weight (g).

B= Weight of dish (g).

Hydrogen ion concentrations (pH): it was measured directly by using pH meter model (microprocessor HI931401, Hanna Instruments) after calibration with buffer solution of pH 4 and 10.

Food and feeding habits:

A total of 126 specimens of *T. zilliio* of varying sizes, from 5.20 to18.00 Cm (total length), were collected seasonally from the different localities of Lake Qarun, during the period from June, 2014 to July, 2015. Long lines and gill nets were the main fishing methods used to catch the fish. Fishes were examined fresh or preserved in 10% formalin solution for latter examination. In the laboratory standard and total lengths were measured to the nearest millimeters and recorded.

To study feeding intensity, all the examined stomachs were assessed according to the following method utilized by Geevarghese (1976). From the intact alimentary tract, the feeding intensity was assessed first in each case. The assessment was based on the visual estimation of the distension of the stomachs ad the relative amount of food contained in them. The examined stomachs were classified into heavy, good, medium, poor ad empty stomachs. The percentage of each category to the total number of stomachs was calculated. Fishes were separated into tow length groups, the first small (5.50-13.90 cm) and the second large (14.00-18.00 cm) and the percentage occurrence of the five categories of stomachs in each length group was estimated.

To study food items, the point assessment method was utilized. After being dissection, each stomach was removed, washed with water, opened and its contents were flushed into a Petri dish and examined. Stomach content were examined individually under a low power binocular microscope. Food items recovered from the stomachs were taxonomically identified as far as possible up to genera; however, most could be identified to species level. Frequency of occurrence and number of individuals per taxon were determined for the dominate food items. Prey items were grouped as unidentified matter when identification was not possible owing to the advanced stage of digestion. Preys were classified into two main groups, animal and plant foods. The percentage of each category to the total number of food items was estimated for the two length groups.

RESULTS

Environmental factors:

The environmental factors considered here were: surface water temperature, salinity and hydrogen ion concentrations. Seasonal variations in the environmental factors at all stations sampled are shown in Tables (1-3) and are graphically represented in Figures (2-4).

Table 1: Seasonal variations of surface water temperature (°C) at different stations of Lake Qarun, during the period from June, 2014 to May, 2015.

Stations	Seasons				Annual average
	Spring	Summer	Autumn	Winter	
Ezbet Abd El-Alim	23.47 ±3.26	27.93 ±1.90	23.13 ±3.56	17.53 ±2.57	23.02 ±4.26
Nema Island	24.33 ±3.26	28.70 ±1.41	24.40 ±4.23	16.93 ±1.79	23.59 ±4.89
Kahk Village	25.40 ±2.48	29.57 ±1.57	25.77 ±4.25	18.23 ±2.40	24.74 ±4.73
El-Sobiahy Village	26.40 ±2.25	31.40 ±2.77	26.30 ±5.27	18.47 ±2.68	25.64 ±5.34
Auop Village	27.17 ±1.80	31.83 ±2.81	26.43 ±6.33	18.80 ±2.80	26.06 ±5.40
Village 8	27.27 ±1.94	32.67 ±2.31	27.70 ±7.38	19.37 ±2.71	26.75 ±5.50
Average	25.67 ±1.55	30.35 ±1.89	25.62 ±1.62	18.22 ±0.88	----------

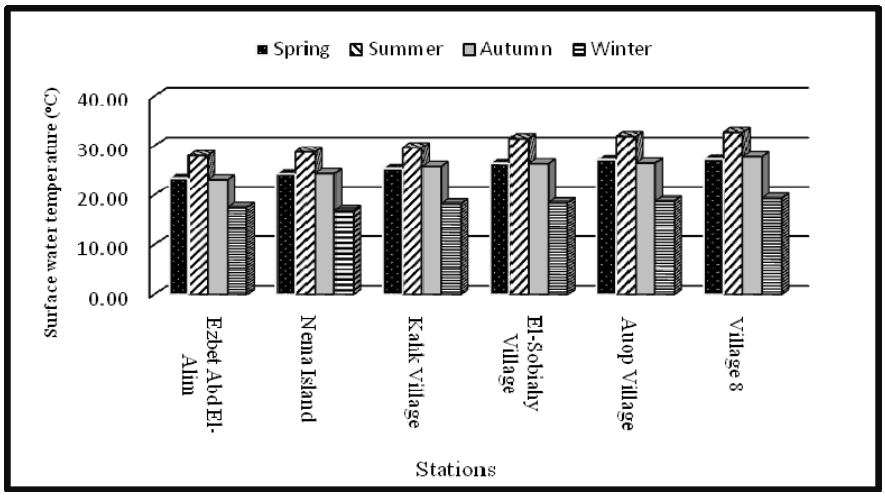

Fig. 2: Seasonal variations of surface water temperature (°C) at the different stations of Lake Qarun, during the period from June, 2014 to May, 2015.

Table 2: Seasonal variations of salinity (‰), at the different stations of Lake Qarun, during the period from June, 2014 to May, 2015.

Stations	Seasons				Annual average
	Spring	Summer	Autumn	Winter	
Ezbet Abd El-Alim	32.16 ±1.11	33.20 ±1.30	34.67 ±2.08	32.00 ±1.65	33.01 ±1.23
Nema Island	33.33 ±1.77	35.43 ±0.90	35.70 ±0.61	31.20 ±1.65	33.92 ±2.10
Kahk Village	33.20 ±1.71	34.53 ±4.86	35.70 ±2.29	29.17 ±3.52	33.15 ±2.85
El-Sobiahy Village	33.63 ±1.42	36.10 ±1.04	33.77 ±5.49	31.17 ±2.23	33.67 ±2.02
Auop Village	34.70 ±1.87	37.10 ±1.14	34.50 ±3.99	32.33 ±1.85	34.66 ±1.95
Village 8	37.43 ±1.96	40.10 ±3.46	40.47 ±2.73	34.40 ±0.36	38.10 ±2.81
Average	34.08 ±1.72	36.08 ±2.38	35.80 ±2.40	31.71 ±1.72	--------

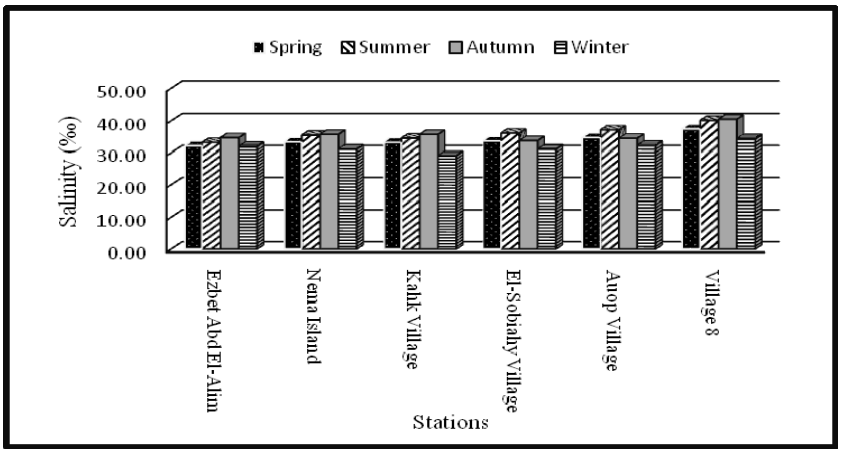

Fig. 3: Seasonal variations of salinity (‰) at the different stations of Lake Qarun, during the period from June, 2014 to May, 2015.

Table 3: Seasonal variations of hydrogen ion concentration at the different stations of Lake Qarun, during the period from June, 2014 to May, 2015.

Stations	Seasons				Annual average
	Spring	Summer	Autumn	Winter	
Ezbet Abd El-Alim	7.96 ±0.09	8.10 ±0.16	8.28 ±0.12	7.96 ±0.12	8.08 ±0.15
Nema Island	8.22 ±0.15	8.36 ±0.22	8.54 ±0.12	8.41 ±0.43	8.38 ±0.13
Kahk Village	8.03 ±0.16	8.08 ±0.22	8.28 ±0.27	8.21 ±0.15	8.15 ±0.12
El-Sobiahy Village	8.33 ±0.05	8.54 ±0.17	8.53 ±0.15	8.30 ±0.27	8.42 ±0.13
Auop Village	8.24 ±0.02	8.56 ±0.04	8.63 ±0.07	8.31 ±0.23	8.44 ±0.19
Village 8	8.40 ±0.06	8.67 ±0.15	8.76 ±0.02	8.37 ±0.10	8.55 ±0.20
Average	8.20 ±0.17	8.38 ±0.25	8.50 ±0.19	8.26 ±0.16	---------

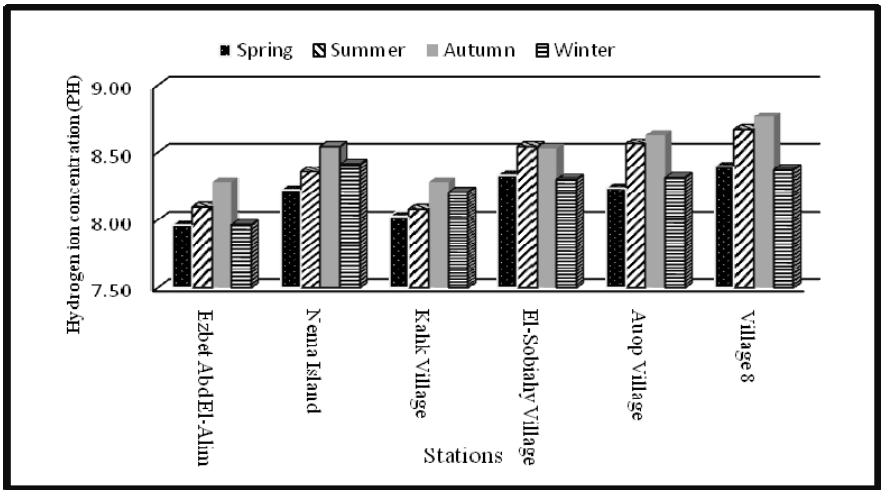

Fig. 4: Seasonal variations of hydrogen ion concentration (PH) at the different stations of Lake Qarun, during the period from June, 2014 to May, 2015.

Surface water temperature:

The maximum average value of surface water temperature was recorded during summer (32.67±2.31 ºC) at Village 8 Station and the minimum value occurred during winter at Nema Island (16.53±1.79 ºC).

Salinity (‰):

The lowest average value of salinity was recorded during winter at Kahk Village Station (29.17±3.52 ‰) and the highest value occurred during autumnat Village 8 Station (40.47±2.73 ‰).

Hydrogen ion concentrations:

Hydrogen ion concentrations exhibited slight seasonal variation in the lake water. It was fluctuated between fluctuated between 7.96±0.12 during winter at Ezbet Abd El-Alim Station and 8.76±0.02 during autumn at Village 8 Station.

Food and feeding habits:

Seasonal variations of food items:

Results (Table 4 and Figure 5) revealed that, the fish is essentially omnivorous and consumed a wide range of plant and animal foods. The major plant food includes diatoms, green algae, blue green algae, red algae.

Table 4: Percentage occurrence of various categories of food items in the stomachs of the cichlid fish, *Tilapia zillii*, collected from Lake Qarun, during the period from June, 2014 to May, 2015.

Seasons / Food items	Spring	Summer	Autumn	Winter	Annual average
Plant food	**48.37%**	**56.10%**	**26.87%**	**39.32%**	**42.66%**
Plant tissues	24.92%	39.54%	20.27%	14.80%	24.88%
Diatoms	2.45%	14.16%	-	6.69%	5.83%
Green algae	1.33%	1.28%	2.61%	15.18%	5.10%
Red algae	0.42%	0.55%	1.49%	1.64%	1.03%
Blue green algae	0.34%	0.56%	1.88%	1.01%	0.95%
Unidentified	18.91%	-	0.61%	-	4.88%
Animal food	**47.94%**	**39.22%**	**3.32%**	**3.50%**	**23.49%**
Molluscs	0.40%	29.75%	-	-	7.54%
Polychaets	15.69%	7.53%	0.52%	1.92%	6.41%
Small fishes	16.83%	-	-	0.01%	4.21%
Insects	12.97%	-	0.11%	-	3.27%
Nematods	0.60%	1.76%	0.07%	-	0.61%
Crustaceans	0.70%	0.15%	0.89%	1.49%	0.80%
Protozoa	0.52%	-	-	-	0.13%
Foraminifra	0.24%	0.01%	0.13%	0.08%	0.11%
Rotifers	-	0.004%	-	-	0.001%
Detritus	-	-	1.61%	-	0.40%
Sand granules	**3.70%**	**4.69%**	**69.81%**	**57.18%**	**33.85%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**

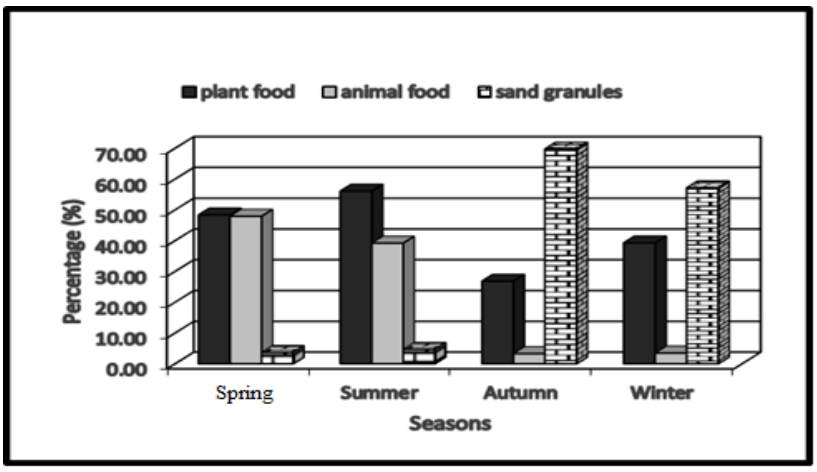

Fig. 5: Percentage occurrence of various categories of food items in the stomachs of, *T. zillii*, collected from Lake Qarun, during the period from June, 2014 to May, 2015.

While, the major animal food includes Mollusca, Polychaeta, small fishes, Insecta, Nematodea, Crustacea, Protozoa, and Foraminifera. Sand granules constituted a considerable percentage, elsewhere, animal detritus constituted a minor percentage in the stomachs of the fish.

Plant foods (42.66 %) were the most dominant and preferred food items consumed by this fish. Plant tissues (24.88%) were the main plant food consumed by the fish. Diatoms and green algae are consumed in approximately equal amounts; being 5.83% and 5.10 % respectively and unidentified food were the main plant food consumed by the fish. Red algae and blue green algae were represented by minor percentages; being 1.03% and 0.95 %, respectively.

The lowest value of plant food (26.87%) was recorded during autumn, then it increased gradually during winter (39.32%) and through spring (48.37%) and reached its highest value (56.10%) during summer. The highest value of plant tissue (39.54%) was recorded during summer and the lowest (14.80%) during winter. The maximum value of diatoms (14.16%) was observed during summer and the minimum value occurred during spring (2.45%). It was entirely absent during autumn. The highest value of green algae (15.18%) was recorded during winter and the lowest occurred in remnant seasons, being: 1.33%, 1.28% and 2.61% during spring, summer and autumn, respectively. The highest value of unidentified food (18.91%) was recorded during spring and the lowest (0.61%) occurred during autumn. It was entirely absent during summer and winter.

Next to the plat food in relative importance of the different food items are animal food (23.49 %). Molluscs (7.54%), Polychaetes (6.41%), small fishes (4.21%) and Insects (3.27%) were the most dominant animal food consumed by the fish. Nematodes, crustaceans, Protozoa, Foraminifera and Rotifera were represented by minor percentages; being 0.61%, 0.80% 0.13%, 0.11 % and 0.001%, respectively. Sand granules constitute a considerable amount in the diet of this fish (33.85%).

The maximum value of animal food was recorded during spring (47.94%), then it decreased gradually during summer (39.22%) and reached its minimum values during autumn and winter; being 3.32% and 3.50%, respectively. Molluscs, Polychaets, small fishes and insects were the main component of animal food consumed by the fish. The highest value of Mollusca (29.75%) was recorded during summer and the lowest (0.40%) during spring. It was entirely absent during autumn and winter. The maximum value of Polychaeta (15.69%) was recorded during spring, then decreased gradually during summer (7.53%) and reached its minimum value during autumn (0.52%) and winter (1.92%).The highest value of small fishes was recorded during spring (16.83%) and the lowest (0.01%) during winter. It was entirely absent during winter and summer. The maximum value of insects was recorded during spring (12.97%). The highest value of sand granule was recorded during autumn (69.81%). It decreased slightly during winter (57.18%) and reached its minimum values during spring and summer being; 3.70% and 4.69%, respectively. Detritus are consumed by a negligible amount only during autumn (1.61%).

Food and feeding habits according to size:

The diet of *T. zillii* showed a considerable variation in the different sized groups and also of different seasons within the same sized groups (Table 5 and Fig. 6). As it is clear from the table there is no qualitative differences in the diet of different sized groups of fishes. The quantitative differences of any article of food between smaller and larger fishes are not of a regular pattern in all seasons.

Results indicated that, the relative amount of plant food increases with the increasing length of the fish; being 32.31% in small size and 66.73% in large one.

Table 5: Percentage occurrence of various categories of food items in the stomachs of *T. zillii* of different sized groups, collected from Lake Qarun, during the period from June, 2014 to May, 2015.

Season / Food items Size	Spring		Summer		Autumn		Winter		Annual average	
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
Plant food	28.90%	90.74%	45.99%	67.80%	15.32%	53.30%	39.03%	59.76%	32.31%	66.73%
Plant tissues	2.04%	74.73%	21.15%	60.83%	9.48%	40.63%	14.92%	6.51%	11.90%	45.68%
Diatoms	3.54%	0.08%	22.26%	4.79%	-	0.005%	6.69%	7.10%	8.12%	2.99%
Green algae	1.39%	1.19%	1.75%	0.73%	2.24%	3.32%	14.88%	36.21%	5.06%	10.36%
Red algae	0.40%	0.46%	0.36%	0.77%	1.74%	1.02%	1.59%	4.61%	1.02%	1.72%
Blue green algae	0.23%	0.57%	0.47%	0.67%	1.87%	1.89%	0.95%	5.32%	0.88%	2.11%
Unidentified	21.30%	13.71%	-	-	-	1.76%	-	-	5.32%	3.87%
Animal food	66.79%	6.92%	51.64%	24.83%	1.72%	6.36%	3.50%	3.08%	30.91%	10.30%
Molluscs	0.58%%	-	37.31%	21.00%	-	-	-	-	9.47%	5.25%
Polychaets	19.74%	6.86%	10.80%	3.75%	-	1.49%	1.94%	-	8.12%	3.03%
Small fishes	24.53%	0.06%	-	-	-	-	0.01%	-	6.14%	0.02%
Insects	18.93%	-	-	-	0.16%	-	-	-	4.77%	-
Nematods	0.88%	-	3.29%	-	-	0.21%	-	-	1.04%	0.05%
Crustaceans	1.02%	-	0.24%	0.05%	1.36%	-	1.48%	2.13%	1.02%	0.54%
Protozoa	0.75%	-	-	-	-	-	-	-	0.19%	-
Foraminifra	0.35	-	-	0.02%	0.19%	-	0.07%	0.95%	0.15%	0.24%
Rotifers	-	-	0.01%	-	-	-	-	-	-	-
Detritus	-	-	-	-	-	4.66%	-	-	-	1.16%
Sand granules	4.32%	2.35%	2.37%	7.37%	82.97%	45.01%	57.47%	37.17%	36.78%	22.98%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

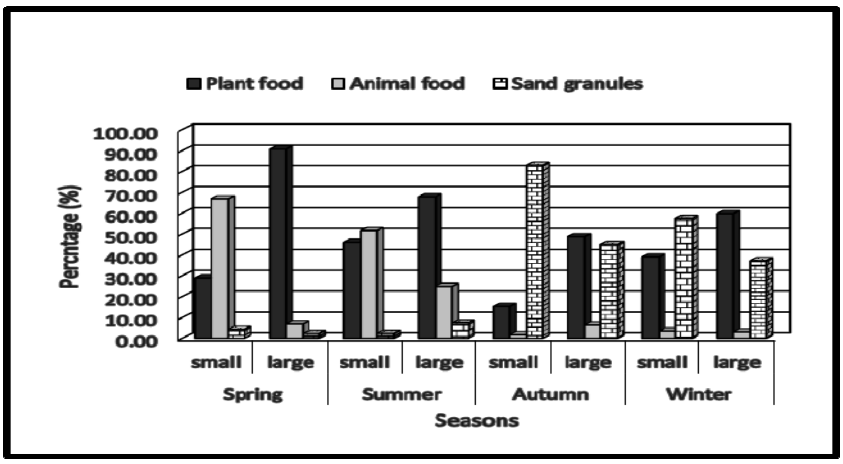

Fig. 6: Percentage occurrence of various categories of food items in the stomachs of *T. zillii* of different sized groups during the period from June, 2014 to May, 2015.

Plant tissues were the main food item consumed by small and large fish, being: 11.90% in younger fish and 45.68% in the older one. Diatoms consumed in large amount by small fish than the large one, being: 8.12% in the former and 2.99% in the latter. Green algae are consumed in large amounts by the older fish than the younger one being: 10.36% and 5.06%, respectively. Detritus (1.16%) are consumed only during autumn by the large group.

The relative abundance of animal food decreased with the increasing fish length, being: 30.91% in the small fish and 10.30% in the large one. Mollusca, Polychaeta and small fishes are consumed with large amount by small size (9.47%, 8.12%and 6.14%) than the large group (5.25%, 3.03% and 0.02%). Insects (4.77%) and protozoa (0.19%) are consumed only by the younger fish. On the other hand, the relative amount of sand granules decreases with the increasing of fish length, being: 36.78% in the younger fish and 22.98% in the older one. In general, the maximum amount of

plant food was recorded in the large sized group during spring (90.74%) and the minimum amount was recorded in the small one during autumn (15.32%). However, the animal food was peaked during spring in the small size (66.79%) and was declined gradually to reach the minimum value (1.72%) during autumn in the same size. The maximum value of sand granules was recorded during autumn in the small fish (82.96%).

From the above findings it can be concluded that, the fish is mainly omnivorous. Diet showed considerable variation in the different sized group during different seasons. The relative amount of plant food increases with the increasing length groups of the fish. However, the relative amount of animal food and sand granules decreases with the increasing length of this fish.

Seasonal variations in the feeding intensity:

The feeding intensity of *T. zillii* throughout the year round clearly indicated a moderate rate of feeding activity. The annual average value of fish whose stomachs devoid of any food content throughout the year were 34 which amounted to 29.84% of the total fish examined. Such percentage varied considerably from season to season**.** The highest value of empty stomachs was recorded during spring (54.17%). It decreased gradually during summer (43.33%) and reached its minimum values during winter (12.50%) and autumn (9.37%). The number of fish which have heavy, good and medium stomachs was 51 which amounted to 39.53% of the total fish examined. However, the percentage of fish which have poor stomachs was 30.63%. The intensity of feeding exhibited seasonal variations with highest rate of feeding activity during autumn and summer (53.13% and 46.67%, respectively). While, the fishes which have poor stomachs represented 37.50% and 10.00%, respectively of the total fish examined. During autumn and winter, however, the percentage of fishes which have heavy, good and medium stomachs represented 37.50% and 20.83%, respectively and the percentage of fishes which have poor stomachs represented 50.00% and 25.00%, respectively of the total fish examined (Table 6 and Fig. 7).

From the above findings it can be concluded that, the fish changed their feeding activity in the different seasons. The highest rate of feeding activity was recorded during autumn and summer and the lowest activity was observed during spring. The highest rate of feeding activity during summer and autumn might be due to effect of high temperature and availability of food items during these seasons.

Table 6: Seasonal variations in the feeding intensity of the cichlid fish, *Tilapia zillii*, of various sized groups, during the period from June, 2014 to May, 2015.

Sized groups / Feeding intensity	**Seasons**				
	Spring	**Summer**	**Autumn**	**Winter**	Average
	7.3-16cm	9.8-17.1cm	8.4-17.2cm	5.8-14.7cm	5.8-17.2cm
Heavy stomachs	4.17%	-	15.62%	-	4.95%
Good stomachs	8.33%	13.33%	3.13%	7.50%	8.07%
Medium stomachs	8.33%	33.34%	34.38%	30%	26.51%
Poor stomachs	25%	10%	37.50%	50%	30.63%
Empty stomachs	54.17%	43.33%	9.37%	12.50%	29.84%
Actively fed	**20.83%**	**46.67%**	**53.13%**	**37.50%**	**39.53%**
Non actively fed	**79.17%**	**53.33%**	**46.87%**	**62.50%**	**60.47%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**

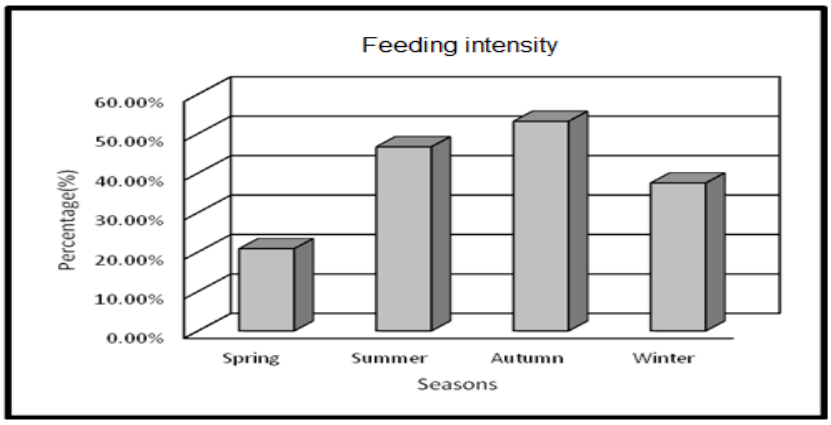

Fig. 7: Seasonal variations in the feeding intensity of *Tilapia zillii*, collected from Lake Qarun, during the period from June, 2014 to May, 2015.

Variations in the feeding intensity according to size:

Variations in the feeding intensity of the two sized groups in different seasons are given in Table (7) and graphically represented in Fig. (8).

The feeding intensity showed a considerable variation in different sized groups and also of different seasons within the same sized group. The annual average value of medium, good and heavy stomachs is relatively larger in the younger fish than in the older one; being 41.63% in the former and 25.60% in the latter.

Table 7: Feeding intensity of the different sized groups of the cichlid fish, *Tilapia zillii*, collected from Lake Qarun, during the period from June, 2014 to May, 2015.

Seasons	Spring		Summer		Autumn		Winter		Average	
Length in Cm / Feeding intensity	Small 7.3-13.9 Cm	Large 14-16 Cm	Small 9.8-13.9 Cm	Large 14-17.1 Cm	Small 8.4-13.9 Cm	Large 14-17.2 Cm	Small 5.8-13.9 Cm	Large 14-14.7 Cm	Small 5.8-13.9 Cm	Large 14-17.2 Cm
Heavy stomachs	5.56%	-	-	-	-	31.25%	-	-	1.39%	7.81%
Good stomachs	11.11%	-	5.88%	23.08%	-	6.25%	8.33%	-	6.33%	7.33%
Medium stomachs	11.11%	-	41.18%	23.08%	50.0%	18.75%	33.33%	-	33.91%	10.46%
Poor stomachs	16.66%	50%	5.88%	15.38%	37.5%	37.5%	44.45%	100%	26.12%	50.72%
Empty stomachs	55.56%	50%	47.06%	38.46%	12.5%	6.25%	13.89%	-	32.25%	23.68%
Actively fed	**27.78%**	**-**	**47.06%**	**46.16%**	**50.0%**	**56.25%**	**41.66%**	**-**	**41.63%**	**25.60%**
Non actively fed	**72.22%**	**100%**	**52.94%**	**53.84%**	**50.0%**	**43.75%**	**58.34%**	**100%**	**58.37%**	**74.40%**
Totals	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

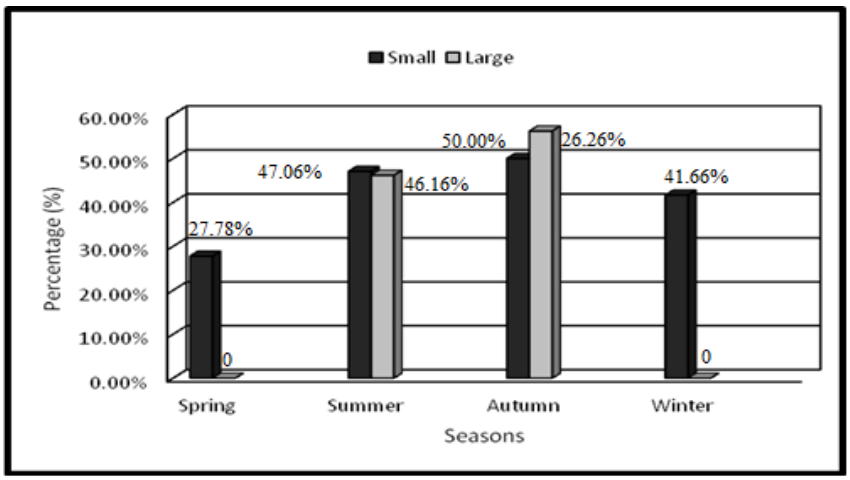

Fig. 8: Seasonal variations in the feeding intensity of *T. zillii* of different sized group, collected from Lake Qarun, during the period from June, 2014 to May, 2015.

The highest rate of feeding activity in the smaller fish was recorded during autumn (50.00%) and the lowest (27.78%) during spring. In the large sized group, however, the maximum value of feeding activity was recorded during autumn (56.25%), it decreased gradually to absence.

DISCUSSION

Lake Qarun constitutes a very important sector the Egyptian fisheries. The environmental factors considered here were surface water temperature, salinity ad hydrogen ion concentrations. Temperature plays an important role in the tolerance, performance, food consumption, growth, reproduction, survival rate, biological activities and distribution of aquatic organisms (Shehata *et al*., 1996 a & b; Khalaf-Allah, 2001 and Ghanem, 2006 & 2011). The changes of water temperature may depend on the variations in meteorological condition, time of sampling, air temperature, back radiation and latent heat of evaporation and seasons (Awad, 1993 and Mahmoud *et al*., 2008). Owing to the shallowness of the lake there is no thermal stratification. The lake seems to have warm shallow water, leading to attract the fish to live and survives. In addition to stimulation of diatoms development and other micro-organisms needed as the basic food supply for the fish (Zambriborch, 1949; El-Maghraby *et al*., 1974 and Khalaf-Allah, 2001). In the present study, the highest average value of surface water temperature was recorded at Village 8 during summer and the lowest occurred at Nema Island during winter. The present findings were nearly similar to that obtained by Elgaid (1980); Abdel-Monem (1991); Ahmed (1994); Khalaf-Allah (2001); Gaber *et al*. (2004); Abdel-Satar *et al*. (2010); Rabeh (2012) and Afifi (2015).

Salinity of Lake Qarun increased with the increasing in the evaporation rate, intrusion of drainage water and consumption of lake salts by EMISAL Company (Ghanem, 2006; Abdel-Satar*et al*., 2010 and Abou El-Gheit *et al.*, 2012). Result revealed that, the values of salinity were ranged between 29.17±3.52‰ during winter at Khak Village Station and 40.47±2.73‰ during autumn at Village 8 Station. Similar observation were nearly observed by Afifi (2015) differed with Sabae (1993); Khalaf–Allah (2001 & 2014); Abdel-Mageed (2005); Ghanem (2006 & 2011) whom reported the maximum value of salinity during summer and attributed That to the operation of EMISAL Company, closed condition of the Lake, shallowness of lake water and amount of drainage water.

The pH value of natural water affects on biological and chemical reactions, controls the solubility of metal ions and affects on natural aquatic life (Mahmoud *et al*., 2008). However, the consumption of dissolved oxygen by algae and phytoplankton leads to increasing of CO2 that leads to decreasing in pH values (AbouEl-Gheit *et al*., 2012). The present study indicated that, the highest values of hydrogen ion concentrations were recorded at Village 8 Station during summer (8.67±0.15) and autumn (8.76±0.02) and the lowest values were detected at Ezbet Abd El-Alim Station during spring (7.96±0.09) and winter (7.96±0.12). This observation was matching with Gaber *et al.* (2004); Abou El-Gheit *et al*. (2012) and Afifi (2015) and not matching with that obtained by Rabeh (2003); Rabeh & Fareed (2006) and Rabeh (2012) whom recorded that, the low values of hydrogen ion concentrations during summer; this may be due to the degradation of organic matter in the sediment.

In the wild aquatic life, there are wide diversity of microscopic organisms and macrophytes which fish species generally feed on (Toguyeni *et al*., 1997; Job & Udo

2002 and Olojo *et al*., 2003). *T. zillii* is considered euryhaline fish and can be survive in partially polluted waters which feeding on a diverse range of filamentous algae and plankton (Toguyeni *et al*., 1997 and Zyadah, 1999). Feeding intensity refers to the degree of feeding as indicated by the relative fullness of stomach. It varies along with the seasons, availability of preferred food items, maturity stage of the fish and spawning season of this species (Jaya and Saksena, 2013).

The present study exhibited that, fish changes their feeding activity with changes of seasons. The highest rate of feeding activity of *T. zillii* was recorded during autumn and the lowest during spring. Low feeding intensity in spring may be attributed to shortage of food items and the spawning season of the fish. Similar observations were recorded by different authors (Dewan & Saha (1979); Khalaf-Allah (2001); Arthi *et al*. (2011) and Jaya & Saksena, (2013).

According to sized group, *T. zillii* fed most activity during autumn and summer and less activity during winter and spring. The highest rate of feeding activity during summer and autumn might be due to the effect of high temperature and availability of food during these seasons. Feeding activity is relatively larger in the younger fish than in the older one. Similar observation was matching with Spataru (1978). who mentioned that, the reason for the abundance of this food items during the dry season could be autotrophic nature of the phytoplankton using light as their energy input for their growth. The results disagree with Shehata (1992 a, b & 1993 a, b, c, d and 1994); Shehata and Zaki (1994) and Khalaf Allah (2001 & 2009) whom reported that, the feeding activity increases with increase length group of the fish.

In the present study, the changes in feeding activity appear to be correlated with water temperature and the availability of food. The cichlid fish, *T. zillii* appeared to diurnal feeders as most of the fishes collected during the day were found to be more or less with empty stomachs. Similar observation was detected by Shehata (1992 a, b & 1993 a, b, c, d and 1994); Shehata and Zaki (1994) and Khalaf-Allah (2001).

Analysis of the stomach contents of *T. zillii* revealed that, the fish is mainly omnivorous and consumed a wide range of animal and plant foods. The major plant foods include plant tissue, algae and diatoms while, the major animal foods included Mollusca, Polychaeta, Insecta, Pisces, Nematoda, Crustacea, Protozoa, Foraminifera and Rotifera. Similar observations were detected by many authors notably; Abdel Backy (1997); Khalaf Allah (2001); Konsowa (2006); Oso *et al*., (2006) and Agbabiaka (2012) and differ with Martinez (2001) and Dadebo *et al*., (2014) whom indicated that, *T. zillii* was mainly herbivorous; feeding on a variety of plat food categories including macrophytes, detritus, phytoplankton, insects, zooplankton, nematodes and ostracods. |Results were in agreement with that obtained by Siddiqui (1977); Spataru (1978); Akinuwmi (2003) and Kariman & Nadhan (2009).

Result revealed that, examined the fish species change their feeding habits according to season. It seems that, this is mainly dependent on the relative abundance of different items of food in the habitat. Thus, the material in the gut of the fishes may be reflect the relative density of food items in the different seasons and the ability of the fish to consume the available items according to their needs. Similar observations were suggested by many authors notably; Shehata 1992 a, b and 1994); Abdel-Backy (1997); Khalaf-Allah (2009); Argyris (2005) and Oliveria *et al*. (2007).

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ARABIC SUMMERY

تأثير بعض العوامل البيئية على عادات الغذاء والتغذية لأسماك البلطي، تيلابيا زيللي القاطنة لبحيرة قارون، مصر

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شعبة علوم البحار والاسماك - قسم علم الحيوان - كلية العلوم جامعة الازهر

يهدف هذا البحث إلى دراسة تأثير العوامل البيئية (درجة الحرارة والملوحة والأس الهيدروجيني) على عادات الغذاء والتغذية لسمكة البلطي الأخضر المجمعه موسميا من بحيرة قارون خلال الفترة من يونيو ٢٠١٤ إلى يوليو ٢٠١٥. تم تجميع ١٢٦ عينة من أسماك البلطي خلال فترة الدراسة.

أظهرت النتائج أن أعلى قيمة لدرجة حرارة مياه البحيرة في محطة قرية ٨ خلال موسم الصيف (٣٢.٦٧ ± ٢.٣١ درجة مئوية) وأدنى قيمه (١٦.٩٣ ± ١.٧٩ درجة مئوية) في محطة جزيرة نعمه خلال موسم الشتاء. كما سجلت القيم القصوى لملوحة المياه في محطة قرية ٨ خلال موسمى الصيف (٤٠.١٠ ± ٣.٤٦ ٪) والخريف (٤٠.٤٧ ± ٢.٧٣ ٪) وتمت ملاحظة اقل قيمة لها (٢٩.١٧ ± ٣.٥٢ ٪) في محطة قرية كحك خلال موسم الشتاء. تم تسجيل أعلى قيم لتركيز أيون الهيدروجين في محطة قرية ٨ خلال موسمى الصيف (٨.٦٧ ± ٠.١٥) والخريف (٨.٧٦ ± ٠.٠٢) وأدنى قيمه له في محطة عزبة عبد العليم خلال موسمى الربيع (٧.٩٦ ± ٠.٠٩) والشتاء (٧.٩٦ ± ٠.١٢). كما اوضحت الدراسة ان القيم العليا لنشاط التغذية خلال موسمى الخريف والصيف، وتم ملاحظة الحد الأدنى من النشاط خلال فصل الربيع. كما ازداد نشاط التغذية نسبيا في الأسماك صغيرة الحجم (٤١.٦٣٪) عن الاسماك كبيرة الحجم (٢٥.٦٠٪). وأظهرت النتائج أن أسماك البلطي خليطية التغذية وتستهلك كمية كبيرة من الغذاء الحيواني والنباتي. وبفحص محتوي المعده لتلك الأسماك تبين أن المحتوي الغذاء النباتي يتكون من الأنسجة النباتية والطحالب والدياتومات بينما أحتوي الغذاء الحيواني علي الرخويات، عديدة الاشواك، الحشرات، وبقايا الاسماك، النيماتودا والقشريات، البروتوزوا، فورامينيفيرا والروتيفيرا. وبينت الدراسة أن المحتوي النسبي للأغذية النباتية يزداد مع زيادة طول أسماك البلطي بينما انخفض المحتوي الحيواني والحبيبات الرملية مع زيادة طول تلك الأسماك.