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Biometry, Length-length and Length-weight Relationships of Little Tuna *Euthynnus alletteratus* in the Tunisian Waters

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ABSTRACT

The present study was carried out to gain some knowledge on length-weight relationship parameters and difference between the biometric characters of little tuna (*Euthynnus alletteratus*) from two regions in the Tunisian coastline. The knowledge of biometric characters has numerous practical applications in fishery biology. A total of 178 *Euthynnus alletteratus* individuals were sampled between January 2008 and December 2009, from two areas of Tunisia, one in the North (Teboulbah) and another one in the South (Zarzis) using multivariate fishing gear. Some fifteen morphometric and six meristic characters were examined for geographic variation. Morphometric characteristics were calculated as a percentage of the fork length. Morphological variation among the *E. alletteratus* collected showed significant differences ($p<0.05$) between Teboulbah and Zarzis specimens in maximum body height (H), Head Length (HL) and snout length (SnL). No significant differences were observed in the meristic characters of the two localities tested. Regression coefficients were estimated by using the logarithms of the fork length and the total weight. The length-weight relationships were determined for combined sexes as $W = 0.031\ FL^{2.815}$ for Teboulbah and $W = 0.022\ FL^{2.906}$ for Zarzis. The b-value obtained for Teboulbah and Zarzis indicate that the fish follows the cube law and its growth is negative allometry.

Key words: Morphological variation, little tuna, biometric characters, negative allometry, Tunisian waters

INTRODUCTION

Knowledge of biometric variations is necessary for the description of species. As a rule, specimens originating from different areas differ from one another in morphology (Franicevic *et al.*, 2005). The genus *Euthynnus*, distributed in tropical and subtropical waters worldwide is represented in Tunisia by the little tuna, *Euthynnus alletteratus* (Hattour, 2000). This primarily coastal species usually appears in Tunisian coasts throughout the year, with significant seasonal differences in landings. The largest annual production is recorded in May, June and July (Hattour, 2000). Little tuna is one of the most important tuna fishing resources in Tunisian waters (Hattour, 2000). From 1996 to 2005 this species accounted for 35.23% of all the small tuna landed in Tunisian waters (ICCAT, 2009).

Although there is some improvement in the number of studies on the biometry of tuna due to the interest in their taxonomy (Franicevic *et al.*, 2005; Zorica and Sinovcic, 2008). However, little tuna did not seem to receive much attention, with the exception of the study made by Gaykov and Bokhanov (2008), who used morphometric characters and meristic counts to differentiate two *Euthynnus alletteratus* sub-populations, from two different areas of the Eastern Atlantic.

Euthynnus alletteratus was recently described as a priority species by the Scientific Advisory Committee of CGPM (FAO, 2009). This is why from now on, the Tunisian population is arising more scientific interest and biological studies, biometric analysis and length-weight relationships are being performed. Teboulbah and Zarzis represent the most important fishing areas for little tuna in Tunisia. Given the distance that separates these two areas and the lack of comprehensive studies on stock identification of this species, the study of biometric differentiation between these two areas seems to be one of the first tasks to tackle.

The goal of this study is to contribute to a better knowledge of the biometry of little tuna, by assessing the morphometric and meristic differences between specimens collected in two different localities in Tunisian waters.

MATERIALS AND METHODS

Overall, 178 little tuna specimens were sampled between January 2008 and December 2009 with different fishing gear in two areas of Tunisian waters: Teboulbah and Zarzis (Fig. 1). Fifteen morphometric characteristics were examined (Fig. 2): Fork Length (FL), Standard Length (SL), Total Length (TL), Head Length (HL), Eye Diameter (ED), length of first dorsal fin base (LD1), length of second dorsal fin base (LD2), length of pectoral fin (LP), maximum body height (H), snout length (SnL), distance of the first dorsal fin (DD1), distance of the second dorsal fin (DD2), distance of ventral fin (DV), distance of the pectoral fin (DP), distance of anal fin (DA). The fork and total lengths were measured to the nearest 0.1 cm. The rest of the morphometric characters were measured to the nearest 0.01 mm. Sexes were pooled for all analyses, since little tuna does not exhibit sexual dimorphism (Gaykov and Bokhanov, 2008).

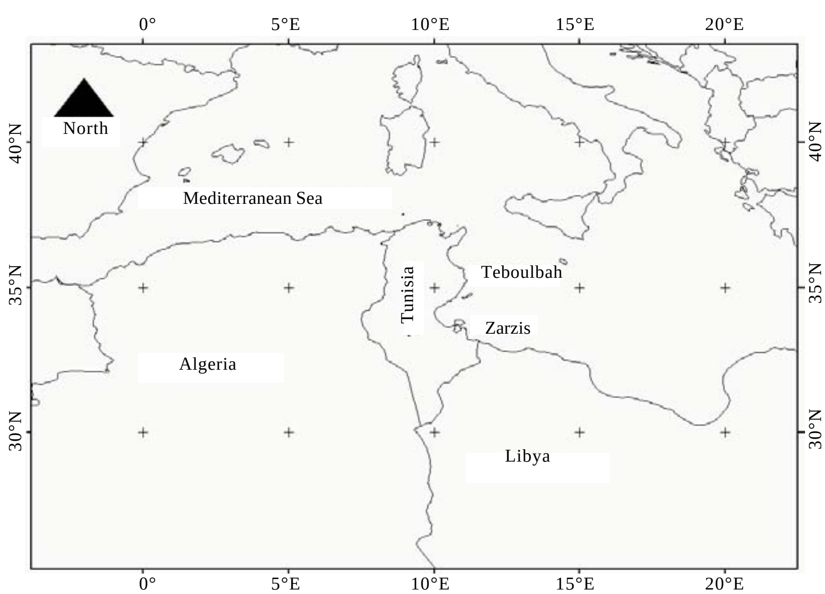

Fig. 1: Location of the sampling stations

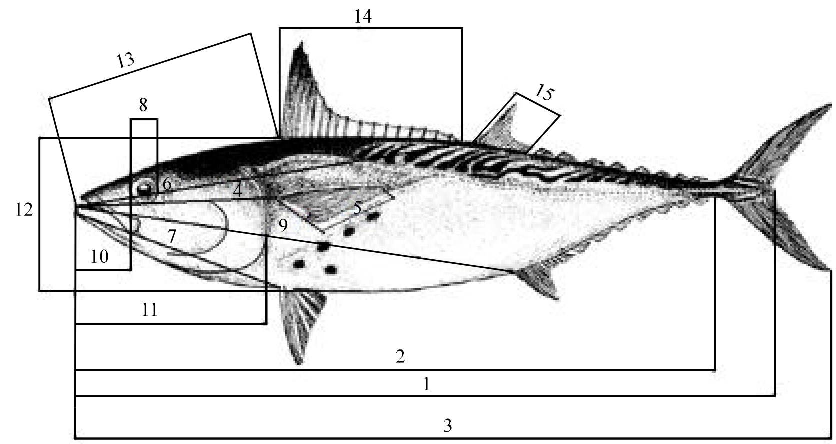

Fig. 2: Morphometric characteristics of the little tuna, *Euthynnus alletteratus*: 1: Fork length (FL); 2: Standard length (SL); 3: Total length (TL); 4: Distance of the pectoral fin (DP); 5: Length of pectoral fin (LP); 6: Distance of the second dorsal fin (DD2); 7: Distance of ventral fin (DV); 8: Eye diameter (ED); 9: Distance of anal fin (DA); 10: Snout length (SnL); 11: Head length (HL); 12: Maximum body height (H); 13: Distance of the first dorsal fin (DD1); 14: Length of first dorsal fin base (LD1); 15: Length of second dorsal fin base (LD2)

In addition, six meristic characters were also studied: number of spines in the first dorsal fin (FDR), number of second dorsal rays (SDR), number of pectoral rays (PR), number of anal rays (AR), number of dorsal finlets (DF) and number of anal finlets (AF). In order to ensure that the meristic characters were completely defined, only adults larger than 36 cm fork length were used. The morphometric characteristics were calculated as a percentage of the fork length. Fork length was expressed as percentage of total length. Length-length relationships were determined by the least squares method to fit a simple linear regression model. Length conversion equations were derived for fork length (FL).

The relationship between the length and weight of the fish was estimated using the equation $W = aL^b$ (Ricker, 1973), being W the weight of the fish, L the fork length and a and b constants. The parameters a and b were estimated by the least squares linear regression on log-log transformed data: $\log W = \log a + b\log L$. The coefficient of determination (R^2) was used as an indicator of the goodness of the linear regression. Biometry data were analysed by arithmetic means, standard deviations and variability coefficients (V). The significance of the differences in the studied characters between the samples from Zarzis and Teboulbah, as well as the isometric growth test hypothesis, were determined by Student's test (Zar, 1966).

RESULTS

The fork length of the analysed *Euthynnus alletteratus* from Zarzis (N = 92) varied from 37.5 to 97.8 cm and their body weight from 975 to 12800 g. The mean values and standard errors (SE) of weight and fork length, which were used for all the relationship analyses, were between 3189.76±46.6 g and 55.05±6.7 cm, respectively. Fork length of the analysed *Euthynnus alletteratus* specimens from Teboulbah (N=86) ranged between 36.3 and 95.5 cm and the mean value was 44.81±4.3 cm. Their body weight ranged between 950 and 11200 g, with a mean value of 2647.76±38.9 g.

Table 1: Relative relationship of measured body proportion of *Euthynnus alletteratus* from north of Tunisian coast (Teboulbah coast) and the southern Tunisian coast (Zarzis coast)

Relationship	Area	Range (%)	$\bar{X} \pm SD$ (%)	t	V (%)
FL/TL	Teboulbah	88.41-97.17	93.51±1.50	1.43	1.6041
	Zarzis	79.38-98.65	94.35±2.37		2.5119
SL/FL	Teboulbah	70.46-96.68	92.77±2.54	1.23	2.7380
	Zarzis	84.93-98.21	92.62±1.28		1.3820
H/FL	Teboulbah	20.69-27.31	23.87±1.43	2.21	5.9908
	Zarzis	19.29-28.48	22.60±1.35		5.9735
ED/FL	Teboulbah	2.55-5.21	3.68±0.42	0.76	11.4130
	Zarzis	2.43-5.04	3.71±0.39		10.5121
HL/FL	Teboulbah	20.00-48.23	23.84±4.23	2.13	17.7433
	Zarzis	22.26-41.54	24.75±2.04		8.2424
SnL/FL	Teboulbah	6.35-12.21	8.68±1.34	2.04	15.4378
	Zarzis	4.31-9.17	7.00±0.74		10.5714
DP/FL	Teboulbah	21.90-28.13	24.34±1.04	1.29	4.2728
	Zarzis	20.76-28.23	24.21±1.32		5.4523
DV/FL	Teboulbah	23.32-29.51	25.76±1.10	1.11	4.2702
	Zarzis	22.72-29.65	26.23±0.89		3.3931
DA/FL	Teboulbah	58.96-72.81	64.09±2.26	0.66	3.5263
	Zarzis	59.65-73.76	65.45±1.43		2.1849
DD1/FL	Teboulbah	23.54-32.62	27.22±1.10	1.15	4.0411
	Zarzis	22.78-32.54	28.30±0.76		2.6855
DD2/FL	Teboulbah	51.40-64.77	57.10±1.85	1.02	3.2399
	Zarzis	51.88-65.54	58.55±1.08		1.8446
LP/FL	Teboulbah	13.64-17.46	15.44±0.45	1.58	2.9145
	Zarzis	13.89-16.86	14.60±0.75		5.1370
LD1/FL	Teboulbah	25.32-33.81	27.10±0.89	1.03	3.2841
	Zarzis	25.65-32.65	27.23±0.76		2.7910
LD2/FL	Teboulbah	6.23-9.21	7.76±0.17	0.81	2.1907
	Zarzis	5.54-9.65	7.81±0.21		2.6889

Morphometric characteristics: Comparison of the morphometric characteristics between the two samples examined indicated statistically significant differences in three morphometric relationships (Table 1): maximum body height (H), head length (HL) and snout length (SnL). All the analyzed morphometric characteristics were entirely proportionate to fork lengths.

All the observed length-length relationships of the specimens from Teboulbah and Zarzis were linear. The estimated equations for the length-length relationships and coefficients of determination R^2 are presented in Table 2. The best fit for Teboulbah length-length relationships was observed for fork length (FL) and total length (TL) ($R^2 = 0.992$). The lowest determination coefficient value was found for the pair fork length (FL) and snout length (Snl) ($R^2 = 0.5541$). The highest length-length relationship coefficient for Zarzis little tuna specimens was for the FL-SL relationship ($R^2 = 0.998$) and the lowest determination coefficient value was found for the pair fork length and the distance of anal fin (0.649) (Table 2).

The variability coefficient of the morphometric relationship between ths sample from Teboulbah coast and the sample from Zarzis coast was relatively low (Table 2).

Table 2: Length-length relationship of *Euthynnus alletteratus* from north of Tunisian coast (Teboulbah coast) and the southern Tunisian coast (Zarzis coast)

Teboulbah		Zarzis	
Equation	R^2	Equation	R^2
FL = 0.9306TL + 0.196	0.992	FL = 0.9788TL - 1.6396	0.997
SL = 0.9318FL - 0.1712	0.984	SL = 0.9292FL - 0.1227	0.998
ED = 0.0257FL + 4.6374	0.711	ED = 0.0248FL + 4.9975	0.779
H = 0.2664FL - 1.5939	0.914	H = 0.2216FL + 0.1872	0.962
HL = 0.2621FL - 1.005	0.631	HL = 0.2404FL + 0.2617	0.969
SnL = 0.1111FL - 0.9929	0.554	SnL = 0.0614FL+ 0.331	0.916
DP = 0.2337FL + 0.4111	0.696	DP = 0.2209FL + 0.9714	0.780
DD1 = 0.2621FL + 0.4242	0.708	DD1 = 0.2013FL + 0.3164	0.817
DD2 = 0.544FL + 1.1416	0.773	DD2 = 0.399FL + 1.3651	0.717
DV = 0.2685FL - 0.4605	0.715	DV = 0.435FL + 0.1285	0.804
DA = 0.5803FL + 2.5541	0.743	DA = 0.349FL + 2.0081	0.649
LD1 = 0.2415FL + 1.132	0.675	LD1 = 0.2223FL + 1.016	0.813
LD2 = 0.019FL + 2.214	0,842	LD2 = 0.1103FL + 2.0131	0.789
LP = 0.1021FL+ 1.912	0.954	LP = 0.1342FL+ 2.032	0.868

Table 3: Summary statistics for meristics characters of *Euthynnus alletteratus* in different sites

Meristical character	Area	Range	Mode	$\bar{X} \pm SD$	t
Dorsal finlets	Teboulbah	6-9	8 (89.7%)	7,99±0.343	0.567
	Zarzis	7-9	8 (91.6%)	8,05±0.635	
Anal finlets	Teboulbah	6-8	7 (89.8%)	6,94±0.423	0.903
	Zarzis	6-8	7 (87.5%)	6,96±0.342	
First dorsal rays	Teboulbah	15-16	15 (88.8%)	15,03±0.725	0.669
	Zarzis	14-16	15 (83.3%)	15,03±0.213	
Second dorsal rays	Teboulbah	11-12	11 (64%)	11,25±0.312	0.445
	Zarzis	11-12	11 (64.3%)	11,63±0.432	
Anal rays	Teboulbah	11-13	13 (58%)	13±0.297	0.878
	Zarzis	11-13	12 (65%)	12,25±0.428	
Pectoral rays	Teboulbah	26-28	27 (65.5%)	26,83±0.131	1.323
	Zarzis	26-28	26 (74.4%)	26,51±0.453	

Meristic characteristics: Data on the meristic characteristics shown by locality are presented in Table 3. Specimens from the Teboulbah coast showed the highest values for anal and pectoral rays, while specimens from Zarzis coast showed the highest value for the second dorsal rays. There were no significant differences between meristic characters of the specimens from Teboulbah and Zarzis. The results were somewhat similar between the specimens captured in the two localities tested.

Length-weight relationship: The length-weight relationships for *Euthynnus alletteratus* specimens from Zarzis and Teboulbah are shown in Fig. 3a and b. Correlation coefficients (R^2>0.9) showed the high correlation between the estimated and the empiric data for the two samples. The equation for Zarzis specimens is: $W = 0.022\ FL^{2.906}$; $R^2 = 0.986$ and for Teboulbah individuals: $W = 0.031\ FL^{2.815}$; $R^2 = 0.984$. The functional regression value (b) derived from the length-weight relationships indicated a negative allometry for Zarzis specimens (b = 2.906; t = 1.99, p<0.05), as well as for Teboulbah specimens (b = 2.815; t = 5.02, p<0.05). The allometry coefficient difference between the two samples is statistically insignificant (t = 0.074, p>0.05).

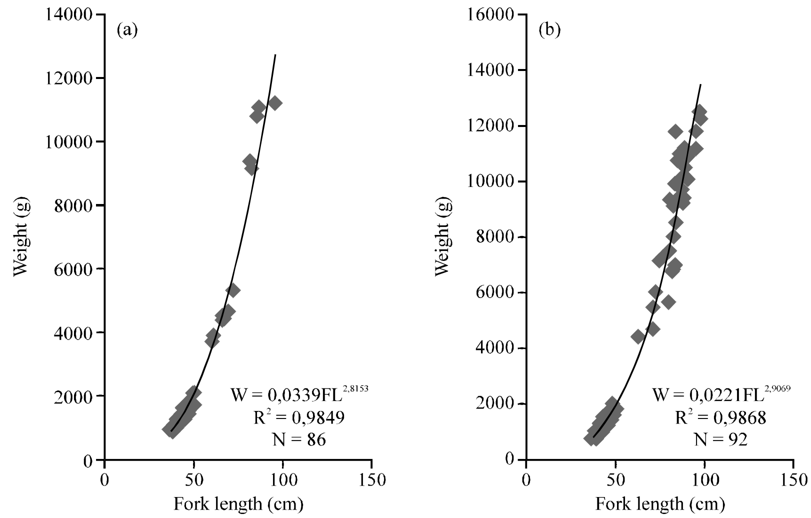

Fig. 3: Length-weight relationships for (a) Teboulbah and (b) Zarzis of *Euthynnus alletteratus*, from catch samples collected in the Tunisian waters

DISCUSSION

Data from this study present the first report on the existence of morphometric variations between two samples from the Tunisian little tuna population. The morphometric measurements carried out in the little tuna caught off the Northern and Southern Tunisian waters demonstrate the existence of morphometric variations between the two samples. The analysed morphological variations among the *E. alletteratus* collected show that the differences between specimens from Teboulbah and Zarzis are statistically significant ($p<0.05$) in maximum body height (H), head length (HL) and snout length (SnL). The snout length of Teboulbah specimens was significantly higher than that of Zarzis, while Zarzis specimens had a larger head length. The values of the maximum body height were significantly higher in Teboulbah individuals than in Zarzis ones ($t = 2.21$). Comparison of the two samples shows some relatively high values in the t-test. Student's t-test does not explain the morphological differences, i.e., very often it shows differences in specimens that belong to the same subspecies. Variation of morphometric characters in specimens from different geographical populations could be caused by differences in genetic structure or environmental conditions (Franicevic *et al*., 2005).

The variation coefficients for most of the indicators are less than 10%, except in some characters related to head length (ED, HL and SnL). In fish, the values of this coefficient within populations are usually far greater than 10% (Carvalho, 1993). Mamuri *et al*. (1998) reported low values of variability coefficients for red mullet, *Mullus barbatus*, which indicate minimal or very low intrapopulation variation.

There are no significant differences at 5% level of confidence between the meristic counts of the two localities tested. Furthermore, the values were similar for both samples, except for the number of anal and pectoral rays, but the difference was very small. The similarities in the meristic characters may indicate that the individuals have been exposed to the same environmental conditions during their larval stages, from which it may be inferred that these individuals have the same geographical origin (i.e., they come from the same spawning site).

On the other hand, the meristic counts indicated that, overall, meristic characters were very similar and are in accordance with earlier investigations of little tuna samples from the Tunisian waters (Hattour, 2000). Gaykov and Bokhanov (2008) found that the mean values of first dorsal ray, second dorsal ray, dorsal finlets and mean number of anal finlets in little tuna from the Gulf of Guinea-Angola are very close to the ones recorded in this study, while much smaller than those obtained in the Central-Eastern Atlantic (Gaykov and Bokhanov, 2008).

In this study, the relationships established using total fish weight always showed an allometric growth (negative allometry) for both Teboulbah and Zarzis little tuna specimens. This result agrees with those given by Hajjej *et al.* (2009) in the Tunisian waters (Kahraman and Oray, 2001) in the Aegean Sea, (Kahraman, 2005) in the Eastern Mediterranean Sea and (Kahraman *et al.*, 2008) in the North-Eastern Mediterranean. Comparing b values of length-weight relationships from different regions, it was observed that this value varies from negative to positive allometry. Isometric allometry was reported in *E. alletteratus* from Senegales waters (Diouf, 1980) and from the Eastern Atlantic Ocean (Gaykov and Bokhanov, 2008) and positive allometry was observed in Tunisian waters (Hattour, 2000). There is a general agreement that differences in the length-weight b parameter could be a reflection of influences of the genotype, or environmental or habitat factors, including the stage of maturity, sex, food, salinity, disease and season or time of capture (Bagenal and Tesch, 1978; Shepherd and Grimes, 1983; Jobling, 1997).

In the present study, it was established that there are no significant meristic differences between the little tuna population in the Teboulbah coast and little tuna in the Zarzis coast. Differences in some morphological characters are possibly due to the variability of habitat and sample size of this study. On the basis of the examined biometric indexes, there was not enough evidence to distinguish two different little tuna subpopulations. The biometric results in this paper are preliminar and provide an insight into distinctions among little tuna populations that might be of use; however, further and more complex research combining morphological and genetic research are required for future assessments.

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