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Some Morphological Traits of the Atlantic Lizardfish *Synodus Saurus* in the Southern Mediterranean Sea

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Abstract: *The objective of this work was to establish main morphological traits of the Atlantic lizardfish Synodus saurus in the Southern Mediterranean Sea (Benghazi, eastern Libya). Seventy fish random sample obtained from the artisanal catch of Benghazi was used to establish 5 morphogenic (descriptive), 15 morphometric, and 6 meristic traits. The fish was elongated, somewhat cylindrical, with hazy transverse rows in some. The snout was pointed, and the jaws had rows of fine teeth. The mean total length of the fish (TL) was 20.14 cm corresponding to a mean total weight (TW) of 66.93 gm. The ratio of head length to TL was 0.223. All the binary correlations between the morphometric parameters were positive and highly significant. The regressions of these parameters with TL were positive (i.e. all the parameters increase simultaneously during growth), highly significant, and mostly with high* R^2*. The length-weight relationship,* $TW = 0.0053*TL^{**3.1109}$*, n = 70,* R^2 *= .965, P = .000, indicated isometric growth (conf. limits of b = ± 0.1411). The Fulton condition factor (*C_F*) was 0.7443. The regression of* C_F *vs TL indicated gradual improvement of the condition of the fish during growth (i.e. gradual increase of* C_F *with increase of TL as indicator of growth), the slope (b) of the power regression was + 0.1110. The meristic traits were conservative, i.e. either did not correlate with TL, or had low "r" (in case of number of lateral line scales). The meristic formula derived from them was:* ***D****, 11-12(12);* ***A****, 9-12(11);* ***P****, 11–13(12);* ***V****, 7-8(8);* ***LLS****, 53-73(62);* ***ALS****, 5-10(7);* ***BLS****, 7-14(10); the values between parenthesis are the modes.*

Keywords: Atlantic lizardfish, *Synodus saurus*, length-weight relationship, condition factor, Meristic formula, Southern Mediterranean Sea.

INTRODUCTION

About 70 species of the family Synodontidae (the Atlantic lizardfish) are found in tropical and subtropical oceans, of these, five are found in the Mediterranean Sea, two being Lessepsian migrants (Golani *et al*., 2006). *Synodus saurus* (Synodontidae), is a benthic fish found in the shallow waters of the Atlantic Ocean, the Mediterranean Sea, and the Red Sea. Its elongated, cylindrical body (resembling a lizard), that may reach up to 60 cm (Froese and Pauly, 2021), reflect its predatory nature. The fish plays a significant role in regulating the abundance of smaller prey fish in shallow waters by virtue of being common, medium sized, and carnivore; it may be used as health marker-species for its habitat (Coll *et al*., 2012). The fish is very common in the artisanal catch of Libya.

Morphological traits of fish are their physical morphogenic, morphometric, and meristic attributes (Talwar and Jhingran, 1992). Morphogenic attributes are descriptive characteristics, including body shape and color, that are not countable or measurable. The measurable characteristics, such weight and body length, are called morphometric attributes. Typically, they increase as the fish grows. Meristic traits are countable characteristics, such as number of rays and spines of fins, scales on the lateral line, gill rakers and vertebrae. They are conservative traits: typically, their numbers do not change during growth, and hence the meristic formulae derived from them may be considered finger prints of individual fish-species (Hubbs, 1922). Morphological characteristics are important for understanding evolutionary relationships, species identification, and ecological roles within aquatic environments, they are also important for fisheries, including aquaculture (Nelson, 2006; Wainwright and Bellwood, 2002; Webb, 1984; Turan *et al*., 2005; Lindsey, 1988).

The length (L cm)–weight (W gm) relationship (LWR: $W = {}_{a}L^{b}$ Where (a) and (b) are constants) and the Fulton Condition Factor ($C_F = 100 * W/L^3$) are vital tools in fisheries biology and ecology. These metrics provide critical insights into fish growth, health, and overall population dynamics, contributing to the sustainable management of fish stocks and the preservation of aquatic ecosystems. They are therefore incorporated in many of the models that describe these activities (Froese, 2006). For instance, variations in the values of (b) can indicate whether a fish population is experiencing changes in food availability, environmental conditions, or even fishing pressures. A value of (b) = 3 typically indicates isometric growth, where length and weight increase proportionally. Deviations from this value (indicates negative, or positive, allometric growth when (b) is less, or more than, 3) can signal ecological or biological changes. Additionally, LWR is important for estimating biomass, particularly when it's more practical to measure lengths of individual fish rather than to weigh the fish (Beverton and Holt, 1957). It also helps in comparing different populations, evaluating fish health, and understanding life-history strategies.

C_F is another critical index used to evaluate the overall health and well-being of fish. It measures the "plumpness" or "fatness" of the fish in relation to its length. A high C_F indicates that the fish is in good condition, typically reflecting adequate food availability, favorable environmental conditions, and lower levels of stress (Le Cren, 1951). Regular monitoring of C_F allows fisheries managers to detect shifts in population health early, enabling timely interventions to manage and conserve fish stocks. It also allows establishing the breeding season of the fish.

The objective of this study was to establish main the morphological traits of *Synodus saurus* in the southern Mediterranean Sea coast, as well as the length-weight relationship and the condition factor.

METHODS

The study area

The *Synodus saurus* specimens for this study were collected from the coastal waters of Benghazi (Juliana Port and surrounding areas, 32°36' N, 20°03' E) in eastern Libya (Fig. 1). Benghazi, the second-largest city in Libya, is a significant deep-sea harbor and industrial hub. The region's coastline features various small seasonal estuaries, lagoons, wetlands, and brackish tidal marshes, all contributing to high biodiversity. Located near the city is the Benghazi Natural Reserve, which includes both marine and terrestrial ecosystems. Additionally, Benghazi serves as a permanent fish landing site and is home to a major fish market (Reynolds *et al*., 1995).

Fig. 1. Benghazi city and port

Establishing the morphological parameters

A random sample of 70 *Synodus saurus* fish was collected from the Benghazi fishing ground for this study. The morphological characteristics of each fish were carefully examined. Fifteen morphometric parameters (as listed in Table 1 and shown in Fig. 2) were measured for each specimen. Weights were recorded to the nearest 0.1 gram using a digital balance, while lengths were measured with a digital Vernier caliper to the nearest millimeter. Additionally, six meristic parameters, listed in the table, were counted for 30 of the fish using a magnifying lens and a dissecting microscope.

Table 1. Descriptive, morphometric and meristic traits (and codes) established for *Synodus saurus* in the present study.

Morphometric traits (cm/gm)	**Meristic traits**
1- Total Weight (gm) **(TW)**	1-Dorsal fin **(D)**
2- Total Length **(TL)**	1- Pectoral fin **(P)**
3- Fork Length **(FL)**	2- Ventral fin **(V)**
4- Standard Length **(SL)**	3- Anal fin **(A)**
5- Body Depth **(BD)**	4- Scales on Lateral line **(SLL)**
6- Head Length **(HL)**	5- Scales Above Lateral line **(SAL)**
7- Pre-anal Lengths **(PAL)**	6- Scales Below Lateral line **(SBL)**
8- Dorsal fin Length **(DFL)**	
9- Pre-pectoral Length **(PPL)**	
10- Pre-Pelvic Length **(PPel)**	**Descriptive characters**
11- Caudal peduncle length **(CP)**	1- body shape
12- Pre-dorsal length **(PDL)**	2- body color
13- Pre-orbital Length **(POL)**	3- presence/absence of spots and strips
14- Eye Diameter **(ED)**	4-shape of mouth (position, retractability
15- Mouth Gape **(S)**	5- shape of caudal fin

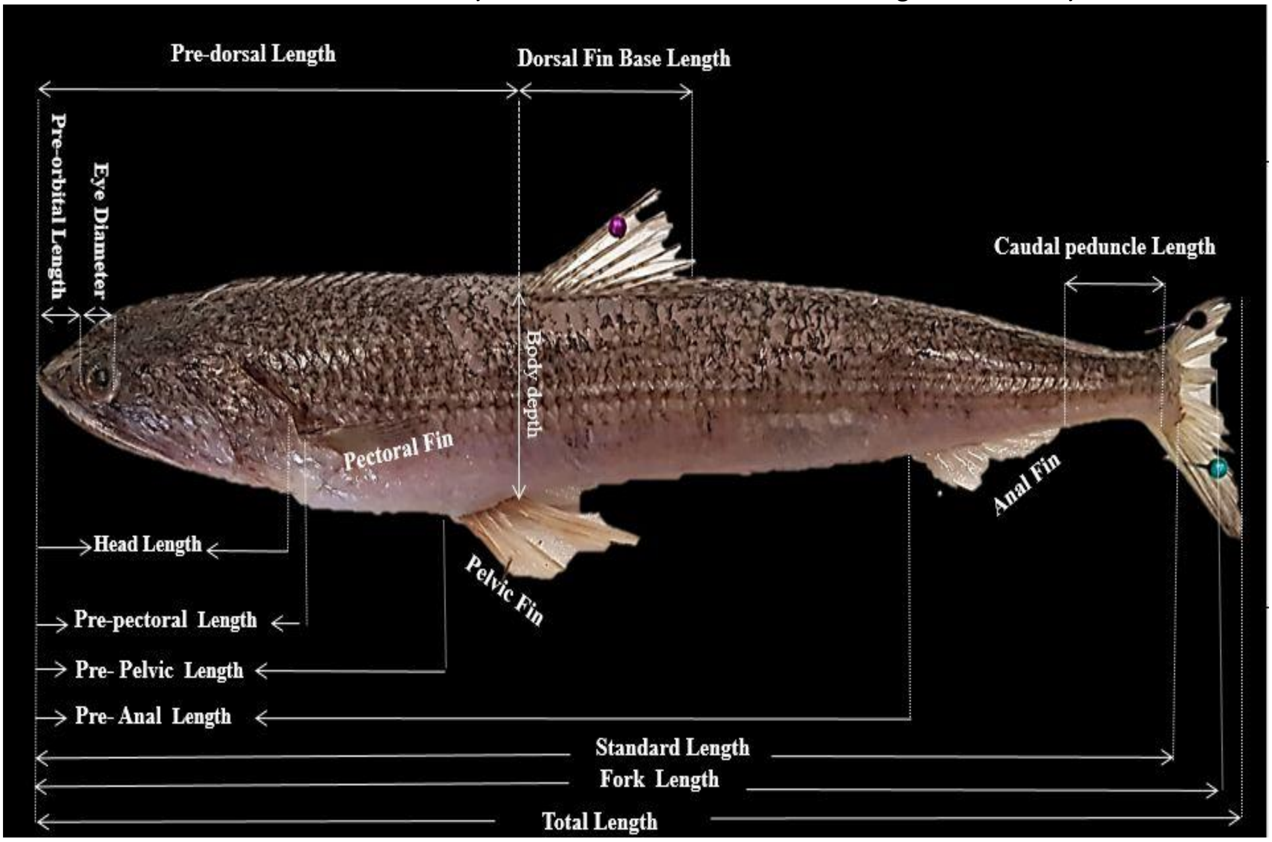

Fig. 2. The morphometric measurements and the meristic counts made on *Synodus saurus* of the present study.

Length-Weight Relationship

The relationship between body weight (W gm) and total length (L cm) of *Synodus saurus* was determined using the equation proposed by Gulland (1985):

$W = {}_{a}L^{b}$ Where (a) and (b) are constants.

Condition Factor

The Fulton Condition Factor (C_F) was calculated following the formula outlined by Fulton (1902):

$C_F = 100 * W/L^3$

RESULTS

The morphometric traits of *Synodus saurus*

The mean length (± Std. Error, n = 70) of the *Synodus saurus* sample was 20.14±.42cm (Table 2), with a corresponding mean weight of 66.93 ± 4.84 gm. The values of the other measured morphometric parameters are presented in the table.

All Pearson's correlation coefficients between the morphometric parameters were positive and highly significant (Table 3).

Linear, logarithmic and power regression of these pairs are shown in Table 4, and few of them in Fig. 3. All regressions were positive (i.e. the slope (b) was positive), highly significant, and mostly exhibited high R^2 values, indicating that the parameters increase together as the fish grows.

Table 2. Descriptive statistics of the morphometric parameters of *Synodus saurus* (n = 70).

Parameter	Minimum	Maximum	Mean	Std. Error	Std. Dev.
TW	24.00	239.00	66.93	4.84	40.53
TL	14.70	30.30	20.14	.42	3.48
FL	13.60	28.90	18.92	.4	3.34
SL	13.10	27.70	17.91	.38	3.17
BD	1.90	4.80	2.84	.07	.61
HL	3.30	6.80	4.58	.10	.86
PAL	9.80	20.30	13.43	.29	2.43
DFL	2.30	4.90	3.29	.07	.62
PPL	3.10	6.40	4.32	.09	.79
PPel	4.20	9.20	5.88	.13	1.12
CP	1.40	2.90	1.90	.04	.31
PDL	5.20	11.20	7.37	.16	1.31
POL	.60	1.60	.95	.02	.21
ED	.60	.90	.74	.01	.09
S	.50	1.50	.83	.02	.20

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Table 3. Pearson's Binary correlations between the measured morphometric parameters (n = 70).

	TW	TL	FL	SL	BD	PAL	PPel	HL	PPL	POL	S	PDL	DFL	CP
TL	.956**													
FL	.96**	.98**												
SL	.957**	.981**	.989**											
BD	.916**	.924**	.933**	.935**										
PAL	.958**	.989**	.995**	.987**	.931**									
PPel	.942**	.974**	.970**	.961**	.901**	.978**								
HL	.932**	.976**	.983**	.969**	.914**	.984**	.967**							
PPL	.927**	.972**	.982**	.965**	.912**	.981**	.962**	.990**						
POL	.885**	.895**	.989**	.898**	.847**	.910**	.869**	.907**	.909**					
S	.816**	.807**	.836**	.836**	.807**	.845**	.785**	.828**	.840**	.910**				
PDL	.931**	.967**	.972**	.972**	.917**	.981**	.952**	.969**	.971**	.924**	.869**			
DFL	.868**	.898**	.896**	.896**	.854**	.909**	.881**	.904**	.912**	.838**	.794**	.904**		
CP	.884**	.886**	.899**	.899**	.839**	.893**	.862**	.868**	.862**	.850**	.790**	.887**	.808**	
ED	.674**	.737**	.191**	.748**	.731**	.761**	.715**	.768**	.764**	.738**	.731**	.783**	.741**	.645**

Table 4. Linear (L), Logarithmic (Log) and power (Pow) regressions of morphometric parameters with fish length (TL), n = 70.

Parameter	Regression	a	b	R^2	P
TW	**L**	-156.9578	11.1299*	0.914	0.000
	Log	-600.0792	223.2770*	0.857	0.000
	Pow.	0.0053*	**3.1109	0.965	0.000
FL	**L**	-0.2505	0.9537*	0.98	0.000
	Log	-39.81	19.67*	0.97	0.000
	Pow.	0.894*	**1.0168	0.98	0.000
SL	**L**	-0.0545	0.8931*	0.963	0.000
	Log	-36.8484	18.3305*	0.945	0.000
	Pow.	0.9028*	**0.9951	0.953	0.000
BD	**L**	-0.4447	0.1632*	0.854	0.000
	Log	-7.2028	3.3613*	0.845	0.000
	Pow.	0.0877*	**1.1564	0.855	0.000
HL	**L**	-0.2921	0.2423*	0.953	0.000
	Log	-10.3866	5.0109*	0.949	0.000

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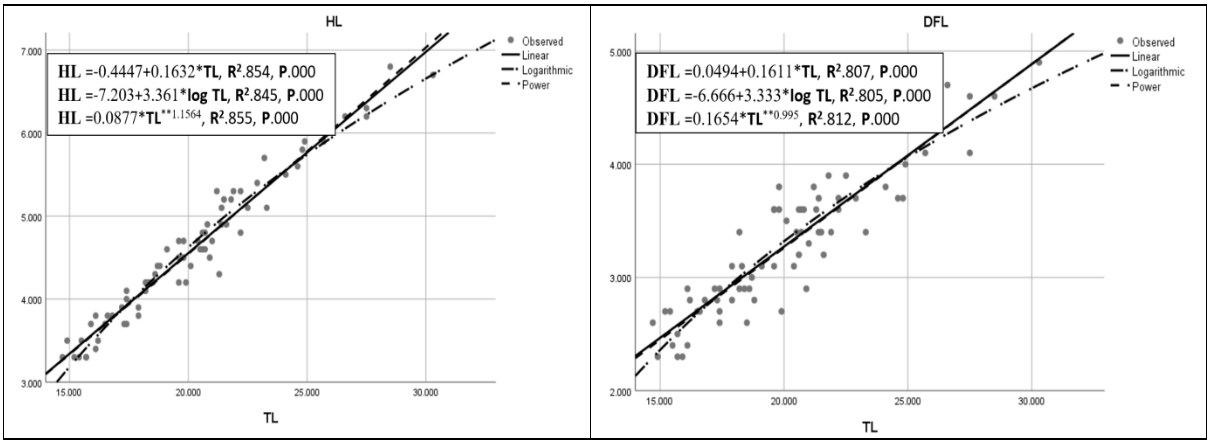
	Pow.	0.1813*	**1.0753	0.950	0.000
PAL	**L**	-0.4469	0.6897*	0.978	0.000
	Log	-28.9308	14.1795*	0.964	0.000
	Pow.	0.6154*	**1.0264	0.974	0.000
DFL	**L**	+0.0494	0.1611*	0.807	0.000
	Log	-6.6660	3.3332*	0.805	0.000
	Pow.	0.1654*	**0.9952	0.812	0.000
PPL	**L**	-0.1225	0.2208*	0.945	0.000
	Log	9.3287	4.5688*	0.943	0.000
	Pow.	0.1890*	**1.0420	0.941	0.000
PPeL	**L**	-0.4311	0.3136*	0.949	0.000
	Log	-13.3398	6.4327*	0.931	0.000
	Pow.	0.2441*	**1.0592	0.947	0.000
CP	**L**	+0.3369	0.0778*	0.784	0.000
	Log	-2.8392	1.5873*	0.760	0.000
	Pow.	0.1731*	**0.7983	0.771	0.000
PDL	**L**	+0.0459	0.3643*	0.934	0.000
	Log	-15.1444	7.5380*	0.932	0.000
	Pow.	0.3568*	**1.0085	0.928	0.000
POL	**L**	-0.1231	0.0535*	0.801	0.000
	Log	-2.3402	1.1028*	0.792	0.000
	Pow.	0.0315*	**1.1336	0.782	0.000
ED	**L**	+0.3673	0.0185*	0.543	0.000
	Log	-0.4292	0.3913*	0.565	0.000
	Pow.	0.1485*	**0.5352	0.551	0.000
S	**L**	-0.1129	0.0466*	0.651	0.000
	Log	-2.0334	0.9571*	0.639	0.000
	Pow.	0.0265*	**1.1403	0.612	0.000

*: significant at 0.05 level. **: significant at 0.01 level



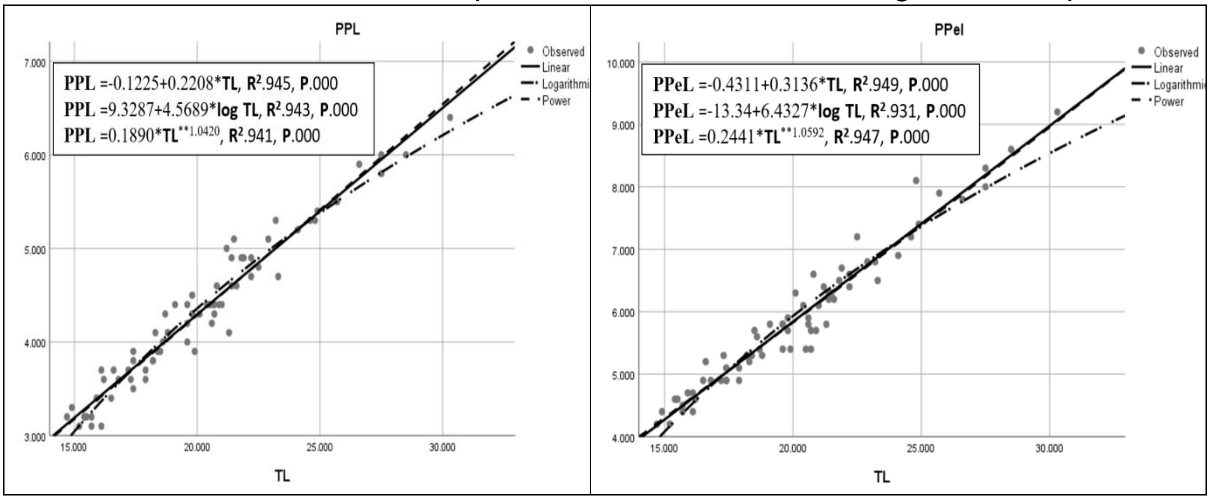


Fig. 3. Linear (L), Logarithmic (Log) and Power (Pow) regressions of some *Synodus saurus* morphometric parameters with fish length (L). Head Length, HL (top left), Dorsal Fin Length, DFL (top right), Pre Pectoral Length PPL, (lower left), and Pre Pelvic Length, PPeL (lower right).

Length-weight relationship

The length-weight relationship of *Synodus saurus* in this study is described by the equation:

$TW = 0.0053*TL^{**3.1109}$, n = 70, R^2 = .965, P = .000 (Fig. 4)

The growth pattern of *Synodus saurus* exhibited isomeric growth, meaning that both length and weight increased at similar rates during growth. The value of b (3.1109 ± 0.1411- mean ± confidence limit) in the power regression was not significantly different from the theoretical value of 3, which corresponds to isometric growth. The relationship was highly significant (P = 0.000), with a very high coefficient of determination (R^2 = 0.965), indicating a strong relationship between the fish's length and weight. Both the intercept (a) and the slope (b) of the regression were significant at the 0.05 and 0.01 levels (denoted by one and two stars, respectively).

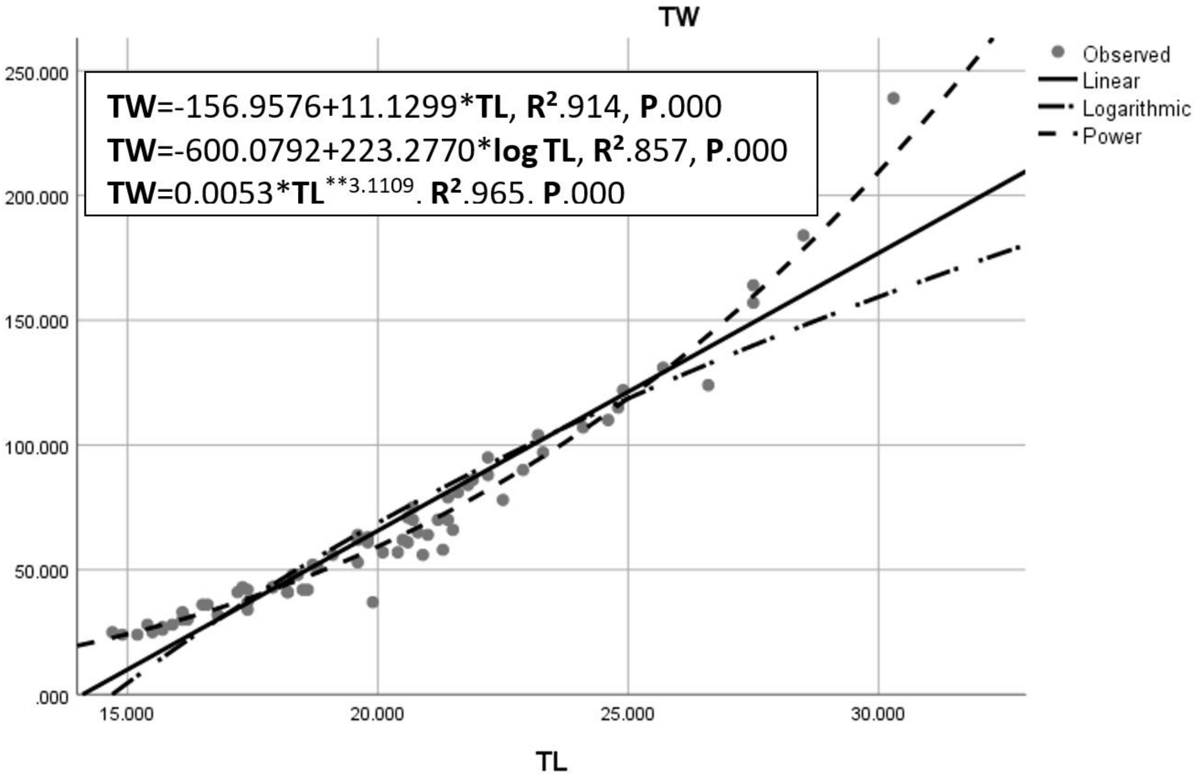


Fig. 4. Linear (L), Logarithmic (Log) and Power (Pow) regressions of *Synodus saurus* Total Weight (TW) with fish length (L).

Condition factor

The mean Fulton condition factor (C_F) (± Std. Error, n = 70) calculated for *Synodus saurus* in this study was 0.7443 ± 0.00847 (Table 5).

The regression of C_F against fish length shows how the "health" or condition of the fish changes as it grows. In this study, linear, logarithmic, and power regressions of C_F vs TL (Fig. 5) were:

- C_F = 0.6588 + 0.0042 * TL, R^2 = 0.043, P = 0.083, n = 70 (Linear)
- C_F = 0.4919 + 0.0844 * log(TL), R^2 = 0.04, P = 0.096, n = 70 (Logarithmic)
- C_F = 0.5317 * TL^0.111, R^2 = 0.034, P = 0.127, n = 70 (Power)

These regressions show a gradual but statistically significant increase in C_F as the fish grew. This means that the ratio of fish weight to fish length increased slightly as the fish length increased. In the power regression, the slope (b) was +0.111.

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Table 5 presents the descriptive statistics of C_F of *Synodus saurus.*

Descriptive Statistics				
	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
C_F	70	.7443	.00847	.07084
Valid N	70			

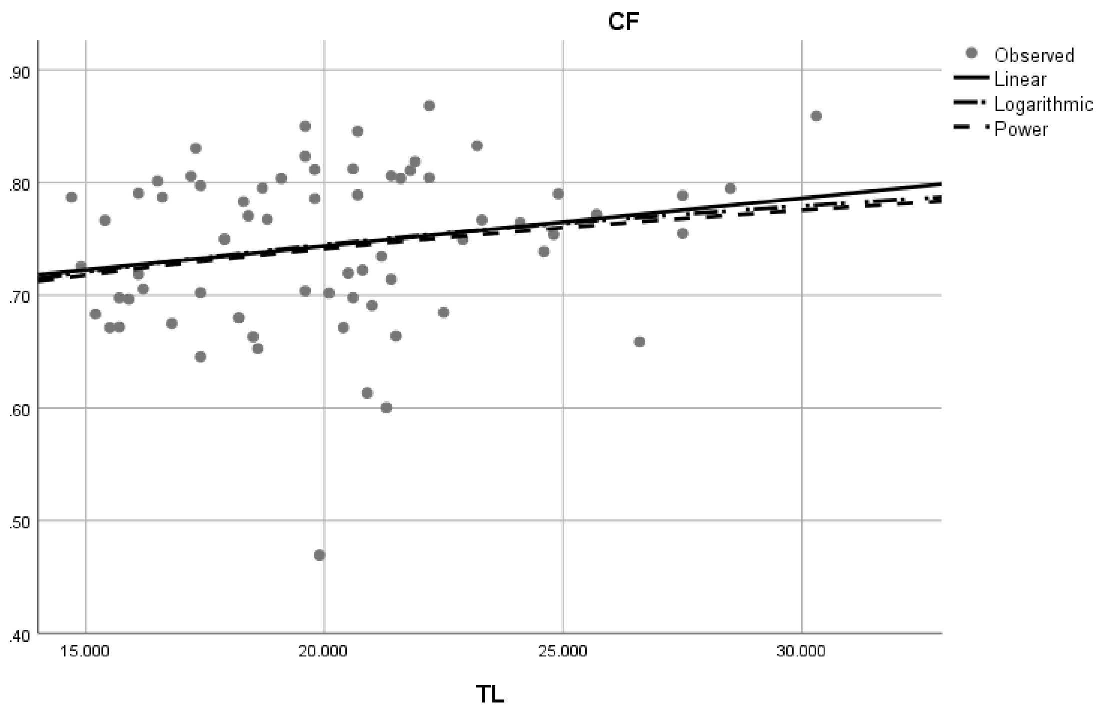

Fig. 5. Linear, Logarithmic and Power regressions of C_F of *Synodus saurus* with fish length (TL), n = 70.

The meristic parameters of *Synodus saurus*

All fins had rays only, but no spines (Table 6). The green row in the table indicates the mode (the most frequent number) of fin rays or lateral line scales. The blue rows represent the maximum and minimum counts. In the table:

All binary correlations involving the number of rays in individual fins (D, P, V, and A, in Table 7) were not significant at P = 0.05, and the values of their coefficients (r) were very low. However, the number of scales on the lateral line (LLS) correlated moderately but significantly with the number of rays in

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the dorsal fin (D). Similarly, the correlations between the number of scales below the lateral line (BLS) and the total length (TL), the number of scales on the lateral line (LLS), and the number of scales above the lateral line (ALS) were all positive, indicating that the number of scales increases with fish growth (Table 7).

Table 6. Basic statistics of the meristic parameters, from which the meristic form of the fish was derived, n = 30. All fins had rays only, but no spines.

		D	P	V	A	LLS	ALS	BLS
N	Valid	30	30	30	30	30	30	30
	Missing	0	0	0	0	0	0	0
Mode		12.00	12.00	8.00	11.00	62.00[a]	7.00	10.00
Minimum		11.00	11.00	7.00	9.00	53.00	5.00	7.00
Maximum		12.00	13.00	8.00	12.00	73.00	10.00	14.00

a. Multiple modes exist. The smallest value is shown

- D: Dorsal fin. P: Pectoral fin. V: Ventral fin. A: Anal fin. LLS: Lateral line scales. ALS: Scales above the lateral line. BLS: Scales below the lateral line.

Table 7. Binary correlations of meristic parameters with each other and with total fish length (TL), n = 30.

	TL	D	P	V	A	LLS	ALS
D	.285						
P	-.115	-.124					
V	.120	-.162	-.078				
A	-.083	-.054	-.032	.199			
LLS	.232	.422*	.215	.083	.281		
ALS	.190	.013	-.028	-.056	-.044	.345	
BLS	.439*	.229	-.004	.026	-.056	.420*	.430*

- D: Dorsal fin. P: Pectoral fin. V: Ventral fin. A: Anal fin. LLS: Lateral line scales. ALS: Scales above the lateral line. BLS: Scales below the lateral line.

The meristic formula

The meristic formula derived for *Synodus saurus* is as follows:

D, 11-12(12); A, 9-12(11); P, 11–13(12); V, 7-8(8); LLS, 53-73(62); ALS, 5-10(7); BLS, 7-14(10)

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DISCUSSION

The *Synodus saurus* in this study displayed typical morphology as described in previous research. The sample (n = 70) was representative of the population, with a mean total length of 20.14 ± 0.42 cm and a mean total weight of 66.93 ± 4.84 g. All 15 measured morphometric parameters strongly and positively correlated with one another. The linear, logarithmic, and power regressions showed similar strength in describing these relationships. The maximum length of *Synodus saurus* reported in the literature is 40 cm, with a common length of around 20 cm (Sulak, 1990; Bauchot, 1987). Esposito (2009) reported lengths ranging from 7.3 to 28 cm for specimens in the central Mediterranean, while Soares and Barreiros (2003) recorded 28.15 cm for those in the Azores. Manaşırl *et al*. (2008) documented lengths of 10.7-31 cm and weights of 9.99-267.56 g in Mersin, Turkey.

The growth pattern observed in this study was nearly isometric. The 'b' value of the power length-weight relationship ($TW = 0.0053 * TL^{3.1109}$, n = 70, $R^2 = 0.965$, P = 0.000) was 3.11, statistically indifferent from the theoretical value of 3 for isometric growth. This is consistent with Manaşırl *et al*. (2008), who reported a (b) value of 3.0241 for the same species in Mersin, Turkey. Other reported (b) values include 3.024 for fish in the Babadillimani Bight (Cicek *et al*., 2006), 3.1314 in the Adriatic Sea (Dulčić *et al*., 2019), 3.169 in Antalya Bay (Tanrıverdi and Hoşsucu, 2007), and 3.1171 in the eastern Mediterranean of Egypt (Mehanna and Frouk, 2021). However, slightly lower 'b' values, such as 2.937 in the Syrian Mediterranean, have also been recorded. More positive values include 3.332 in the Azores (Morato *et al*., 2001) and 3.32 in the Mediterranean Sea of Egypt (Abdallah, 2002). Overall, the length-weight relationship of *Synodus saurus* is typically isometric, many times slightly positive allometric.

In this study, the Fulton condition factor (C_F) of *Synodus saurus* was 0.7443. The regression of C_F against fish length indicated a mild but statistically significant increase in C_F as the fish increased in size, with a power-regression slope of +0.1110. This suggests that larger fish were in better condition than smaller ones, possibly because they are more capable of catching arger preys. Data on C_F for *Synodus saurus* in other studies are scarce, as the condition factor is more often used to track breeding seasons and spawning periods through monthly changes (e.g., Manaşırl *et al*., 2008; Tanrıverdi and Hoşsucu, 2007). The C_F value of 0.7443 obtained in the present study is consistent with Dulčić *et al*. (2019), who reported 0.79 for the species in the Adriatic Sea, and Amir *et al*. (2020) values of 0.65 to 0.73 in the Syrian Mediterranean.

Both (b) and in C_F are indicator of the relation between fish weight and its corresponding total length, and are, therefore, affected by same factors. The variability of (b) and C_F values within and between populations of the same species - as is seen across the above studies - is a complex interplay of multiple spatiotemporal factors such as temperature, food availability, seasonal changes, and breeding season (Pauly, 1980; García-Berthou, 2001). These factors can affect fish growth rates and body composition, leading to significant variations in the length-weight relationship. Understanding these influences is essential for effective fisheries management and conservation strategies, ensuring the sustainability of fish populations. For instance, rising temperatures can increase fish metabolism, leading to faster feeding and growth, which raises both (b) and C_F values (Froese, 2006). Conversely, lower temperatures slow growth and reduce these values (Henderson *et al*., 2018). In food-rich environments, fish tend to have higher (b) and C_F values (Weatherley and Gill, 1987). On the other hand, food scarcity slows growth, lowering both (b) and C_F values, deviating from isometric growth (Zhou *et al*., 2017).

Seasonal changes also influence these values due to shifts in temperature, food availability, and reproductive cycles. During breeding seasons, energy is often redirected toward reproduction, leading to variations in (b) and C_F values (Sanchez-Vazquez *et al*., 2019). Prey availability also affects fish condition, impacting the length-weight relationship (Miller *et al*., 2021). Spawning periods may temporarily decrease fish weight as energy is focused on reproduction, reducing both (b) and C_F values, the timing of breeding and spawning cycles can be inferred from monthly changes in C_F values (Weatherley and Gill’s (1987), Beyer *et al*., 2018, Froese's (2006 work). The meristic formula for *Synodus saurus* derived in the present study, Golani *et al*. (2006), and Smith (1997), respectively, is as follows:

- D 11-12 (12); A 9-12 (11); P 11–13 (12); V 7-8 (8); LLS 53-73 (62); Above lateral line scales ALS 5-10 (7); BLS 7-14 (10).
- D, 11-13; A, 9-12; P, 12-14; V, 8; LL, 54-60
- D 11-13, A 9-12, P 11-14, V 8, LL 57-60

These formulae closely align with each other. All fins were observed to have rays only, with no spines. Mode values are provided in parentheses following the guidelines of Mohammed (2019). No significant correlations were found between these parameters, or between these parameters and fish length, suggesting that meristic parameters are highly conservative and independent of fish size, but are specific to the species. While the number of fin rays was highly constant, the number of lateral line scales showed greater variability. It must be noted that if more fin rays were to be added during growth, more joints must be created to articulate them with the bones inside the body. Processes such as somitogenesis, which forms the somites contributing to the vertebral column, and the development of fin rays, occur in the early stages and are fixed after that (Lindsey, 1988; Strauss and Bond, 1990; Hubbs, 1926).

Though meristic traits are largely conservative, slight variations may arise in response to environmental conditions during early development. The above three formulae are similar, but not identical. Studies indicated that factors like water temperature, salinity, and oxygen levels during embryonic or larval stages can influence vertebrae or fin ray counts to some degree (Barlow, 1961). Temperature, in particular, has been found to affect vertebral counts in several species, with colder water often resulting in a greater number of vertebrae (Jordan, 1891; Lindsey, 1988). However, once these traits are established, they do not change as the fish grows, making them reliable indicators for species identification and phylogenetic research. Thus, while meristic traits exhibit limited plasticity during early development, they remain largely constant throughout a fish's life (Swain and Foote, 1999).

REFERENCES

Abdallah, M. (2002). Length-weight relationship of fishes caught by trawl off Alexandria, Egypt. NAGA, ICLARM. Q. Vl 25.

Amir Ibrahim, Chirine Hussein, Afraa darweesho. (2020). "Reproductive Biology of *Synodus saurus* (Linnaeus, 1758) in the Marine Waters of Syria (Lattakia District)," *SSRG International Journal of Agriculture & Environmental Science*, vol. 7, no. 2, pp. 15-19, 2020. *Crossref,* https://doi.org/10.14445/23942568/IJAES-V7I2P105

Barlow, G. W. (1961). Causes and significance of morphological variation in fishes. *Systematic Zoology, 10*(3), 105-117.

Bauchot, M. L. (1987). Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Commission des Communautés Européennes and FAO, Rome.

Beverton, R. J., & Holt, S. J. (1957). On the dynamics of exploited fish populations. Chapman and Hall.

Beyer, J. E., et al. (2018). "Reproductive allocation and growth dynamics in fish." *Fish Biology*.

Coll, M., Piroddi, C., Albouy, C., Ben Rais Lasram, F., Cheung, W. W., Christensen, V., ... & Pauly, D. (2012). The Mediterranean Sea under siege: spatial overlap between marine biodiversity, cumulative threats and marine reserves. *Global Ecology and Biogeography*, 21(4), 465-480. https://doi.org/10.1111/j.1466-8238.2011.00697.x

Dulčić J., Dragičević B. and Plepel A. (2019). Some biological characteristics of the Atlantic lizardfish *Synodus saurus* (Actinopterygii: Synodontidae) in the Adriatic Sea. *Front. Mar. Sci. Conference Abstract: XVI European Congress of Ichthyology*. doi: 10.3389/conf.fmars.2019.07.00012.

Froese, R. (2006). "Cube law, condition factor and weight–length relationships: History, meta-analysis and recommendations." *Journal of Applied Ichthyology*, *22*(4), 241-253.

Froese, R., & Pauly, D. (Eds.). (2021). *Synodus saurus* (Linnaeus, 1758). FishBase. Retrieved from https://www.fishbase.se/summary/Synodus-saurus.html

Fulton, F. (1902). Rate of growth of sea fishes. *Scientific Investigations of Fish*.

García-Berthou, E. (2001). "The characteristics of fish populations in the river Ebro." *Hydrobiologia*.

Golani, D, Ozturk, B. and Basusta, N. (2006). The Fishes of the Eastern Mediterranean. Turkish Marine Research Foundation, Istanbul, Turkey. 259 pp.

Gulland, J. A. (1985). Fish stock Assessment. A manual of basic methods. Marine resources service. Rome, Italy, p. 293.

Henderson, A., et al. (2018). "Temperature effects on fish growth and condition." *Aquatic Ecology*.

Hubbs, C. L. (1922). Variations in the number of vertebrae and other meristic characters of fishes correlated with the temperature of the water during development. *The American Naturalist*, 56(645), 360-372.

Hubbs, C. L. (1926). The structural consequences of modifications of the developmental rate in fishes. American Naturalist.

Jordan, D. S. (1891). Relations of temperature to vertebrae among fishes. *Proceedings of the United States National Museum, 14*, 107-120.

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.

Lindsey, C. C. (1988). Factors controlling meristic variation. *Fish Physiology*, 11, 197-274.

Manaşırl, Meltem; Dursun Avşar; Hacer Yeldan; Erdoğan Çiçek. (2008). Population Dynamical Parameters of the Atlantic Lizardfish (*Synodus Saurus*) From the Babadillimani Bight (Silifke-Mersin) In Turkey. Journal of FisheriesSciences.com- (2008) Volume 2, Issue 3.

Mehanna, Sahar F. and Farouk, Alam Eldeen. (2021). Length-Weight Relationship of 60 Fish Species from the Eastern Mediterranean Sea, Egypt (GFCM-GSA 26). Front. Mar. Sci., 27 July 2021. Sec. Marine Biology. Volume 8 – 2021.

Miller, R. J., *et al.* (2021). "Seasonal dynamics of fish populations in temperate zones." *Journal of Fish Biology*.

Mohammed (2019). Morphological Study to identify tilapia species (Cichlidae) in Ain Um Hufayan Lagoon, Eastern Libya Coast. Thesis. Marine Biology Branch, Department of Zoology, Faculty of Science, Omar AL-Mukhtar University, Albaida, Libya.

Moratoa, T.; P. Afonsoa; P. Lourinhoa; J. P. Barreirosb; R. S. Santosa; R. D. M. Nashc. (2001). Length-weight relationships for 21 coastal fish species of the Azores, north-eastern Atlantic. Fisheries Research 50 (2001) 297±302 Short communications.

Nelson, J. S. (2006). *Fishes of the World* (4th ed.). Wiley.

Pauly, D. (1980). "On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks." *Journal du Conseil*.

Reynolds, J. E., Haddoud, D. A., Vallet, F., (1995). Prospects for aquaculture development in Libya, Libfish Field Document No 9. Tripoli / Rome, FAO.

Sanchez-Vazquez, F. J., *et al*. (2019). "Seasonal effects on fish reproductive strategies." *Fish Physiology and Biochemistry*.

Smith, C. L. (1997). Identification keys for the fishes of the Gulf of Mexico. Texas A&M University Press.

Soares, Marta and Barreiros, João Pedro. (2003). Feeding habits of the lizardfish Synodus saurus (Linnaeus, 1758) (Actinopterygii: Synodontidae) from the Azores. Journal of Water Supply Research and Technology—AQUA. January 2003. 7(1):29-38. 7(1):29-38

sposito, F., et al. (2009). Diversity, structure and function of fish assemblages associated with Posidonia oceanica beds in an area of the eastern Mediterranean Sea and the role of non-indigenous species. *ResearchGate*. Retrieved from https://www.researchgate.net/publication/49681202_Diversity_structure_and_function_of_fish_assemblages_associated_with_Posidonia_oceanica_beds_in_an_area_of_the_eastern_Mediterranean_Sea_and_the_role_of_non-indigenous_species

Strauss, R. E., & Bond, C. E. (1990). Taxonomic methods: morphology. *In C.B. Schreck & P.B. Moyle (Eds.), Methods for Fish Biology*. American Fisheries Society.

Sulak, K. J., (1990). Synodontidae. In J. C. Quero, J. C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the Fishes of the Eastern Tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris. Vol. 1. 365-375.

Swain, D. P., & Foote, C. J. (1999). Stocks and chameleons: The use of phenotypic variation in stock identification. *Fisheries Research, 43*(1), 113-128.

Talwar, P. K., Jhingran A. G. (1992). Inland fishes of India. Rec. Ind. J., 3: 19-24.

Tanrıverdi, Raziye Yılmaz and Hoşsucu, Belgin (2007). The length-weigt relationship and relative condition factor of the Lizardfish, *Saurida undosquamis* (Richardson, 1848) and *Synodus saurus* (Linnaeus,1758) in Antalya Bay on the eastern Mediterranean coast of Turkey. Conference: Ulusal Su Günleri 2007/National Water Days 2007. At: Antalya-Turkey.

Turan, C., Erguden, D., Gurlek, M., & Yaglioglu, D. (2005). Morphometric and meristic variation of anchovy (*Engraulis encrasicolus*) populations in the Black, Aegean and northeastern Mediterranean Seas. *Journal of Ichthyology, 45*(4), 1-9.

Wainwright, P. C., and Bellwood, D. R. (2002). Ecomorphology of feeding in coral reef fishes. *Coral Reef Fishes: Dynamics and Diversity in a Complex Ecosystem*, 33-55.

Weatherley, A. H. and Gill, H. S. (1987). The Biology of Fish Growth. Academic Press, London, 444 pp

Weatherley, A. H., and Gill, H. S. (1987). "The growth and recruitment of fish populations." *Canadian Journal of Fisheries and Aquatic Sciences*.

Webb, P. W. (1984). Form and function in fish swimming. *Scientific American, 251*(1), 58-68.

Zhou, Y., et al. (2017). "Impact of dietary deficiencies on growth performance of fish." Aquaculture *Nutrition*.