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Comparative study on morphometric relationships and condition factor of *Siganus rivulatus* inhabits the Red Sea, Suez Canal and the Mediterranean Sea, Egypt

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ABSTRACT

Siganus rivulatus is one of the most successful Lessipsian migrant fish from the Red Sea to the Mediterranean Sea through Suez Canal. In the present study, a comparison between the populations in native and new habitats was estimated based on morphometric characters, meristic count, and condition of the fish. A total of 1741 individuals of *S. rivulatus* (334 from the Red Sea; Hurghada, 581 from Suez Canal; Ismailia and 826 from the Mediterranean; Port-Said) were collected seasonally from autumn 2017 to summer 2018. The total length (TL) fluctuated between 14-28cm in the Red Sea with the mode at length-class 16-16.9cm (14.37%), while TL in Suez Canal and the Mediterranean ranged from 8 to 22cm, the mode was 10-10.9cm (25.3%) and 12-12.9cm (15.25%), respectively. TL, SL and TW displayed significant differences between sites (ANOVA, $P \geq 0.05$), with the higher values of all morphometric parameters for Red Sea population. The meristic equation was "D, XIV+10; A, VII+9; V, I+3+I; P, 15-16" at all studied sites. Length-weight relationships were estimated as $W=0.0112L^{3.0349}$, $W=0.0085L^{3.1825,}$ and $W=0.0154L^{2.9091}$ for the Red Sea, Suez Canal and the Mediterranean, respectively. Seasonal variation in Fulton's condition factor (Kf) and Clark's (Kc) were estimated based on the total weight (TW) and gutted weight (GW) respectively. The values of Kf and Kc showed significant differences between sites (ANOVA, $P \geq 0.05$). Kf seemed to be affected by temperature as the maximum value recorded in summer while the minimum was in winter. was considered another factor that may affect the condition of the fish as spring (reproductive season) showed high decrease in the value of Kc at all sites when we removed the mature gonad.

INTRODUCTION

Rabbitfish (Family Siganidae) is a widespread fish especially in the Indo-Pacific region **(Woodland, 1983)** that considered from the most popular fish food in many parts of the world **(Lam, 1974)**. They are represented by four species in the Egyptian sector of the Red Sea; *Siganus rivulatus, S. luridus, S. argenteus* and *S. stellatus* **(Fischer & Bianchi, 1984)**. The opening of Suez Canal in 1869 allowed the migration of several Red Sea species to the

Mediterranean Sea which known as the Lessepsian migrant species **(Por, 1978)**. The two species; *S. rivulatus* (Forsskål, 1775) and *S. luridus* (Ruppel, 1828) are the most successful Lessepsian migrant fish via the Suez Canal which established in the Mediterranean Sea with a large population **(George *et al*., 1964; Aleem, 1969; Ben-Tuvia, 1978, 1985; Papaconstantinou, 1990; Bariche *et al*., 2004)**. The marbled spinefoot rabbitfish, *S. rivulatus*, which known locally as "Sigan" is the most common which established in the Mediterranean Sea constituting high economic importance **(Aleem, 1969; George, 1972; Papaconstantinou, 1990)**. According to **GAFRD (2016)**, the average rabbit fish Egyptian catch, mainly *Siganus rivulatus*, was 500 tons from the Red Sea and 828 tons from the Mediterranean during 2018.

The relationship between length-weight can be used to determine the well-being of individuals and the differences between the same species at different locations **(King, 2007)**. It also important in fisheries management for growth studies among species **(Moutopoulos & Stergiou, 2002)**. Condition factor "K" is another expression and approach for dealing with the length- weight studies indicates the suitability of a specific water environment for growth of fish by comparing the value for a specific locality with that of another **(Alam *et al*., 2014)**. It is used also to express fish condition with regard to degree of wellbeing, fatness or relative robustness in numerical terms **(Schneider *et al*., 2000)** and considered a measure of various ecological and biological factors. The "K" values depend generally on physiological features of fish especially maturity, spawning, life-cycle, environmental factors and food availability in a water body **(Ujjania *et al*., 2012; Dan-Kishiya, 2013)**.

Due to the growing of needs to fish protein and the increasing importance of *S. rivulatus* in Egypt, more researches are needed for a better management policy to preserve good population structure and its sustainable future in the Egypt especially after observation of decreasing in its catch in the last four years **(GAFRD, 2018)**.

Some biological and ecological studies on *S. rivulatus* have been conducted in different Egyptian coasts (**El-Gammal, 1988; El-Ganainy & Ahmed, 2002;** in the Red Sea, **El-Drawany, 2015** in Bitter Lakes, and **El-Okda, 1998; El-Far, 2008** in the Mediterranean). **Abdelhak *et al*. (2020)** studied the reproductive biology of this species from the Mediterranean and Red Seas and Suez Canal. *Siganus rivulatus* population in the Mediterranean Sea are morphometrically and genetically similar those population that relate to coral reefs in the Red Sea **(Mohammed, 1991; Hassan *et al*., 2003)**, in spite of the few morphological changes noted between the two habitats **(Diamant, 1989; Golani, 1990)**.

The aim of the present study is to compare the morphometric relationships such as length-weight relationship and condition factor of *S. rivulatus* inhabit in their native habitat (Red Sea), and those established in new habitats (Suez Canal and Mediterranean Sea). The updating of basic biological information of *S. rivulatus* is needed for the evaluation of the status of the fish to implement the best planning of its fishing and culturing in the Egyptian waters and manage its sustainability.

MATERIALS AND METHODS

- Sampling and study area

A total of 1741 specimens of *Siganus rivulatus* were collected from the Red Sea at Hurghada (334), Suez Canal at Ismailia (581) and the Mediterranean Sea at Port-Said (826) (Fig. 1). Samples were obtained seasonally during the period autumn 2017- summer 2018 from the artisanal fleet working at these areas. Fishes were put in crushed ice and transported to the laboratory immediately for further analysis.

Fig (1): Location of the three studied sites; Red Sea (Hurghada), Suez Canal (Ismailia) and Mediterranean Sea (Port Said).

- **Meristic and morphometrics parameters and relationships**

Different morphometric measurements; total length (TL), standard length (SL), width, head length (HL), pre dorsal length (PDL), pre anal length (PAL), orbit length (O) -Eye diameter- the length between the anterior and posterior margins of the eye, and inter-orbital width (IO) that length between the edges of the two eyes which measured from the ventral side (Fig. 2), were measured according to **Froese & Pauly (2004)** for each fresh specimen to the nearest 0.1cm. Total weight (TW) and Gutted weight (GW) -body without viscera; stomach and gonad- were weighed with an accuracy of 0.1 g.

Relations between total length and the different morphometric parameters (TL against each of SL, width, HD, O, PDL and PAL) were plotted as scattered diagrams and the different linear regression equations were calculated as follow:

$$Morphometric\ parameter = a + b \times TL$$

while TW against SL were described by:

$$TW = a \times SL^b$$

The coefficient of correlation R^2, and the standard error SE were estimated **(Statgraphics, 2005)**. The meristic characteristics were counted as: Dorsal fin (D) rays + spines, Anal fin (A) rays + spines, ventral fin (V) rays + spines and Pectoral fin (P) ray and spines.

- **Length-weight relationship**

The length weight relationships were estimated from the allometric equation;

$TW = a \times TL^b$ **(Ricker, 1973)**

where (TW) total body weight (g), (TL) the total length (cm), a and b are the coefficients of the functional regression between (W) and (L).

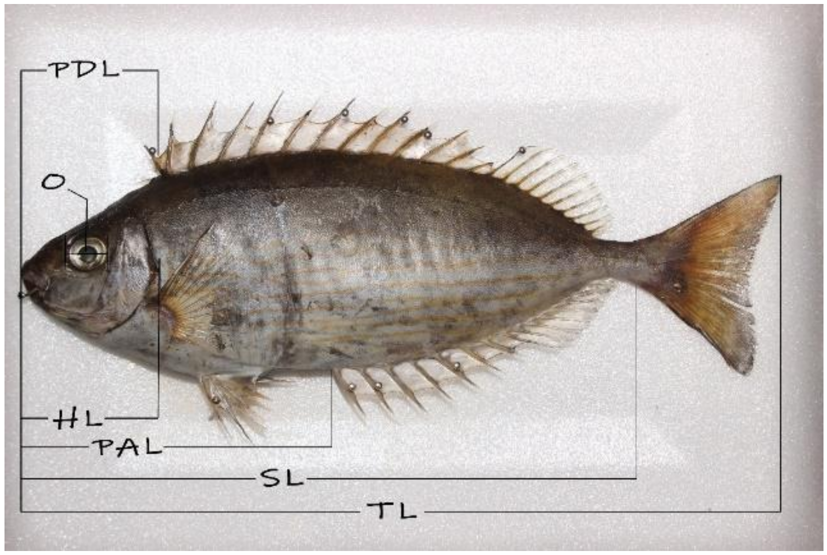

Fig (2): Raw measurements of *Siganus rivulatus;* total length (TL), standard length (SL), head length (HL), pre dorsal length (PDL), pre anal length (PAL), orbit length (O) -the length between the anterior and posterior margins of the eye.

- **Condition factor**

Absolute or Fulton's coefficient (Kf) and relative or Clark's coefficient (Kc) were calculated using the equations:

- $\boldsymbol{Kf = \left(\frac{TW}{TL^3}\right) \times 100}$ **(Fulton, 1902)**
- $\boldsymbol{Kc = \left(\frac{GW}{TL^3}\right) \times 100}$ **(Clark, 1928)**,

where, (Kf) is Fulton's condition factor, (Kc) is Clark's condition factor, (TW) is the total weight of fish, (GW) is the gutted weight, and (TL) is the observed Total Length (cm).

The specimens of each site were grouped into a 1 cm length classes, then Kf and Kc were estimated as seasonal average for each investigated area, and for different length-classes

- **Statistical analysis**

All statistical tests, mean, range values, standard deviation and simple linear regression were estimated using the program Microsoft® Excel 2002. One-way ANOVA analysis was used for TL, SL, TW, Kf and Kf, with statistically significant at ($P \leq 0.05$), to compare between different studied area using SPSS for windows (11.0.0), (copyright© SPSS Inc.).

RESULTS

- **Length-frequency distribution**

Length frequency distribution of *S. rivulatus* were estimated for all collected individuals (1741) in the present study. The TL of fish from the Red Sea (n=334) was fluctuated between 14-28 cm, with the most frequent length class of 16-16.9 cm (14.37%), while TL of specimens from the Suez Canal (n=581) and the Mediterranean (n= 826) ranged between 8 and 22cm, with the mode of 10-10. (25.3%) and 12-12.9 cm (15.25%), respectively (Fig. 3).

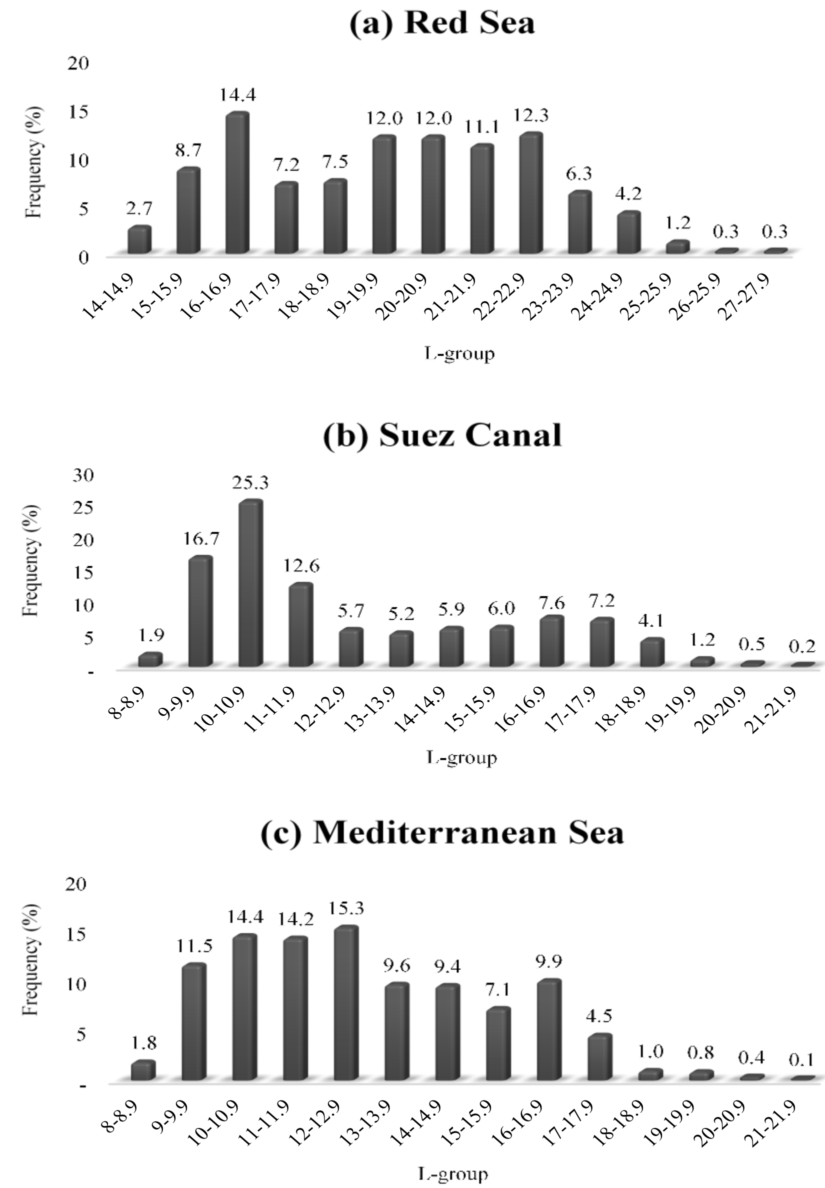

Fig (3): Length frequency distribution of *S. rivulatus* collected from Red Sea (a), Suez Canal (b) and Mediterranean Sea (c).

- Relations of morphometric and meristic parameters

As shown in Table (1); the Red Sea population had the highest values for all investigated morphometric measurements; TL, SL, HL, width, PDL, PAL, O, IO, TW, and GW, while the measurements of Suez Canal and Mediterranean populations were close to each other. The morphometric parameters TL, SL and TW showed significant differences between sites (ANOVA, $P \leq 0.05$). The morphometric regressions of TW against SL and TL against each of SL, width, HD, O, PDL and PAL for the Red Sea, Suez Canal and Mediterranean demonstrated positive allometric growth (Table 2). The meristic equations of all studied sites were approximately similar; D, XIV+10; A, VII+9; V, I+3+I; P, 15-16 (Table 2).

Table (1): Morphological measurements for *S. rivulatus* (Mean± standard deviation (SD), minimum (Min.)-maximum (Max.) and proportion of total length (% of TL) collected from (a) Red Sea, (b) Suez Canal and Mediterranean Sea.

Area / Parameters	Red Sea			Suez Canal			Mediterranean Sea		
	mean±SD	Min.-Max.	(%) of TL	mean±SD	Min.-Max.	(%) of TL	mean±SD	Min.-Max.	(%) of TL
TL (cm)	20.09±2.75	14.1-27.9	100	13.64±3.13	8.2-21.1	100	13.31±2.72	8.1-21.1	100
SL (cm)	15.83±2.15	11.3-22.3	78.79	10.77±2.46	6.3-17	78.94	10.47±2.09	6.1-16.6	78.68
HL (cm)	3.80±0.49	2.7-5.3	18.92	2.68±0.51	1.7-3.9	19.68	2.65±0.49	1.8-4	19.87
Width (cm)	6.03±0.89	3.8-8.6		4.12±0.97	2-7		3.80±0.77	2.2-7.2	
PDL (cm)	4.11±0.70	2.5-6	20.46	3.16±0.66	1.9-4.7	23.14	2.94±0.69	1.8-5.3	22.06
PAL (cm)	8.57±1.27	6-12	42.66	6.05±1.39	3.5-9.2	44.38	5.70±1.21	3.5-9.1	42.82
O (cm)	0.97±0.11	0.7-1.4	25.53 of HL	0.76±0.12	0.5-1.1	28.17 of HL	0.73±0.14	0.4-1.1	27.49 of HL
IO (cm)	1.41±0.23	0.9-2		0.96±0.22	0.6-1.6		0.86±0.18	0.5-1.4	
TW (g)	106.7±42.78	31.4-277.4		41.44±28.4	6.6-132.3		32.51±20.23	6-115.34	
GUT. W (g)	81.81±33.29	20.8-189	76.67 of TW	31.45±21.93	3.4-105.4	75.88 of TW	25.25±15.79	4.5-96	77.65 of TW

Table (2): The linear regression analysis of morphometric parameters of *S. rivulatus* in the Red Sea, Suez Canal and Mediterranean Sea.

Relationship / Sites	Con.	SL & TW	TL & SL	TL & width	TL & HL	TL & O	TL & PDL	TL & PAL	N
Red Sea	a	0.0215	0.265	0.0188	0.3615	0.343	0.2764	0.2894	334
	b	3.0605	0.7747	0.2991	0.1712	0.0312	0.2183	0.441	
	R^2	0.9391	0.9817	0.8539	0.9267	0.6355	0.7419	0.9193	
Suez Canal	a	0.0176	0.1231	0.1554	0.5311	0.2911	0.4497	0.1441	581
	b	3.1933	0.7804	0.2908	0.1579	0.341	0.1984	0.4332	
	R^2	0.98	0.9884	0.8773	0.9353	0.7313	0.8822	0.9493	
Mediterranean Sea	a	0.276	0.3405	0.3208	0.3314	0.1747	0.1856	0.0614	826
	b	2.9559	0.7612	0.2615	0.1738	0.0415	0.2067	0.4137	
	R^2	0.9158	0.986	0.8555	0.9356	0.6894	0.6692	0.9107	
Meristic formula: D, XIV+10; A, VII+9; V, I+3+I; P, 15-16.									

- **Length-weight relationship of *S. rivulatus***

Total length (TL) of all individuals collected from Red Sea ranged between 14.1 and 27.9cm (average: 20.09±2.75cm) and total weight (TW) fluctuated between 31.4 and 277.4 g (average: 106.71±42.78 g). The TL range was (8.2-21.1cm) in both Suez Canal and Mediterranean specimens; with an average of 13.46±3.13cm and 13.31± 2.72cm, respectively. The TW ranged from 6.6 to 132.3g (41.11±28.4g) in Suez Canal and from 6 to 115.34 (32.51±20.23g) in Mediterranean (Table 1).

The length-weight relationship equations of *S. rivulatus* were $W=0.0112L^{3.0349}$, $W=0.0085L^{3.1825}$, and $W=0.0154L^{2.9091}$ with correlation coefficients (R^2) of 0.9492, 0.9834 and 0.9324 for Red Sea, Suez Canal and Mediterranean, respectively (Fig. 4). The exponent b values indicated positive allometric growth in the Suez Canal population while it was isometric in the Red and Mediterranean Seas populations.

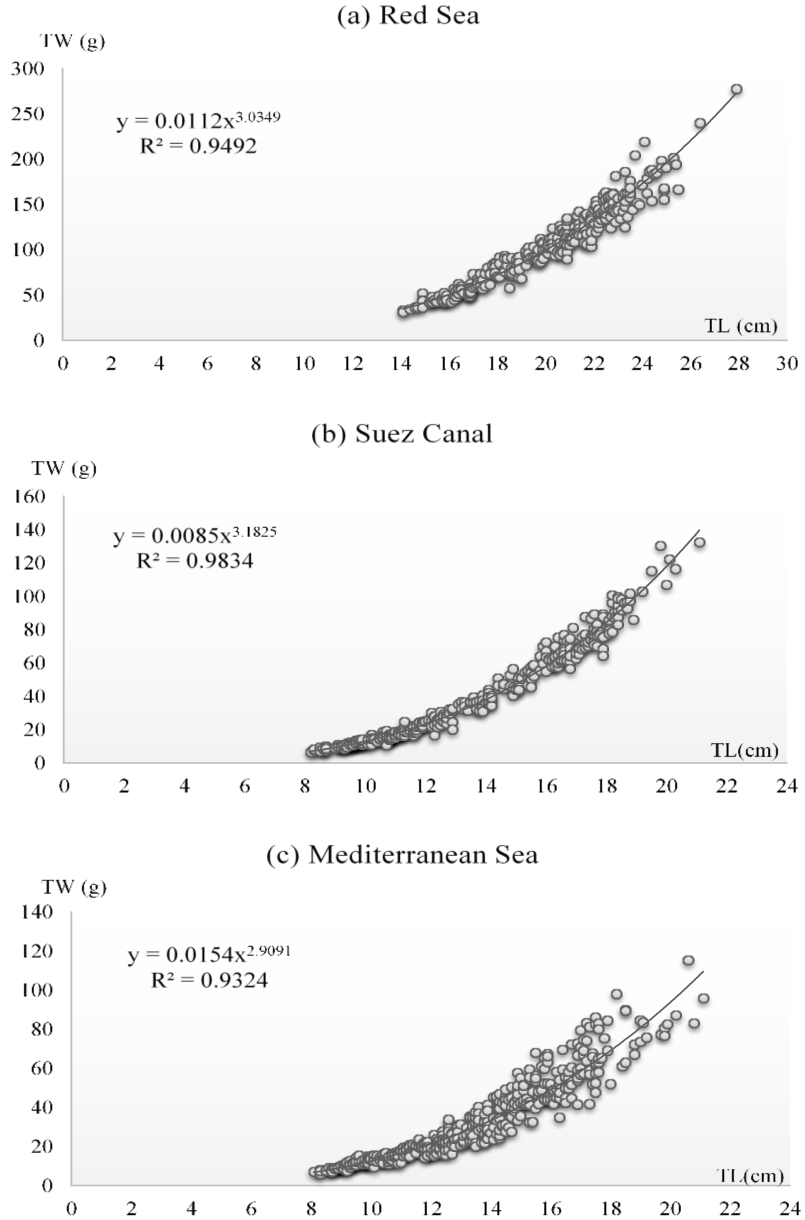

Fig (4): Length weight relationship of *S. rivulatus* in the Red Sea (a), Suez Canal (b) and Mediterranean Sea (c).

- **Condition factor (K)**

Fulton condition factor (Kf) of *S. rivulatus* displayed the same seasonal variation pattern in all studied areas; giving the highest values in summer (1.341, 1.4628 and 1.2833) and the lowest values in winter (1.217, 1.3199 and 1.1498) in Red Sea, Suez Canal and Mediterranean, respectively (Fig. 5a, b &c). On the other hand, Clark condition factor (Kc) demonstrated similar pattern in both Suez Canal and the Mediterranean (Fig. 5b&c), with the highest values in summer (1.1198 and 1.0308, respectively) and the lowest values in winter (0.9819 and 0.9005, respectively). Conversely, Kc in the Red Sea showed different pattern (Fig. 5a) when the highest value was recorded in autumn (1.022) and unusual decrease was observed during spring (0.913). Both Kf and Kc showed significant differences between the studied areas (ANOVA, $P \leq 0.05$).

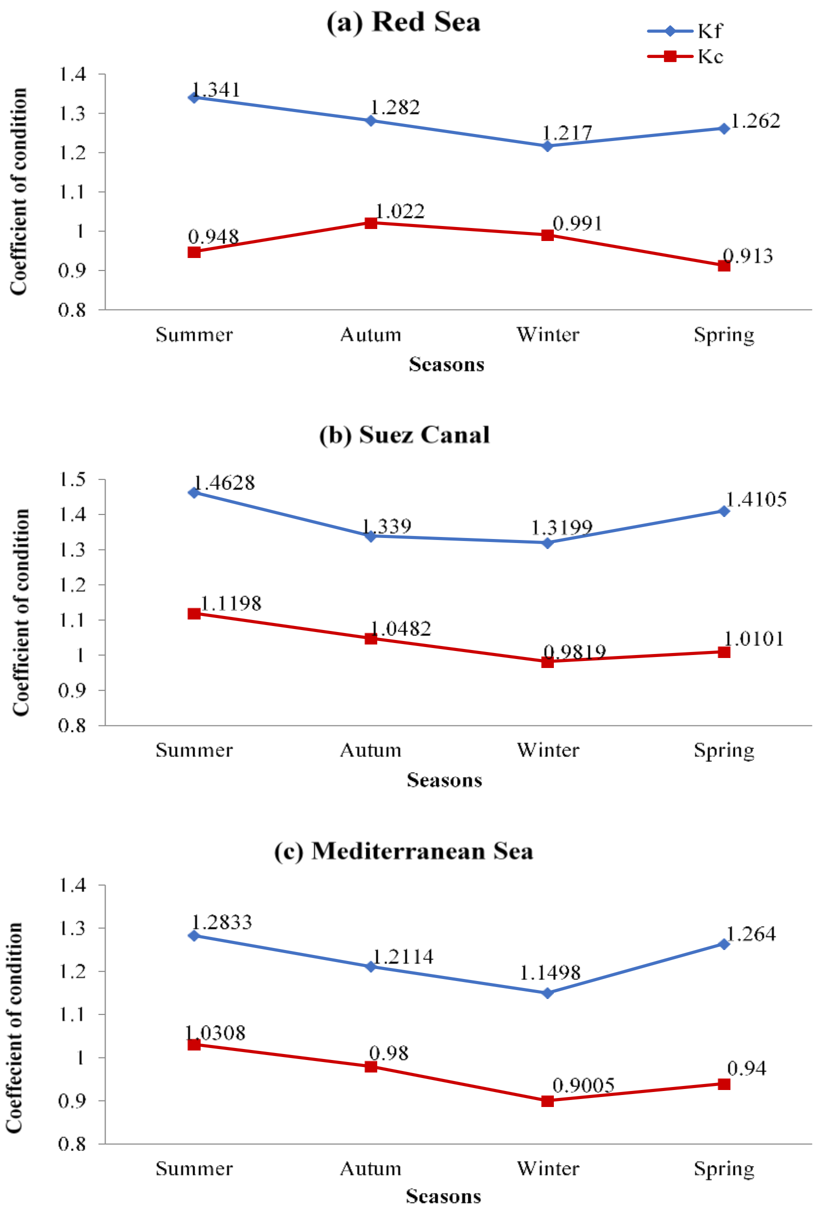

Fig (5): Seasonal variation in Fulton's and Clark's coefficient (Kf and Kc) of *S. rivulatus* at Red Sea (a), Suez Canal (b) and Mediterranean Sea (c).

Variation in Kf and Kc values of *S. rivulatus* with length groups were estimated at each studied area (Fig. 6). Kf values showed fluctuation between different length groups, with irregular trend. The values ranged from 1.312 to 1.163 in Red Sea (Fig. 6a), 1.503 to 1.329 in Suez Canal (Fig. 6b) and 1.34 to 1.104 in the Mediterranean Sea (Fig. 6c). On the other hand, Kc showed similar trend in all location in which the values decreased with increasing length. It decreased from 1.01 in length group 16cm to 0.796 in 25cm in Red Sea (Fig. 6a), from 1.11 in length group 11cm to 0.854 in 20cm in Suez Canal (Fig. 6b), and from 1.015 in length group 9cm to 0.754 in 21cm in Mediterranean Sea (Fig. 6c).

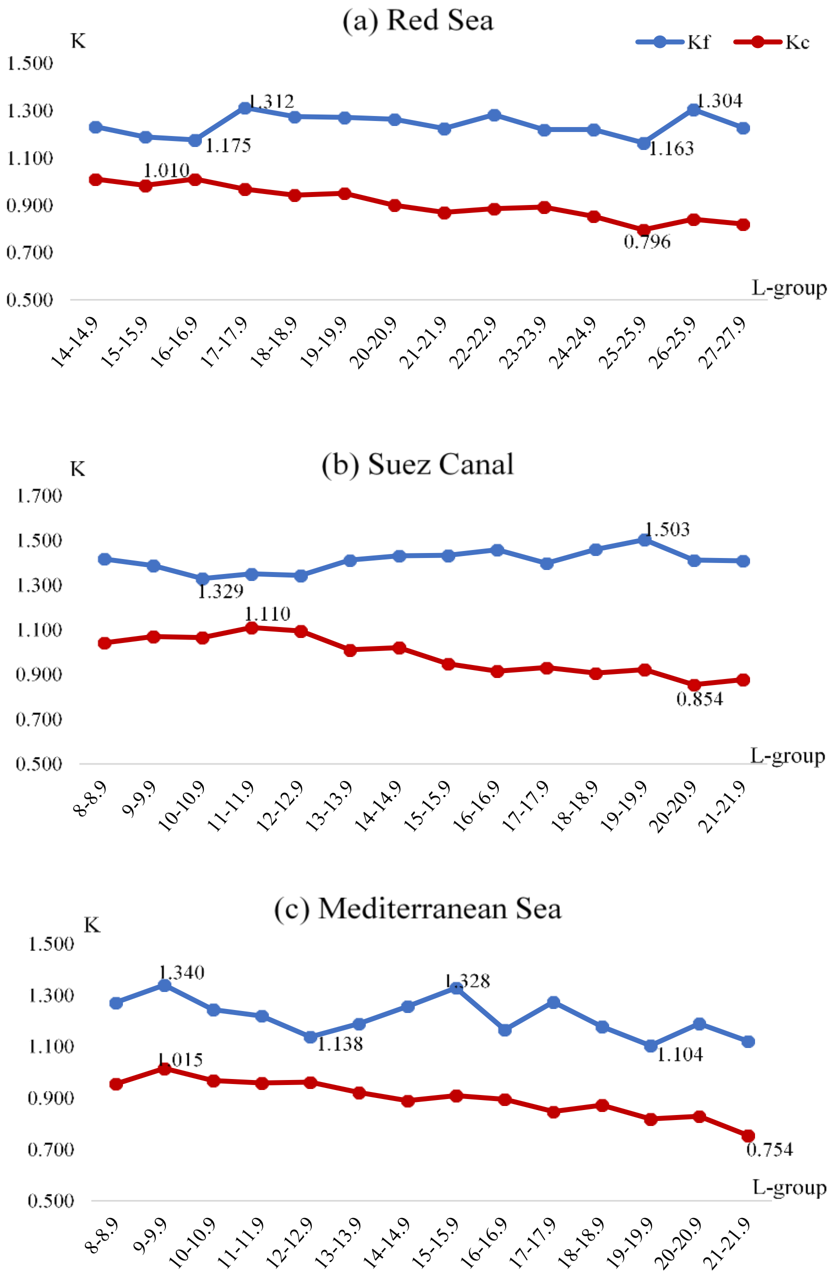

Fig (6): Fulton's and Clark's coefficients for length groups of *S. rivulatus* collected from Red Sea (a), Suez Canal (b) and Mediterranean Sea (c).

DISCUSSION

Siganus rivulatus is a commercially important fish species in the Egyptian marine waters (Red Sea, Suez Canal and Mediterranean Sea). It is one of the most abundant fishes caught by different artisanal gears, particularly trammel and gill nets in the marine small-scale fisheries of Egypt **(Saber & Gewida, 2020)**. Its catch was about 500 tons from Red Sea and 828 tons from Mediterranean during 2018 **(GAFRD, 2019)**.

Biometric characters (morphometric indices, morphometric regression and merestic characters) of *S. rivulatus* were investigated to identify local stocks of this species. Morphometric indices have been of common use by ichthyologists to differentiate between different races of the same fish species, or fishes of the same species living in different localities **(Skelton, 1976)**.

In the present study, the modal size *S. rivulatus* was 16.5cm in the Red Sea, 10.5cm in Suez Canal and 12.5cm in the Mediterranean Sea. These lengths were smaller than those recorded in previous studies in each location such as; 12cm on Lebanese coast **(Bariche, 2005)**, 16.2cm at Alexandria coast **(El-Far, 2008)**, 18cm at Bitter lake **(El-Drawany, 2015)** and Libyan coast **(Shakman *et al.*, 2008)**. The variability in the most frequented length could be due to various fishing gears used in sampling, as reported by **El-Far (2008)** when he recorded difference in the most frequented length of *S. rivulatus* at the same site and time (13, 16 and 17cm) caught by nylon trammels with different mesh sizes (2.08, 2.27, 2.5cm, respectively).

The relationships between total length and different studied morphometric measurements were positively correlated at all studied areas. The same was observed for *S. rivulatus* on Libyan coast **(Shakman *et al.*, 2008)**. There was no significant difference in the meristic counts (D, XIV+10; A, VII+9; V, I+3+I; P, 15-16) between different locations. In agree, the meristic formula of family Siganidae was described by Woodland (1990) as (D, XIV + 10; A, VII + 8-10; V, I + 3 +I; P, 15-17) and that of *S. rivulatus* was stated by **Shakman *et al.* (2008)** as D, XIV+10; A, VII+8-10; V, I+3+I. Any change in meristic counts of Lessepsian migrant species is a combination of shifting or shortening of the spawning seasons and the different temperature regimes between the two seas **(Golani, 1990).**

Studying of length-weight relationship is very important in fisheries science as it used for forecasting the potential yield and determining the most favorable size of capture to obtain optimum yield; these management parameters are directly related to the weight of the fish **(Suresh *et al.*, 2006)**. The value of ‘b’ is the key parameter in estimating population growth through length-weight relationship **(Simon & Mazlan, 2008)**, it is usually close to 3 in all fish, despite many variations of fish forms and may fall in the range of 2.5-3.5 **(King, 1996**). The length-weight relationship is considered isometric when the value of b equal to 3, while it is allometric when the value is higher or lower than 3 **(Ricker, 1975)**. The b value usually used to show the robustness of the fish and compare the condition of the fish **(Le Cren, 1951)**. In the present study, b values of *S. rivulatus* were found to be 3.0349, 3.1825 and 2.9091 in Red Sea, Suez Canal and Mediterranean Sea, respectively. These results agree with the findings of **Gayanilo & Pauly (1997)**.

Table (3) summarizes the findings of previous studies on the length weight relationship of *S. rivulatus* and our results. The differences in b values could be due to differences in growth and morphometry between regions **(Barnabe, 1976)**. **Froese (2006)** interpret the differences in b values within the same species by a number of abiotic factors such as temperature which vary with geographical distribution, habitats, food availability in the environment, season and fishing vessels or biotic factors such as recorded lengths of the caught specimens, age, stomach fullness, sex and gonad maturity.

Table 3. Length-weight relationship of *S. rivulatus* from the present study and the previous studies in different locations.

Author	Location	Sex	a	b	R^2	n	size rang (cm)
Preen Study	Red Sea (Hurghada)	C	0.0112	3.0349	0.9492	334	14.1-27.9
	Suez Canal (Ismailia)	C	0.0085	3.182	0.9834	581	8.2-21.1
	Mediterranean (Port-Said)	C	0.0154	2.9091	0.9324	826	8.1-22.1
Red Sea							
Hashem, 1983	Saudi Arabia	C	0.021	3.071		898	11-30
El-Gammal, 1988	Egypt (Hurghada)	M F	0.012 0.011	2.838 2.841	0.99 0.99	114 137	-
Tharwat & Al-Owafeir, 2003	Saudi Arabia	C	0.013	2.990	0.99	200	150-270
Gabr *et al.*, 2018	Saudi Arabia (Jeddah)	C	0.011	3.06	0.96	2177	11.3-28.3
Suez Canal							
El-Drawany, 2015	Bitter Lakes, Egypt	M F	0.01042 0.00952	3.010 3.042	0.98 0.98		9-28.5 9-28.9
Mediterranean Sea							
Mouneimne, 1978	Lebanon (Junieh)	C	0.071	3.142	-	458	5-25.2
Mohammed, 1991	Egypt	M F C	0.018 0.017 0.012	2.830 2.866 2.934	0.99 0.99 0.99	-	-
EL-Okda, 1998	Egypt	C	0.016	2.872	-	1126	110-280
Taskavak & Bilecenoglu, 2001	Turkey	C	0.047	3.203	0.98	355	107-241
Abdallah, 2002	Egypt (Alexandria)	C	0.022	2.820	0.93	112	55-27.6
Bilecenoglu & Kaya, 2002	Turkey (Antalya)	M F C	0.075 0.064 0.071	3.135 3.221 3.179	0.95 0.95 0.95	229 292 521	7.1-20.6 7-21.5 7-21.5
Bariche, 2005	Lebanon (Batrun)	M F C	0.020 0.010 0.010	3.323 3.011 3.04	0.95 0.96 0.99	98 93 781	12.7-23.2 12.6-26.7 24.8-26.7
El-Far, 2008	Egypt (Alexandria)	M F C	0.039 0.017 0.023	2.594 2.906 2.783	0.97 0.98 0.93	586 617 1217	10.9-25.9 9.7-22.9 8.6-25.9
Shakman *et al.*, 2008	Libyan coast	C	0.0233	2.82	0.93	1672	6.2-27.4
Hagras, 2015	Bardawil lagoon	M F C	0.0141 0.0161 0.0163	2.9584 2.905 2.8971		606 617 4066	7-20.9 8-21.9 7-21.9

Condition factor is widely used to express the stability of an environment to a certain fish species **(El-Far, 2008)**, it indicates its fatness, general wellbeing and gonad development **(Hile, 1936)**. **Fulton (1902)** was the first to calculate the condition factor "Kf" using a total body weight (absolute condition factor), based on the hypothesis that the heavier fish of a given length is in better condition. Gutted weight (GW) could be used instead of total weight (TW) in calculation of condition factor "Kc" in order to exclude the effect of stomach content and the weight of gonad which may mask the true of fish condition **(Lagler, 1956; Ricker, 1975)**.

The absolute condition factor values (Kf) in the present study showed that the temperature was one of the most effective parameters in condition of the fish, as it had the highest values in summer and the lowest in winter at all studied locations, the values in autumn and spring were close (Fig. 5). It is indicating to the suitability of the environment with regards to feeding condition or reproductive strategy. **Yeldan & Avsar (2000)** stated that Fulton's Condition Factor is opposite to gonadosomatic index (GSI) due to the inverse relationship between the gonadal development and the food elements deposited in the muscle tissue, such that when the GSI increases the Kf is expected to decrease.

When we used the GW instead of the TW in calculation of condition factor, the Kc values showed the same pattern in Suez Canal and Mediterranean except during spring season when it decreased more than other, which mean the gonads and stomach were very heavy. This confirm the observation of spring being the reproductive season, when fish consume most of the food in gonads development instead of the food elements deposited in the muscle tissues of fish. In Red Sea, the Kc values showed much more decreasing in spring, in addition to decreasing in summer also even became lower than the values in autumn and winter, this may due to extension of the reproductive season in Red Sea during summer, and to the fully stomach observed in stomach analysis (unpublished data). **Welcome (1979)** mentioned that, the condition factor influences the reproductive cycle in fish. In agreement with the present Kf results of *S. rivulatus*; **Hagras (2015)** recorded the highest value in Bardawil lagoon in September (summer) and the lowest in December and January (winter) followed by that recorded during spawning time. **Barchie *et al.* (2009)** stated that Kf of the same species at Lebanese coasts (eastern Mediterranean) decreased during the spawning season, and increased again after spawning, and reached a minimum in February (winter). **Shakman (2008)** estimated little differences between seasons on Libyan coasts; but the lowest values still observed in December and January (winter) and during spawning months. **Yeldan & Avsar (2000)** recorded the biggest decrease of Kf value in December and the maximum in July. This situation was similar in Jeddah, Red Sea populations **(Hashem, 1983)** where K values decreased during maturation and spawning activities. The data from the Red Sea and Suez Canal population is scarce and incomplete. **El-Far, (2008)** used gutted weight to estimate the condition factor (Kc) of *S. rivulatus* on Alexandria coast, the results agreed with the present study in winter (January and February when the lowest values of Kc were observed in the Mediterranean, while the highest value was recorded in May. **D'Ancone (1963)** pointed out that the coefficient of condition varies with the state of gonad maturity, months, seasons, climate and possibly with age. The condition factor is directly related to environmental conditions **(Clesceri *et al.*, 1999)** and changes in K, for several fishes have been ascribed to a depletion of body reserves during gonad maturation **(Htun-Han, 1978)**. There were significant differences recorded in values of Kf and Kc between the studied areas (ANOVA, $P \leq 0.05$).

The fluctuation of Kf values with different length group in Red Sea (1.163-1.312), Suez Canal (1.329-1.503) and Mediterranean (1.104-1.34) may be due to the fact of; while the smaller fish needs more energy to grow, the larger fish usually contain mature gonads and full stomach which had heavy weight. **Tharwat & Al-Owafier (2003)** recorded similar range for *S. rivulatus* inhabit the Red Sea (1.1-1.3).

On the other hand, the observed decline in Kc values with increasing fish length could be returned to; having bigger and more full stomach as observed in stomach analysis work (unpublished data), and to consume almost of the food for the development of reproductive cells (gonads maturation) instead of the growing muscles of the body **(Yeldan & Avsar, 2000)**, while higher Kc in fish with smaller length reflecting the accordance with high growth pattern of small fish when fish deposited almost of the food elements in the tissues of its muscle to grow well. This result is in agreement with the study of **El-Far (2008)** who recorded decreasing of K values (using GW) in males, females and combined sexes of *S. rivulatus* on Alexandria coast with increasing length of the fish. Inversely, **Tharwat & Al-Owafier (2003)** discussed the condition factor for *S. rivulatus* in the Red Sea and showed a gradual increase in values of absolute and relative condition factor with increasing fish length

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