



Some biological aspects of *Oreochromis niloticus* and *Oreochromis aureus* caught by trammel nets from El-Salam Canal, Egypt

El-Azab E. Badr El-Bokhty* and Mohamed A. Fetouh
National Institute of Oceanography and Fisheries (NIOF), Egypt
*Corresponding Author: elbokhty@yahoo.com

ARTICLE INFO

Article History:

Received: Nov. 18, 2022

Accepted: Dec. 16, 2022

Online: Feb.5, 2023

Keywords:

El-Salam Canal,
Trammel nets,
Condition factor,
Oreochromis niloticus,
Oreochromis aureus

ABSTRACT

This preliminary study is the first concerning length-weight, condition factor, relative condition factor and length-girth relationships of two tilapia fish (*Oreochromis niloticus* and *Oreochromis aureus*) caught by trammel nets from El-Salam Canal. The results of the length-weight relationship showed slightly negative asymmetric growth for both species. The average condition factor (K) was 1.70 (± 0.12), and 1.72 (± 0.14) for *O. niloticus* and *O. aureus*, respectively. The relative condition factor (K_n) averaged 1.00 (± 0.05) for *O. niloticus* and 1.01 (± 0.04) for *O. aureus*. These values suggested a good condition for these two species. The values of exponent (b) of length-girth relationships ranged from 0.722 for *O. aureus* to 0.823 for *O. niloticus*. These results may be helpful for the fishery and biological management of the two species.

INTRODUCTION

El-Salam Canal (**Fig. 1**) is one of the major agricultural land reclamation projects in Egypt, which aims to develop the Sinai lands. It brings the Nile water to the deserts of north Sinai; originating from the River Nile at 210 km on Damietta branch and running south east ca. 89.4 km. Then, it crosses the Suez Canal through a siphon to the peninsula extending 175 km eastward in North Sinai having a mixture of drainage water and the Nile water (1:1 ratio) (**Othman et al., 2012**).

Trammel nets are one of the most widely used gears in traditional fisheries in Egypt. They are similar to those used in Lake Manzala and for a detailed technical feature of trammels; it's referred to **El-Bokhty (2017)**. Because of the nature of its construction, a trammel net is able to catch both small sized and big sized fish, so the catching efficiency is relatively higher than gillnets (**Koike & Matuda, 1988**).

Length-weight relationship studies of any fish species is a pre requisite for the study of its population (**Le Cren, 1951**). It gives information on stock composition, size increment, growth patterns and wellbeing of the fish (**Fafioye & Oluajo, 2005**). This relationship is a useful tool in fishery assessment that helps in predicting weight required in yield assessment from length (**Garcia et al., 1998**) and when comparing life history and morphology of fish population belonging to different regions, as well as studying ontogenetic allometric changes in fish species (**Hossain, 2010**). According to (**Pauly, 1984**), it was also possible to stabilize taxonomic characteristics of a species by mere dependence on length-weight relationships.

The condition factor (K) of a fish reflects physical and biological circumstances and fluctuations by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren, 1951). It also indicates the changes in food reserves and therefore an indicator of the general fish condition. D'Ancona (1936) pointed out that, the coefficient of condition varies with the state of gonadal maturity, months, and season and possibly with age.

The relative condition factor (K_n) is an important additional biometric tool derived from LWRs (Le Cren, 1951). The relative condition factor measures the deviation of an organism from the mean weight in a given sample in order to assess the suitability of a given aquatic environment for fish growth (Yilmaz *et al.*, 2012; Mensah, 2015). General fitness for fish species is assumed when K_n values are equal to or close to 1.

Fish body length and girth length are related to biological parameters such as condition and swimming capability. The body length and girth parameters determine whether a gape-limited predator can ingest a special fish, thus explaining predator–prey relationships and the ecological position of fishes within the food webs in which they are implanted (Hambright, 1991; Pauly, 2000; Stergiou & Karpouzi, 2003).

Data of length–girth, along with other biological parameters (such as fish behavior) and technical aspects (such as fishing techniques, gear construction and dimensions) determine the size selectivity of nets.

Some scientists have been interested in studying the fish of the cichlid family, especially the *O. niloticus* and *O. aureus* fish in Egypt (Bayoumi & Khalil, 1988; Abdel-baky & El-Serafy, 1990; Shalloof, 1991; Bakhom, 1994; Mekrawy *et al.*, 1994; Soliman *et al.*, 1998; Abdalla & Talaat, 2000; Bakhom & Abdallah, 2002; Khallaf *et al.*, 2003; Moussa, 2003; Mehanna, 2004 & 2005; El-Bokhty, 2006; Ibrahim *et al.*, 2008; Mahmoud & Mazrouh, 2008; Authman *et al.*, 2009; Shalloof & El-Far, 2009; Hassan & El-Kasheif, 2013; Mahmoud *et al.*, 2013; Saeed, 2013; El-Bokhty & El-Far, 2014 a&b), Shalloof & El-Far, 2017; Khallaf *et al.*, 2019 and Mehanna *et al.*, 2020).

The current investigation is the first study regarding the length–weight relationships, condition factor, relative condition factor, and body length–girth relationships of *Oreochromis niloticus* and *Oreochromis aureus*. It aimed to evaluate the biological status and fitness of these species caught by trammel net from El-Salam Canal.

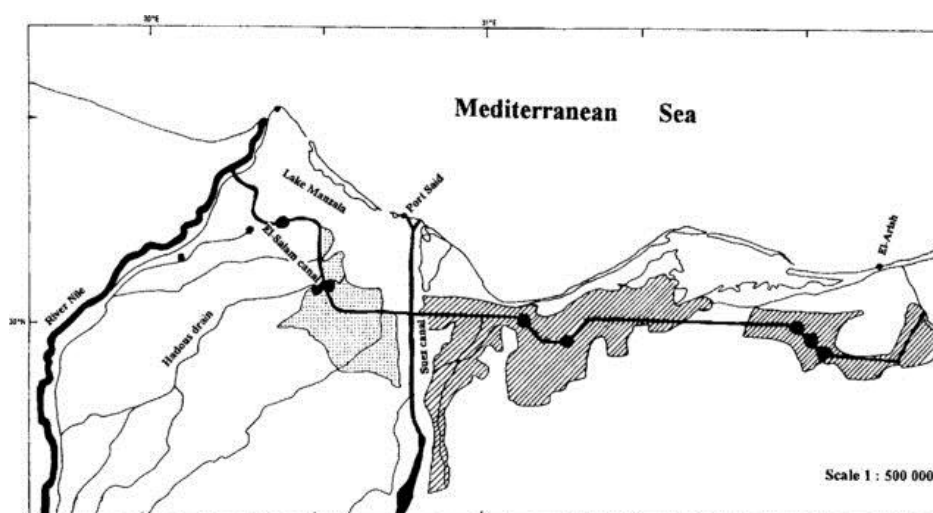


Fig. (1). Map showing El-Salam Canal (ca. 88 km between Damietta branch of the Nile and the Suez Canal) (after Serag & Khedr, 2001)

MATERIALS AND METHODS

Fish samples were collected during autumn 2018 from commercial trammel nets used in El-Salam Canal. Fish were separated to the different species and for each fish; the following measurements were recorded. The length of fish was measured with millimeter scale to the nearest millimeter and body weights were measured using mono-pan balance to the nearest gram and girth was measured in front of the first dorsal fin .

The length weight relationship of fish is usually expressed according to **Le-Cren (1951)** by the equation:

$$W = a L^b$$

Where (W) is fish body weight (g), (L) is total fish length (cm), A logarithmic transformation was used to make the relationship linear as:

$$\text{Log (W)} = \text{Log (a)} + b \text{Log (L)}.$$

The (a) is representing the intercept and (b) is the slope of the relationship. The coefficient of determination (R^2) is an indicator of the quality of this regression. The value of (b) provides information on the fish growth type (isometric or allometric). The relationship was tested for significance by using Minitab 18 software.

The condition factor (K) was calculated by **Fulton's (1902)**.

$$K = 100W/L^3$$

Where W is fish body weight (gm), (L) is total fish length (cm). Relative condition factor (K_n) calculated according to **Le Cren (1951)**.

$$K_n = W_o/W_c$$

Where (W_o) is the observed weight, and (W_c) is the calculated weight. Good growth condition of the fish is deduced when $K_n \geq 1$, while the organism is in poor growth condition compared to an average individual with the same length when $K_n < 1$.

For most species, the relationship between girth and length is of the linear form

$$G = a + bL \quad (\text{Santos et al., 2006}),$$

Where (G) is the observed girth, (L) is the observed length, and (a) and (b) are coefficients determined by regression.

The relationships in the present work were tested for significance by using Minitab 18 software.

RESULTS AND DISCUSSION

In the present work the length of *O. niloticus* specimens ranged between 11.3 and 21.5 cm but those of *O. aureus* were ranged from 9.8 to 18.5 cm. The weights of *O. niloticus* ranged from 24 to 165 g. while the *O. aureus* weight ranged from 18 to 93 g. Fish are said to exhibit isometric growth when length increases in equal proportions with body weight for constant specific gravity. The regression co-efficient for isometric growth is '3' and values greater or lesser than '3' indicate allometric growth (**Gayaniilo & Pauly, 1997**).

The logarithmic transformation of the length weight relationship of *O. niloticus* and *O. aureus* gave a straight line (**Fig. 2**). The value of (b) is 2.793 and 2.686 for *O. niloticus*

and *O. aureus* respectively. Length-weight relationships were highly significant at $p < 0.05$ and showed that about 97 % ($R^2=96.9$) of *O. niloticus* and for *O. aureus* was 94 % ($R^2=94.3$) variation in total weight of the fish can be explained by the following linear regression model;

$$\log_{10}(W) = -1.519 + 2.793 \log_{10}(L) \quad \text{for } O. \textit{niloticus}$$

$$\log_{10}(W) = -1.417 + 2.686 \log_{10}(L) \quad \text{for } O. \textit{aureus}$$

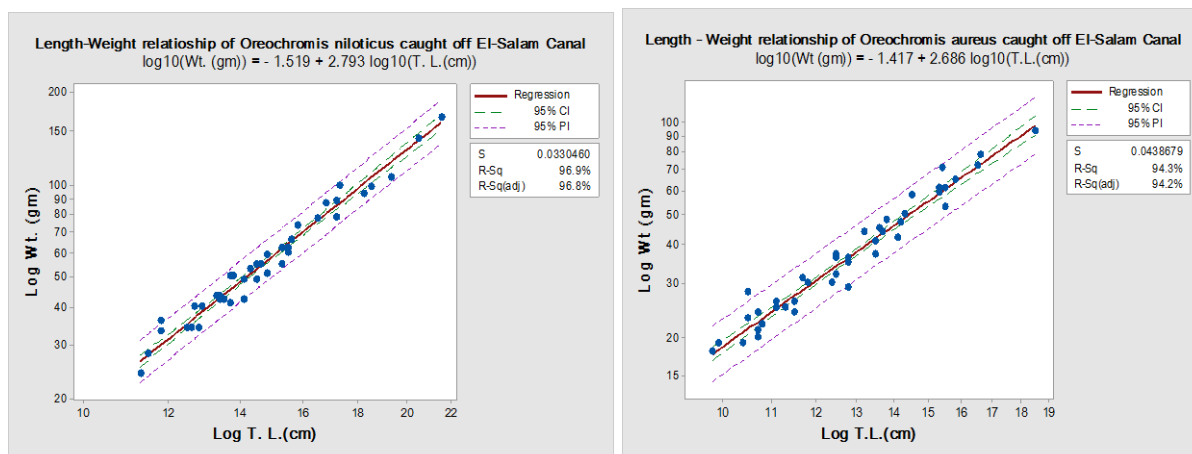


Fig (2). The relationships between weight and length of *O. niloticus* and *O. aureus* caught by trammel net from El-Salam Canal

According to **Ricker (1975)** the growth, of *O. niloticus* and *O. aureus* caught by trammel net from El-Salam Canal during 2018 were slightly negative asymmetric. More early, **Frost (1945)** explained that the changes in the fish shape, physiological changes hydrological environmental conditions, different food availability during life and biological span, growth increment or break in growth can all affect the growth exponent (b). The differences in b -values can also be attributed to the combination of one or more of the following factors: (a) differences in the number of specimen examined (b) area/season effect and (c) differences in the observed length ranges of the specimen caught (**Moutopoulos & Stergiou, 2002**).

Fulton's coefficient of condition (K) is another factor showing the mathematical relation between length and weight of a fish. It shows the degree of robustness or wellbeing of fish, and its value may change according to age, length, weight, sex, state of maturity.... etc.

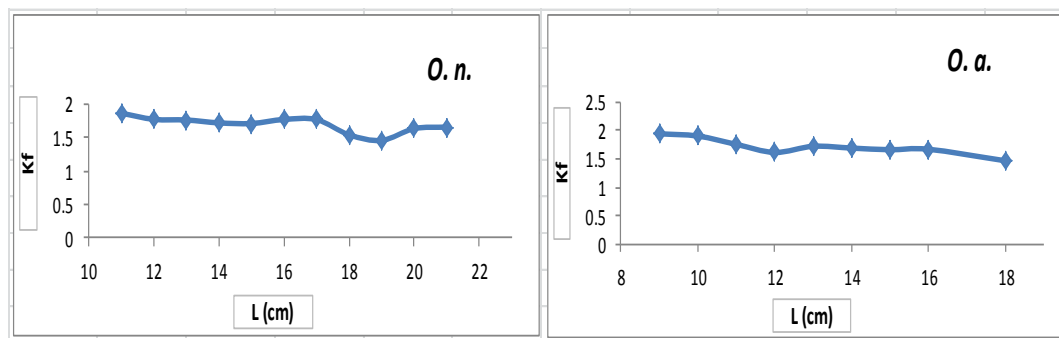
Concerning Fulton's condition factor (K), it ranged from 1.46 to 1.87 with an average of 1.70 (± 0.12) for *O. niloticus*. While for *O. aureus*, it ranged between 1.47 and 1.94 with an average of 1.72 (± 0.14) (**Table 1** and **Fig. 3**).

Table (1): The condition factor (K) and relative condition factor (K_n) of *O. niloticus* and *O. aureus* caught by trammel net from El-Salam Canal

L	<i>O. niloticus</i>		<i>O. aureus</i>	
	k	K_n	k	K_n
9	--	--	1.94	1.04
10	--	--	1.90	1.04
11	1.87	1.02	1.76	0.99
12	1.78	0.99	1.62	0.94
13	1.77	1.00	1.72	1.02
14	1.72	0.99	1.69	1.02
15	1.71	1.00	1.66	1.03
16	1.77	1.05	1.67	1.05
17	1.77	1.06	--	--
18	1.55	0.93	1.47	0.96
19	1.46	0.89	--	--
20	1.64	1.01	--	--
21	1.66	1.04	--	--
Average	1.70	1.00	1.72	1.01
± SD	0.12	0.05	0.14	0.04

The deviation of the relative condition factor (K_n) from 1 provides information regarding differences in food availability and the consequences of physical and chemical traits on the life cycle of fish species (Le Cren, 1951). According to length group (K_n) values of *O. niloticus* in the current study fluctuated between 0.89 and 1.06 with an average 1.00 (± 0.05) and the corresponding values of *O. aureus* ranged between 0.94 and 1.05 with an average 1.01 (± 0.04) (Table, 1 and Fig. 4). Many factors influence the growth status of fish such as reproductive cycles, food availability, as well as environmental and habitat factors (Morato *et al.*, 2001).

Although no study was carried out on the physical and chemical parameter to confirm this, Bagenal & Tesch (1978) reported that if the condition factor “k” ≥ 0.5 , the fish is in a good condition. Therefore, the results suggest a good condition for the two species.

**Fig. (3):** Condition factors (K) of *O. niloticus* and *O. aureus* caught by trammel net from El-Salam Canal

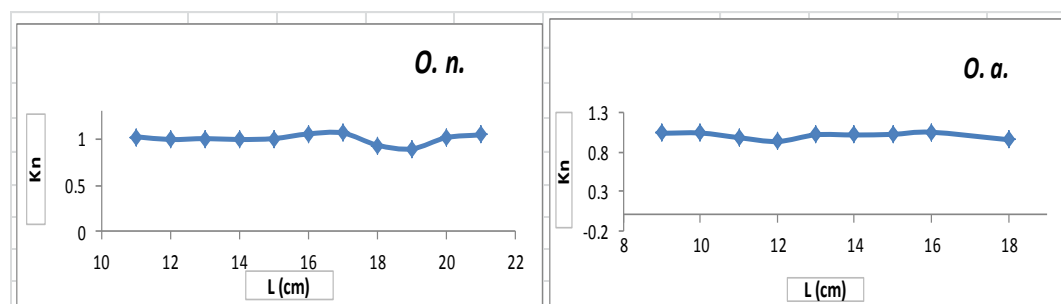


Fig. (4): Condition factors (K_n) of *O. niloticus* and *O. aureus* caught by trammel net from El-Salam Canal

Several studies have been carried out on the relationship between length and weight, condition factors, and relative condition factors of *O. niloticus* and *O. aureus* in Egyptian waters. Manzala Lake (Bayoumi & Khalil, 1988; Abdel-baky & El-serafy, 1990; Shalloof, 1991; Soliman *et al.*, 1998; Bakhoun & Abdallah, 2002; El-Bokhty, 2006 and Mehanna *et al.*, 2020); Burullus Lake (Moussa, 2003); Mariut Lake (Bakhoun, 1994); Nasser Lake (Mekkawy *et al.*, 1994); River Nile (Khallaf *et al.*, 2003; Mahmoud & Mazrouh, 2008; Authman *et al.*, 2009; Hassan & El-Kasheif, 2013; El-Bokhty & El-Far, 2014 b; Shalloof & El-Far, 2017 and Khallaf *et al.*, 2019); Nozha Hydrodom (Mahmoud *et al.*, 2013); Lake Edku (Abdalla & Talaat, 2000 and Saeed, 2013); Abu-Zabal Lakes (Ibrahim *et al.*, 2008 and Shalloof & El-Far, 2009) and Wadi El-Raiyan Lakes (Mehanna 2004 & 2005). Table (2) showed different results from previous studies on *O. niloticus* and *O. aureus* in different places in Egypt.

Fish body girth can be calculated via three producers: (i) across the vertical eye diameter (G_1), (ii) behind the gill-cover (G_2) and (iii) in front of the first dorsal fin (G_3). These girth types determine the probability of different ways of capture by a fishing gear, assessed by G_1 when fish are tangled, by G_2 when fish are gilled and by G_3 when fish are wedged (Reis & Pawson, 1999; Stergiou & Karpouzi, 2003). The results of the present work indicated that, the length-girth relationships of the selected species in this investigation are particularly useful for trammel net fisheries management in El-Salam Canal.

Table (2): Comparison of length-weight relationships regression parameters (a and b), condition factor (K), and relative condition factor (K_n) of *O. niloticus* and *O. aureus* from different locations in Egypt.

Location	Region	Species	a	b	Kf	Kn	Author	
El-Salam Canal		<i>O. niloticus</i>	-1.519	2.793	1.7	1	Present study	
		<i>O. aureus</i>	-1.417	2.686	1.72	1.01		
Lake Manzala		<i>O. niloticus</i>	0.0143	3.08			Mehanna <i>et al.</i> , 2020	
		<i>O. aureus</i>	0.01745	3.0104			El-Bokhty, 2006	
		<i>O. niloticus</i>	0.01332	3.0939			Bakhoum and Abdallah, 2002	
		<i>O. aureus</i>	-1.1537	2.748	1.628			
	Southwest(A)	<i>O. niloticus</i>	-1.6910	2.8715	1.467		Bakhoum and Abdallah, 2002	
		<i>O. aureus</i>	-1.7765	2.953	1.321			
	Southeast (B)	<i>O. niloticus</i>	-2.0475	3.199	1.45		Bakhoum and Abdallah, 2002	
		<i>O. aureus</i>	-2.0475	3.199	1.45			
			<i>O. niloticus</i>	0.0424	2.704		1.01	Soliman <i>et al.</i> , 1998
			<i>O. aureus</i>	0.0567	2.561		1.009	
			<i>O. niloticus</i>	-1.68	2.98	1.96		Bayoumi and Khalil, 1988
			<i>O. aureus</i>	-1.63	2.9	1.93		
		<i>O. niloticus</i>	-1.82	3.0282		0.98	Abdel-baky and El-Serafy, 1990	
		<i>O. aureus</i>	-1.82	3.0282		0.98		
Lake Burullus	Eastern	<i>O. niloticus</i>	0.0163	2.8944	1.2		Moussa, 2003	
		<i>O. aureus</i>	0.0179	2.9036	1.39			
	Middle	<i>O. niloticus</i>	0.0139	3.0042	1.42			
		<i>O. aureus</i>	0.0164	2.9471	1.41			
	Western	<i>O. niloticus</i>	0.0091	3.294	2.06			
		<i>O. aureus</i>	0.0153	2.9864	1.53			
Lake Mariut	Southeast basin	<i>O. niloticus</i>	-1.71	2.932	1.643		Bakhoum, 1994	
		<i>O. aureus</i>	-1.4289	2.6258	1.498			
	Lake proper	<i>O. niloticus</i>	-1.196	3.138	1.551			
		<i>O. aureus</i>	-1.7419	2.8514	1.262			
Lake Edku		<i>O. niloticus</i>	0.017	3.033			Abdalla and Talaat, 2000	
		<i>O. aureus</i>	0.0326	2.753			Saeed, 2013	
		<i>O. niloticus</i>	-1.5217	2.9	1.72			
		<i>O. aureus</i>	-1.3935	2.76	1.53			
Wadi El-Raiyan Lakes	1st lake	<i>O. niloticus</i>	0.021	2.982			Mehanna, 2005	
	2nd lake	<i>O. niloticus</i>	0.016	3.077			Mehanna, 2004	
		<i>O. aureus</i>	0.0122	3.109				
River Nile	Bahr Shebeen	<i>O. niloticus</i>	0.0427	2.77	2.07		Khallaf <i>et al.</i> , 2003	
	Nile Canal		0.0214	3.1971			Khallaf <i>et al.</i> , 2019	
	Beni Suef	<i>O. niloticus</i>	0.0377	2.792	1.03 to 1.9	0.99 to 1.93	Hassan and El-Kasheif, 2013	
		<i>O. aureus</i>	0.02397	2.922			El-Bokhty and El-Far, 2014b	
	Rosetta Branch	<i>O. niloticus</i>	0.018	3.008	1.84		Mahmoud and Mazrouh, 2008	
		<i>O. aureus</i>	0.025	2.872	1.79			
	Damietta Branch	<i>O. niloticus</i>	0.028	3.075			Authman <i>et al.</i> , 2009	
		<i>O. niloticus</i>	0.018	3.017	1.919		Shalloof and El- Far, 2017	
<i>O. aureus</i>		0.081	2.42	1.759				
Nozha Hydrodom		<i>O. niloticus</i>	0.027	2.909	2.05		Mahmoud <i>et al.</i> , 2013	
		<i>O. aureus</i>	0.022	2.973	1.96			
Abu- Zabal		<i>O. niloticus</i>	0.089	2.403	1.71		Shalloof and El- Far, 2009	
		<i>O. aureus</i>	0.179	2.108	1.66			
		<i>O. niloticus</i>	0.028	2.859	1.86		Ibrahim <i>et al.</i> , 2008	
		<i>O. aureus</i>	0.044	2.67	1.89			

Length-girth relationships (**Fig. 5**) are important because they allow the estimation of girth from length measurements, which are easier to obtain and are more readily available. These relationships, in conjunction with existing length data, can be important tools in the management of trammel net fisheries. The exponent (b) ranged from 0.722 ($R_{sq}= 78.7\%$) for *O. aureus* to 0.823 ($R_{sq}= 91.7\%$) for *O. niloticus*. the length- girth relationships were found to be as the following:

$$G = -0.5129 + 0.8228 L \quad \text{for } O. niloticus$$

$$G = 0.4396 + 0.7222 L \quad \text{for } O. aureus$$

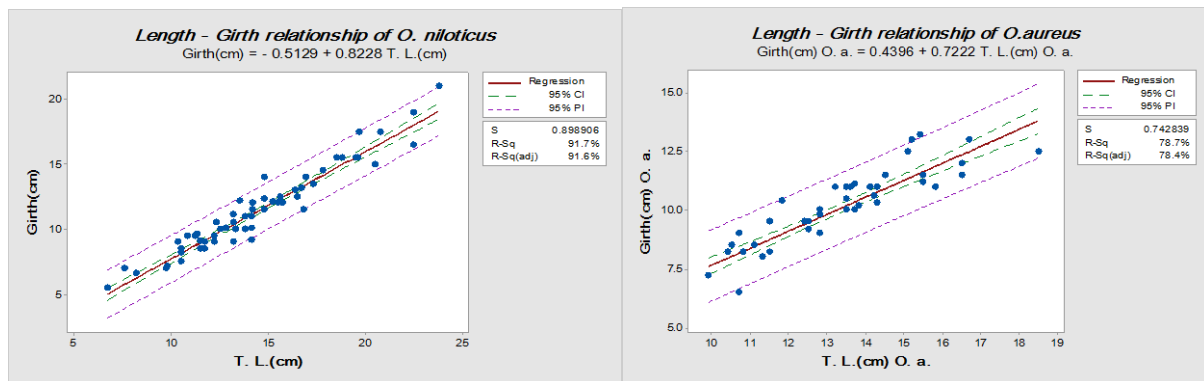


Fig (5): The length- girth relationship of *O. niloticus* and *O. aureus*, caught by trammel net from El-Salam Canal during 2018.

CONCLUSION

The growth pattern of *O. niloticus* and *O. aureus* caught by trammel net from El-Salam Canal during 2018 was slightly negative asymmetric. The two species have a good growth condition. The length-girth relationships of the selected species in this investigation are particularly useful for trammel net fisheries management in El-Salam Canal. More investigations are needed to study the effect of water mixing between Nile water and agricultural drains on these fish traits.

REFERENCES

- Abd El-Baky, T.E. and El-Serafy, S.S. (1990).** Length weight relationship and relative condition factor of three species of cichlid fishes inhabiting Lake Manzalah, Egypt. Bull. Inst. Oceanogr. Fish., **16**(1): 147 - 169.
- Abd-Alla, A. and Talaat, K.M. (2000).** Growth and dynamics of tilapias in Edku Lake, Egypt. Bulletin of Institute of Oceanography and Fisheries, A.R.E., **26**: 183-196.
- Authman, M.M.; El-Kasheif, M.A. and Shalloof, K.A. (2009).** Evaluation and management of the fisheries of Tilapia species in Damietta Branch of the River Nile, Egypt. World J. Fish. Mar. Sci., **1**(3): 167-184.
- Bagenal, T.B. and Tesch, A.T. (1978).** Conditions and Growth Patterns in Fresh Water Habitats. Blackwell Scientific Publications, Oxford.
- Bakhom, S.A. (1994).** Comparative study on length-weight relationship and condition factor of genus *Oreochromis* in polluted and non-polluted parts of Lake Mariut, Egypt. Bull. Inst. Oceanogr. Fish., **20**(1): 201 - 210.
- Bakhom, S.A. and Abdallah, M. (2002).** Study to detect impacts of pollution on fishery biology of tilapias in Lake Manzalah, Egypt. J. of King Abdul-Aziz Univ. for Mar. Sci., **13**: 147-160.

- Bayoumi, A.R. and Khalil, M.T. (1988).** Tilapia fisheries in lake Manzalah, Egypt. Bull. Inst. Oceanogr. Fish., **14** (3): 87-99 .
- D'Ancona, M.V. (1936).** La Crossance chez les animaux de la Mediterranee Rpp. Comm. Int. Mer. Med. **10**.
- El-Bokhty, E.E.B. (2006).** Assessment of family Cichlidae inhabiting Lake Manzala, Egypt. Egyptian Journal of Aquatic Biology & Fisheries, **10**: 85-106.
- El-Bokhty, E.E.B. (2017).** Technical and design characteristics of trammel nets used in Lake Manzalah, Egypt. Egyptian Journal of Aquatic Biology & Fisheries, **21**(3): 1-10.
- El-Bokhty, E.E.B. and El-Far, A. (2014 a).** Evaluation of *Oreochromis niloticus* and *Tilapia zillii* fisheries at Aswan region, River Nile, Egypt. Egyptian Journal of Aquatic Biology and Fisheries, **18**(3): 79 - 89.
- El-Bokhty, E.E.B. and El-Far, A. (2014 b).** Some fishery aspects of Nile tilapia, *Oreochromis niloticus* at Rosetta branch of the Nile River, Egypt. Egyptian Journal of Aquatic Biology and Fisheries, **18**(3): 41-51.
- Fafioye, O.O. and Oluajo, O.A. (2005).** Length-weight relationship of five fish species in Epe Lagoon, Nigeria. African Journal of Biotechnology, **4**(7): 749-751.
- Frost, W.E. (1945).** The age and growth of eels (*Anguilla anguilla*) from the Windermere catchment area. Part 2. J. Anim. Ecol., **14**: 106-124.
- Fulton, T.W. (1902).** The rate of growth of fishes. 20th Annual Report of the Fishery Board of Scotland, **1902**(3): 326-446.
- Garcia, C.B.; Duarte, J.O.; Sandoral, N.; Von Schiller, D.; Melo, G. and Navajan, P. (1998).** Length-weight relationship of demersal fishes from the Gulf of Salamanca, Columbia Naga. ICLARM Quaterly, **16**: 30-32.
- Gayanilo, F.C. and Pauly, D. (1997).** FAO ICLARM stock assessment tools (FISAT): References manual, FAO Computerized information series (Fisheries), **8**: 262.
- Hambright, D.K. (1991).** Experimental analysis of prey selection by largemouth bass: role of predator mouth width and prey body depth. Trans. Am. Fish Soc., **120**: 500–508.
- Hassan, A. and El-Kasheif, M. (2013).** Age, growth and mortality of the cichlid fish *Oreochromis niloticus* (L.) from the River Nile at Beni Suef Governorate, Egypt. Egyptian Journal of Aquatic Biology and Fisheries, **17**(4): 1-12.
- Hossain, M.Y. (2010).** Morphometric relationships of length-weight and length-length of four Cyprinid small indigenous fish species from the Padma River (NW Bangladesh). Turkish Journal Fisheries Aquatic Science, **10**: 131-134.
- Ibrahim, S.M.; Shalloof, K.A. and Salama, H.M. (2008).** Effect of environmental conditions of Abu-Zabal Lake on some biological, histological and quality aspects of fish. Global Veterinaria, **2**(5): 257-270.
- Khallaf, E.A.; Alne-na-ei, A.A.; El-Garawani, I.M. and Elgendy, R.G. (2019).** A study on growth, mortality and a biochemical growth indicator of *Oreochromis niloticus* in a Nile Canal, Egypt. Egyptian Journal of Aquatic Biology and Fisheries, **23**(2): 639-656.

- Khallaf, E.A.; Galal, M. and Athuman, M. (2003).** The biology of *Oreochromis niloticus* in a Polluted Canal. *Ecotoxicology*, **12**(5): 405-416.
- Koike, M. and Matuda, K. (1988).** Catching efficiency of a trammel net with different vertical slackness and mesh size of inner net. *Proceeding World Symposium on Fishing Gear and Fishing Vessel Design*, Marine Institute, St. John's Newfoundland, Canada: 468-472
- Le Cren, E.D. (1951).** The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *Journal of Animal Ecology*, **20**(2): 201-219.
- Mahmoud, H.H. and Mazrouh, M.M. (2008).** Biology and fisheries management of Tilapia species in Rosetta branch of the Nile River, Egypt. *Egyptian Journal of Aquatic Research*, **30**: 272-285.
- Mahmoud, H.H.; Ezzat, A.A.; Ali, T.E. and El-Samman, A. (2013).** Fisheries management of cichlid fishes in Nozha Hydrodrome, Alexandria, Egypt. *Egypt. J. of Aquat. Res.*, **39**: 283-289.
- Mehanna, S.F. (2004).** Population dynamics of two cichlid, *Oreochromis aureus* and *Tilapia zillii* from Wadi El- Raiyan lakes, Egypt. *Agri. & Mar.Sci.*, **9**(1): 9- 16.
- Mehanna, S.F. (2005).** Population dynamics and management of the Nile tilapia *Oreochromis niloticus* at Wadi El-Raiyan Lakes, Egypt. *African Journal of Biological Sciences* 1: 79-88.
- Mehanna, S.F.; Desouky, M.G. and Makky, A.F. (2020).** Growth, mortality, recruitment and fishery regulation of the Nile Tilapia, *Oreochromis niloticus* (Teleostei: Cichlidae) from Manzala Lake, Egypt. *Iranian Journal of Ichthyology*, **7**(2): 158-166.
- Mekkawy, I. A.; Mohamad, S.H.; Abass, F.F. and Okasha, S.A. (1994).** Some biological aspects of *Oreochromis niloticus* (Linnaeus, 1758) from Lake Nasser, Egypt and the effect of Lake Impoundment. *Bull. Fac. Sci., Assiut Univ.*, **23**(2- E): 101-142.
- Mensah, S.A. (2015).** Weight-length models and relative condition factors of nine freshwater fish species from the Yapei Stretch of the White Volta, Ghana. *Elixir. Appl. Zool.*, **79**: 30427–30431.
- Morato, T.; Afonso, P.; Loirinho, P.; Barreiros, J.P.; Sanstos, R.S. and Nash, R.D.M. (2001).** Length-weight relationships for 21 costal fish species of the Azores, Northeastern Atlantic. *Fish Res.*, **50**: 297–302.
- Moussa, S. (2003).** Impact of inorganic pollutants on aquatic environment and fish performance in Lake Borollus. Ph. D., Inst. Env. Stud. & Res., Ain Shams University, 210 pp.
- Moutopoulos, D.K. and Stergiou, K.I. (2002).** Length–weight and length–length relationships of fish species from the Aegean Sea (Greece). *Journal of Applied Ichthyology*, **18**(3): 200-203.
- Othman, A.A.; Rabeh, S.A.; Fayez, M.; Monib, M. and Hegazi, N.A. (2012).** El-Salam canal is a potential project reusing the Nile Delta drainage water for Sinai desert

- agriculture: Microbial and chemical water quality. *Journal of Advanced Research*, **3**(2): 99-108.
- Pauly D. (1984).** Fish population dynamics in tropical waters: a manual for use with program calculators. ICLARM Studies and Revision, **8**: 1-325.
- Pauly, D. (2000).** Predator–prey ratios in fishes. In: Froese, R., Pauly, D. (Eds.), *Fishbase 2000: Concepts, Design and Data Sources*. ICLARM, Manila.
- Reis, E.G. and Pawson, M.G. (1999).** Fish morphology and estimating selectivity by gillnets. *Fish Res.*, **39**: 263–273.
- Ricker, W.E. (1975):** Computation and interpretation of biological statistics of fish populations. *Bull. Fish. Res. Board Can.*, **191**: 1–382.
- Saeed, S. (2013).** Impact of environmental parameters on fish condition and quality in Lake Edku, Egypt. *Egyptian Journal of Aquatic Biology and Fisheries*, **17**(1): 101-112.
- Santos, M.N.A.; Canas, P.G.L. and Monterio, C.C. (2006).** Length-girth relationships for 30 marine species. *Fish. Res.*, **78**: 368-373.
- Serag, M.S. and Khedr, A.H.A. (2001).** Vegetation–environment relationships along El-Salam Canal, Egypt. *Environmetrics: The official journal of the International Environmetrics Society*, **12**(3): 219-232.
- Shalloof, K.A. (1991).** Biological studies on Tilapia species in the middle region of Lake Manzala. M.Sc. Thesis, Faculty of Science, Mansoura University, Egypt 244 pp.
- Shalloof, K.A. and El- Far, A.M. (2009).** Age, growth and fishery biology of cichlid spp. In Abu-Zaable lakes, Egypt. *J. Aquat. Biol. Fish.*, **13**:101- 116.
- Shalloof, K.A. and El- Far, A.M. (2017).** Length-weight relationship and condition factor of some fishes from the river Nile in Egypt with special reference to four tilapia species. *Egyptian Journal of Aquatic Biology and Fisheries*, **21**(2): 33-46 .
- Soliman, I.A.; Shawky, K.A. and El-Agamy, A.E. (1998).** Some biological aspects of four cichlid species in Lake Manzalah. *Bull. Nat. Inst. Oceanogr. Fish., A.R.E*, **24**: 313-323.
- Stergiou, K.I. and Karpouzi, V.S. (2003).** Length–girth relationships for several marine fishes. *Fish. Res.*, **60**: 161-168.
- Yilmaz, S.; Yazıcıoğlu, O.; Erbas_aran, M.; Esen, S.; Zengin, M. and Polat, N. (2012).** Lengthweight relationship and relative condition factor of white bream, *Blicca bjoerkna* (L., 1758), from Lake Ladik, Turkey. *J. Black Sea/Medit. Environ.*, **18**: 380–387.