Length-Weight Relationship and Condition Factors of *Lagocephalus sceleratus* Collected from Libya´s Eastern Mediterranean Sea, Tobruk Coast, Libya.

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ABSTRACT

This study was designed to study the length-weight relationship (LWR) and condition factor of the puffer fish, *Lagocephalus sceleratus* (GMELIN, 1789), an emerging fishery resource around Tobruk coast, eastern Libyan Mediterranean Sea. 181 fish specimens were caught by hooks and trolling lines during June 2021 from four artisanal fishery sites around Tobruk City, east of Libya namely: Main port of Tobruk, Al Tamimi, Al Agaila, and Kambut. The collected fishes were classified into juveniles and adults two groups. The total length (L) of fish was measured to the nearest 0.1 cm and total weight (W) was recorded to the nearest 0.1 g. Length-weight relationship and condition factors were investigated. Data were analyzed and power regression values were estimated by Statistical Package for Social Science (SPSS) program. The study showed that the averages total length of juveniles, adults, and all fishes were 26.13 ± 3.60, 58.33 ± 5.53, and 54.77 ± 11.45 cm respectively, while the corresponding values of total weight were 159.02 ± 74.22, 2243.79 ± 703.18 and 2013.43 ± 932.56 g. LWR indicated isometric growth for juveniles ($W=0.008L^{3.006}$), slightly negative allometric for adults ($W=0.020L^{2.856}$), and positive allometric for all fishes ($W=0.004L^{3.268}$). The Fulton´s condition factor (K_F) and relative condition factor (K_n) were found to be 0.84 ± 0.08 and 1.03 ± 0.10 for juveniles, 1.11 ± 0.19 and 0.99 ± 0.17 for adults, 1.08 ± 0.20 and 0.93 ± 0.16 for all fishes. These investigated parameters are essential pre-requisites for the assessment and management of puffer fish as invader fish.

INTRODUCTION

The puffer fishes are the part of Tetraodontidae family consists of approximately 184 species under 27 genera (**Matsuura, 2015**), of which seven are recorded in the Mediterranean Sea (**Başusta *et al.*, 2013**). Four species of puffer fish {*Lagocephalus lagocephalus* (**Linnaeus, 1758**), *Lagocephalus sceleratus* (**Gmelin, 1789**), *Lagocephalus suezensis* (**Clark and Gohar, 1953**), and *Sphoeroides pachygaster* (**Müller and Troschel, 1848**) have been documented and widely spread along Libyan coast of Mediterranean Sea (**Elbaraasi *et al*., 2019**). **Hussain *et al*. (2020)** studied the

Lagocephalus sceleratus fish and revealed that the fish has recognized itself in great numbers and caused severe problems to the artisanal fisheries because it attacks fish caught in nets and lines. **Arakawa *et al*. (2010)** explained that *L. sceleratus* has a serious hazard to consumers through its harmful tetradotoxin (TTX), a toxin that can be fatal to man.

Knowledge of length-weight relationship (LWR) is an important tool in the management of the resource and determining the exact age of reproduction, growth rate, over fishing and under fishing (**El-Azrag, 1981**). Moreover, LWR can provide information about the general health of the fish, habitat conditions, life history, fish fatness and wellbeing and morphological characteristics of the fish (**Schneider *et al*., 2000; Froese, 2006**).

The biological studies of family Tetraodontidae are very important to fisheries and fish product consumers, and are urgently needed to decrease their population in Libyan coast. The present study on the length-weight relationships and condition factor of puffer fish, *Lagocephalus sceleratus* from eastern Libyan coast of Mediterranean Sea will provide relevant information required to assess the biological information and performance of this species, which give chance to exploitation and management for this invader fish.

MATERIALS AND METHODS

Study area

The study area comprised four fishery sites, which located in Mediterranean coasts, eastern of Libya, around Tobruk city. These sites are: main port at Tobruk bay basin, Al Tamimi, Al Agaila and Kambut. Essential information related to the studied sites are shown in **Table 1** and **Fig. 1**.

Table 1. Essential information of the studied sites around Tobruk city, Libya

Site	Direction to Tobruk city	Distance from Tobruk city	Coordinate
Tobruk/ main port	-	-	23:59:00 E 32:04:22 N
Al Tamimi	West	90 km	23:03:38 E 32:20:07 N
Al Agaila	East	35 km	24:12:06 E 31:59:31 N
Kamput	East	60 km	24:28:46 E 31:54:22 N

Sampling of fish specimens

A total of 181 fish specimens of *Lagocephalus sceleratus* were collected during June 2021. Hooks and trolling lines were used in capturing of fish samples. All fishes caught from four sites were gathered at Diving Club, Tobruk, where the competition of puffer fish was held and prizes were introduced to those fishermen, who most catch of puffer fish.
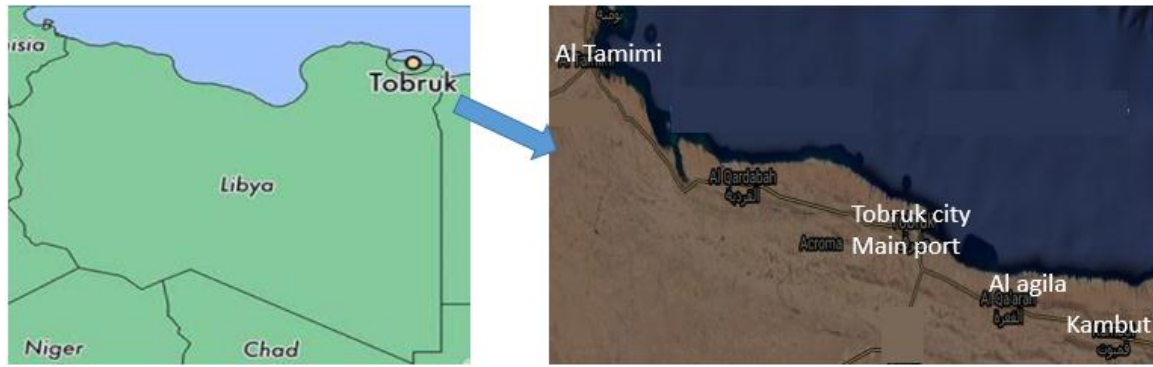
Fig. 1. A map of the study regions

Morphometric measurements

Total length (L) of fish was measured to the nearest 0.1 cm from the tip of snout to end of the upper lobe of the caudal fin, using a measuring tape. Total body weight (W) was recorded to the nearest 0.1 g using a digital balance. The measurements of the adult fish were taken at the collecting site (Tobruk City), while measurements of juveniles were taken at Department of Zoology, Faculty of Science, Tobruk University.

Biological studies

Length-weight relationship

The relationship between length and weight of L. *sceleratus* was calculated according to the equation $W = a L^b$ (**Le Cren, 1951**). Where: W= total weight of fish (g), L= Total length of fish (cm), a = constant and b = the regression coefficient (exponent).

Condition factors

Fulton's condition factor (K_F), was calculated according to **Fulton (1902)** from the following formula: $K_F = W*100 / L^3$. Where W = total weight (g) and L = total length (cm). Relative condition factor (K_n), was calculated using the formula: $K_n = Wo/Wc$, where Wo is the observed weight and Wc is the calculated weight estimated from LWR (**Vazzoler, 1996**). When the value of $K_n \geq 1$, the fish is in good condition and vice versa when the value of $K_n < 1$ (**Saha & Thomas, 2020**).

Data analysis

Data of total length and weight of 181 samples were classified into two groups vis: Juveniles (n=20) ranged in total length from 20.8 to 34.5 cm and adults (n=161) with total length ranged from 48.0 to 75.4 cm. Length and weight data of juveniles and adults were analyzed separately and collectively. Also these data were utilized for calculation of the relationship between total length and body weight of juveniles and adults. The power regression values of the length-weight relationship were tested for significance using T-test. Data were analyzed using Statistical Package for Social Science (SPSS, version, 23).

RESULTS AND DISCUSSION

Length and weight are regarded as important growth criteria in the ecology of fish. Results in **Table 2** showed descriptive statistics of total length and weight of *Lagocephalus sceleratus*. The collected fishes classified into two groups (juveniles and adults) according to total fish length. The total length of juveniles was ranged from 20.8 to 34.5 cm, with mean and standard deviation as 26.13±3.60 cm, while the corresponding total length of adult was ranged from 48.0 to 75.4 cm with mean and standard deviation as 58.33±5.53 cm **(Table, 2)**. Slightly similar findings were obtained by **Hussain *et al*. (2020)**, they found that total length of *L. sceleratus* collected from eastern Libyan coast, Ain El- Ghazala fish location ranged from 19.5 to 73.4 cm, while they found that total length of fish collected from Derna location ranged from 49.5 to 73.4 cm. **Sabrah *et al.* (2006)** presented that total length of males *L. sceleratus* ranged from 18.5 to 78.5 cm with a mean of 45.90±14.66 cm while the length of females ranged between 19.1 and 69.5 cm, with a mean length of 45.20±14.73 cm. **Başusta *et al*. (2013)** found that the maximum length of *L. sceleratus* were 78.4 cm. Smaller total length of *L. sceleratus* fish than the present findings was reported by **Kalogirou (2013)**, who found the length of five to six cm for juveniles and 30 to 40 cm for larger individuals. **Saha & Thomas (2020)** studied *L. inermis* fish and they found that its total length ranged from 10.5 to 49.6 cm.

Table 2. Descriptive statistics of total length and weight of *Lagocephalus sceleratus* fish

Class	N	Total length (cm)			Total weight (gm)		
		Min.	Max.	Mean±SD	Min.	Max.	Mean±SD
Juveniles	20	20.8	34.5	26.13±3.60	71.4	350.4	159.02±74.22
Adults	161	48.0	75.4	58.33±5.53	1000.0	5000.0	2243.79±703.18
All	**181**	**20.8**	**75.4**	**54.77±11.45**	**71.4**	**500.0**	**2013.43±932.56**

The recent results observed that the total weight of juveniles ranged from 71.4 to 350.4 g with mean and standard deviation of 159.02±74.22 g. However, the total weight of adult fish ranged from 1000.0 to 5000.0 g with a mean and standard deviation of 2243.79±703.18g **(Table 2)**. Slightly similar results were observed by **Sabrah *et al*. (2006),** they reported that total weight of males ranged from 82.9 to 5100 g with a mean weight of 1393.8±1123.52 g, whereas the weight of females ranged between 115 and 4445 with a mean weight of 1368.4±1063.67 g. **Hussain *et al*. (2020)** recorded that the total weight ranged from 149.3 to 4000.5 g for *L. sceleratus* fish collected from Ain El-

Ghazala and total weight ranged from 1657.2 to 4011.8 g for the same fish collected from Derna.

The means of total length and weight for all fishes (combined juveniles and adults) in this study were 54.77±11.45 cm and 2013.43±932.56 g, respectively **(Table 2)**. **Khalaf *et al*. (2014)** found that the total length of samples (*L. sceleratus*) varies between 10.8 cm and 71 cm, and the average is 43.99±17.65 cm for both males and females, while they found the total weight of the specimens ranges between 14 g and 4,603 g with an average value of 1458.52±1329.49g.

Length weight relationship of *Lagocephalus sceleratus* fish was found in **Table 3**. The results showed significant (P<0.001) power function regression between total body length and total body weight of buffer fish. The power function values **α** as constant and **ß** as exponent for juveniles were found to be 0.008 and 3.006 respectively with R^2=0.94 **(Fig. 2)**. However, corresponding values for adult fishes were 0.020 and 2.856 with R^2=0.73 **(Fig. 3)**. The corresponding regression values for all fishes (juveniles and adults) were 0.004 and 3.268 with R^2=0.97 **(Fig. 4)**.

Table 3. Power function regression values of length-weight relationship in *L. sceleratus* fish

Class	N	α	ß	R^2	Sig. level
Juveniles	20	0.008	3.006	0.942	*
Adults	161	0.020	2.856	0.725	*
All	**181**	**0.004**	**3.268**	٠.٩6٧	*

α: Constant; ß: Exponent and **R^2: Determination factor**

According to ß values the juveniles, isometric growth was observed and adults showed slightly negative asymmetric growth, while all fishes (juveniles and adults) showed a positive asymmetric growth. **Hussain *et al*. (2020)** observed that the length weight relationship for *L. sceleratus* fish collected from Ain El- Ghazala region was represented by the equation W = $0.01881*L^{2.8774}$ and reflects a near isometric growth. **Başusta *et al*. (2013)** revealed that types of growth for both males (2.6733) and females (2.7183) was negative allometric growth for *L. spadiceus*, but an indication of nearly isometric growth for females (2.915) and negative allometric growth for males (2.6446) of *L. sceleratus* were recorded. Also, negative allometric growth for males (2.76), females (2.78) and pooled (2.77) were obtained by **Saha & Thomas (2020)** for *Lagocephalus inermis* fish. **Aydin (2011)** observed isometric growth (2.979 as exponent) in his study of the length-weight relationship of *L. sceleratus* captured from Turkey's Mediterranean Sea coast. **Suvarna & Abraham (2019)** studied *Lagocephalus spadiceus*

collected from south-west coast of India and they revealed negative allometric growth as the 'b' value of fishes was 2.813±0.03.
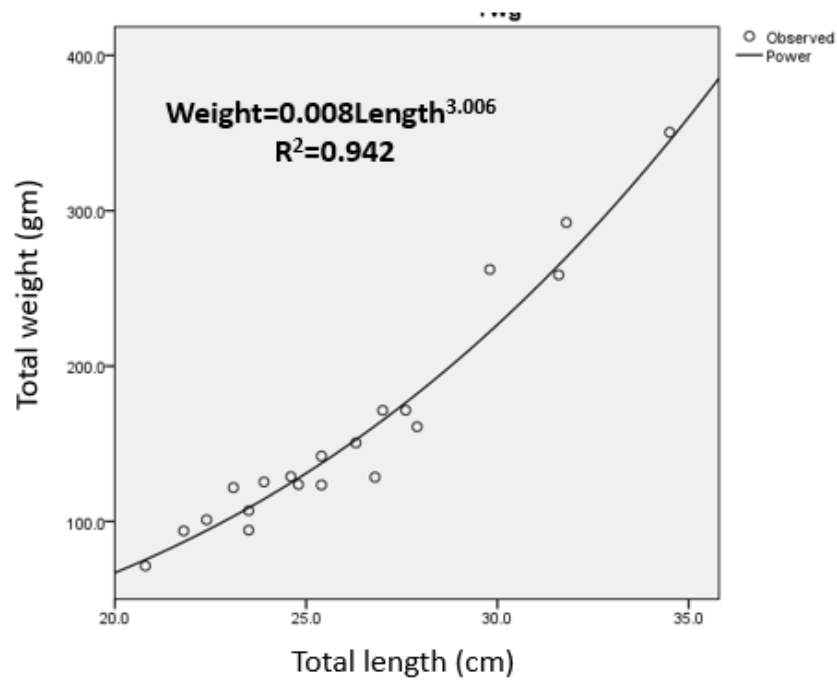

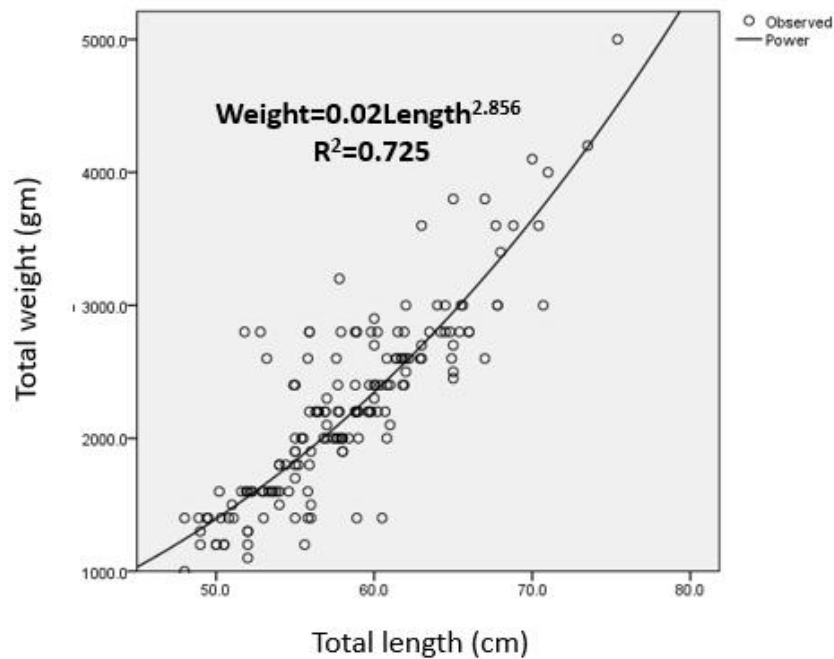**Fig. 2. Relationship between total length and weight of juvenile *L. sceleratus* fish**

Fig. 3. Relationship between total length and weight of adult *L. sceleratus* fish
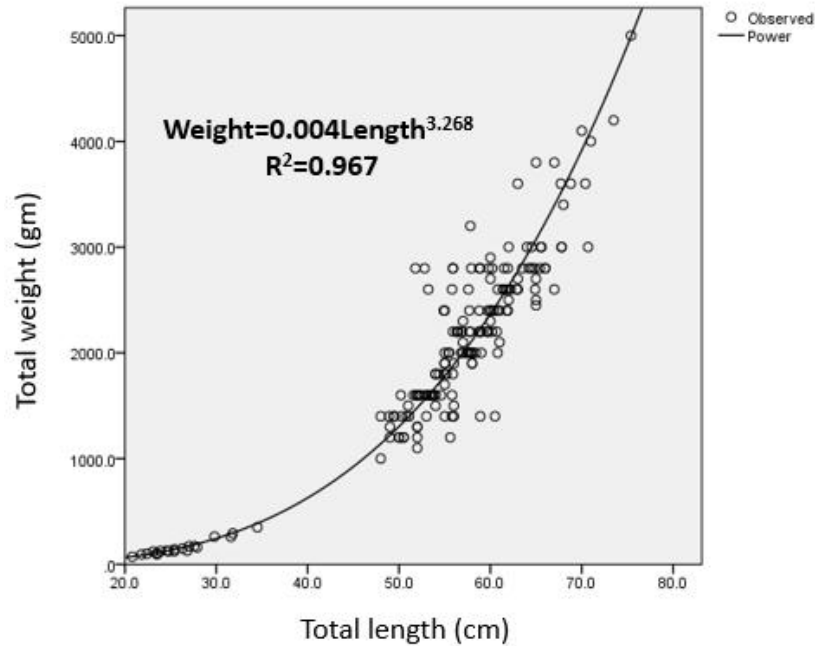
Fig. 4. Relationship between total length and weight of *L. sceleratus* fish

The values of Fulton condition factor (K_F) for *Lagocephalus sceleratus* fish were presented in **Table 4**. The results showed that the Fulton condition factor (K_F) of juveniles was ranged from 0.67 to 0.99 with an average of 0.84±0.08, while those factors for adults were ranged from 0.63 to 2.01 with an average of 1.11±0.19. The Fulton condition factors for all fishes (juveniles & adults) were ranged from 0.63 to 2.01 with mean as 1.08±0.20. **Hussain *et al*. (2020)** investigated Fulton condition factors of *L. sceleratus* and explained increasing trend from January (1.20) to June (1.41), July (1.43) and August (1.45). Higher condition factors than values of this study were observed by **Suvarna & Abraham (2019)** for *Lagocephalus spadiceus* as 2.55±0.47 for males, 2.49±0.74 for females and 2.51±0.66 for the total population, which showed good condition of the fish.

Table 4. Fulton conditions factor (K_F) of *L. sceleratus* fish captured from eastern coast of Libya

Item	N	Fulton condition factor (K_F)		
		Minimum	**Maximum**	**Mean±SD**
Juveniles	20	0.67	0.99	0.84±0.08
Adults	161	0.63	2.01	1.11±0.19
All	181	0.63	2.01	1.08±0.20

Values of relative condition factors (K_n) were calculated and presented in **Table 5**. The relative condition factors for juveniles ranged between 0.82 and 1.21, with mean of ١.٠٣±0.١0 and reflected good condition of juveniles. The corresponding values of adult fish ranged between 0.57 and 1.78, with mean of ٠.٩٩±0.١٧, while the relative condition factors for all fishes ranged from 0.53 to 1.75 with mean of ٠.٩٣±0.١٦which reflects not good enough conditions of those fishes. **Saha & Thomas (2020) studied** male and female of L. inermis and estimated relative condition factors equal to 1 which signifies that the condition of the fish is good.

Table 5. Relative conditions factor (K_n) of *L. sceleratus* fish captured from eastern Mediterranean coast of Libya

Class	N	Relative Condition factor (K_n)		
		Minimum	Maximum	Mean±SD
Juveniles	20	0.٨٢	١.٢١	١.٠٣±0.١0
Adults	161	0.٥٧	١.٧٨	٠.٩٩±0.١٧
All	**181**	٠.٥٣	١.٧٥	٠.٩٣±0.١٦

CONCLUSION

According to the above values of exponents of power regression, Fulton´s condition factors and relatives condition factors that the juvenile fish recorded isometric growth and good condition, the adult fish recorded slightly negative allometric growth, while values of all fishes reflected the positive allometric growth and slightly good conditions. The investigated parameters in this study are essential pre-requisites for assessment and management of puffer fish as invader fish.

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