

## Some Population Parameters of Morocco dentex, *Dentex maroccanus* Valenciennes, 1830 in the Northeastern Mediterranean Sea

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### Research Article

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### ABSTRACT

In this study, a total of 95 *Dentex maroccanus* samples ( $n_f=37$ ,  $n_m=58$ ) were examined from the northeastern Mediterranean Sea. The sex ratio was calculated as 0.63:1. The mean total length (TL), fork length (FL), and standard length (SL) were  $12.1 \pm 0.082$  cm,  $11.1 \pm 0.075$  cm, and  $10.0 \pm 0.068$  cm for all samples, respectively. The mean weight (W) was  $32.81 \pm 0.575$  g. The length-length relationships were determined as  $TL=1.1367SL+0.7136$ ,  $TL=1.0607FL+0.2804$ , and  $FL=1.0631SL+0.494$  for all samples, respectively. The total length-weight relationships were determined as  $W=0.08TL^{2.409}$ ,  $W=0.1183TL^{2.246}$ , and  $W=0.0489TL^{2.613}$  and the growth was negative allometric for all individuals, females, and males, respectively. The mean condition factor was calculated as 1.84 for all individuals, 1.78 for females, and 1.88 for males. There are no previous studies about the population parameters of Morocco dentex and the present study gave the first information on the length-weight, length-length relationships, and condition factors of *D. maroccanus* population inhabiting the northeastern Mediterranean Sea.

**Keywords:** Condition factor, *Dentex maroccanus*, Length-weight relationship, Length-length relationship, Mediterranean Sea.

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## Introduction

*Dentex maroccanus* (Morocco dentex) is an Atlantic-Mediterranean fish [1] and a significant demersal commercial sparid species that is present throughout the Mediterranean [2]. Morocco dentex inhabits the muddy lower shelf [3] and lives independently of the bottom [4]. It is distributed from the Bay of Biscay to the Gulf of Guinea, the eastern Atlantic, and the southern Mediterranean [5,6]. It is reported from Algeria [6], and the Aegean Sea [3,7,8]. In addition, it was reported as one of the most abundant species from the shelf of Antalya Bay [1]. *Dentex maroccanus* feeds on both benthic macrofauna and pelagic species [4]. The morphological sexual dimorphism was determined for *D. maroccanus* inhabiting eastern Algeria [6,9].

The length-weight relationships used for fisheries biology and fisheries management, generally, aid to determine [10-12] and comparing [13,14] the regional-specific biological characteristics of the fish species. The length-weight relationship can be used for morphometric comparison and it allows the determination of the condition of fish species [15]. When only length measurements are provided, the length-weight relationship can be used to calculate the weight [16]. Little information is available for *D. maroccanus* which is a Mediterranean species, and the relationships between different length types (relationships of fork length-total length, standard length-total length, standard length-fork length) are very important for comparative growth studies. The knowledge of condition factors is

particularly useful for studying fish biology. The condition factor (K) reflects data on the physiological condition of the fish concerning its welfare [17]. The sex ratio gives fundamental data to evaluate fish population stock sizes and evaluate their reproductive potential [18].

The Mediterranean Sea is regarded as one of the most complex marine habitats [19]. Despite the abundance of species in the eastern Mediterranean region, climate change and human activity are having an impact on coastal ecosystems [20,21]. Many fish stocks, particularly demersal ones, are regarded as being overfished or even depleted [22]. Regular fish stock monitoring and analysis is crucial for both fisheries management and fisheries biology to ensure the aquatic ecosystem's sustainability [23-26]. For this reason, it is necessary to examine the population characteristics of fish species.

There have been limited studies on the population parameter of *D. maroccanus*. The population parameters of *D. maroccanus* were mainly studied in the Aegean Sea on the coast of Turkey. It has been determined that there is no published study about the population parameters of this species inhabiting the Mediterranean Sea. There are several studies on age, growth, and reproduction in Algeria [6] and Saros Bay [2], on the length-weight relationship in Saros Bay [27] and the northeastern Aegean Sea [7], on ecological distribution on the shelf of Antalya Gulf [1], on diet composition in the central Turkish Aegean Sea [8]. In order to generate information

to assist future stock management and sustainable fishing, this study is the first to give some population parameters such as length-weight relationship (LWR), length-length relationship (LLR), and condition factor for *D. maroccanus* in the northeastern Mediterranean Sea.

## Materials and Methods

*Dentex maroccanus* individuals were collected in March-April 2021 from the northeastern Mediterranean Sea (Mersin Bay). The total length (TL), fork length (FL), and standard length (SL) were measured to the nearest 1 mm, and the weight (W) was recorded to the nearest 0.1 g. The sex of *D. maroccanus* individuals was determined by macroscopic investigation of the gonads. The sex ratio (female:male) was calculated with the equation: the total number of females/total number of males [28]. Whether there was a statistical difference between the length and weight values of females and males was tested using the t-test. The exponential regression equation,  $W = a \times TL^b$ , was used to calculate length-weight relationships (LWRs) [29]. In this equation, W is weight in g, TL is the total length in cm, a and b are constants. The %95 confidence interval of b values of both sexes and all individuals were calculated [30]. The parameters of "a" and "b" were estimated from the linear regression equation "logW=loga + blogTL" applied to the log-transformed. The growth type is isometric when b is equal to 3, positive or negative allometric when the b value is

greater or less than 3, respectively. Whether the b value obtained from the length-weight relationship is different from 3 was tested with the t-test and the growth type was determined. Length-length relationships (LLRs) such as FL-TL, SL-TL, and SL-FL were calculated from the equation:  $y = ax + b$ , and the coefficient of determination ( $R^2$ ) was determined. Fulton condition factor (K) was calculated from the equation:  $K=100 \times (W/L^3)$  [31]. In this equation, K is the condition factor, W is the weight (g) and TL is the total length (cm). The statistical analyses were calculated by Minitab 16 software.

## Results

A total of 37 females (38.9%) and 58 males (61.1%) of *Dentex maroccanus* individuals (n=95) were evaluated. The sex ratio (female:male) was calculated as 0.63:1. The descriptive statistics of weight, total length, fork length, standard length, and condition factor of both sexes and all individuals were given in Table 1. The mean total length and weight of all *D. maroccanus* samples, females and males were determined as  $12.1 \pm 0.082$  cm,  $12.3 \pm 0.130$  cm,  $11.9 \pm 0.100$  cm, and  $32.81 \pm 0.575$  g,  $33.93 \pm 0.839$  g,  $32.10 \pm 0.766$  g, respectively. The condition factor was  $1.84 \pm 0.017$  for all samples,  $1.78 \pm 0.026$  for females, and  $1.88 \pm 0.021$  for males, respectively. The condition factor showed statistically significant variation between females and males of *D. maroccanus* ( $P < 0.05$ ).

Table 1. The descriptive statistics of the variables and condition factors of *D. maroccanus* in the northeastern Mediterranean Sea (S.E.: Standard error, Min: Minimum, Max: Maximum, F: females, M: males)

Mean±S.E. (Min. - Max.)	Weight (g)	Total Length (cm)	Fork Length (cm)	Standard Length (cm)	Condition Factor
<b>F+M</b>	$32.81 \pm 0.575$ (17.80-52.00)	$12.1 \pm 0.082$ (9.9-14.3)	$11.1 \pm 0.075$ (9.1-12.9)	$10.0 \pm 0.068$ (8.3-12.1)	$1.84 \pm 0.017$ (1.49-2.25)
<b>F</b>	$33.93 \pm 0.839$ (18.60-45.80)	$12.3 \pm 0.130$ (10.6-14.3)	$11.3 \pm 0.122$ (9.5-12.9)	$10.2 \pm 0.115$ (8.7-12.1)	$1.78 \pm 0.026$ (1.49-2.07)
<b>M</b>	$32.10 \pm 0.766$ (17.80-52.00)	$11.9 \pm 0.100$ (9.9-13.5)	$10.9 \pm 0.090$ (9.1-12.4)	$9.8 \pm 0.080$ (8.3-11.2)	$1.88 \pm 0.021$ (1.49-2.25)

The calculations were separately made for all individuals, females, and males because both the weight and total length were statistically different between males and females of Morocco dentex (t-test;  $P < 0.05$ ).

The distributions of total length-frequency (%) and weight-frequency (%) (for ♀, ♂, ♀+♂) were shown in Figure 1.

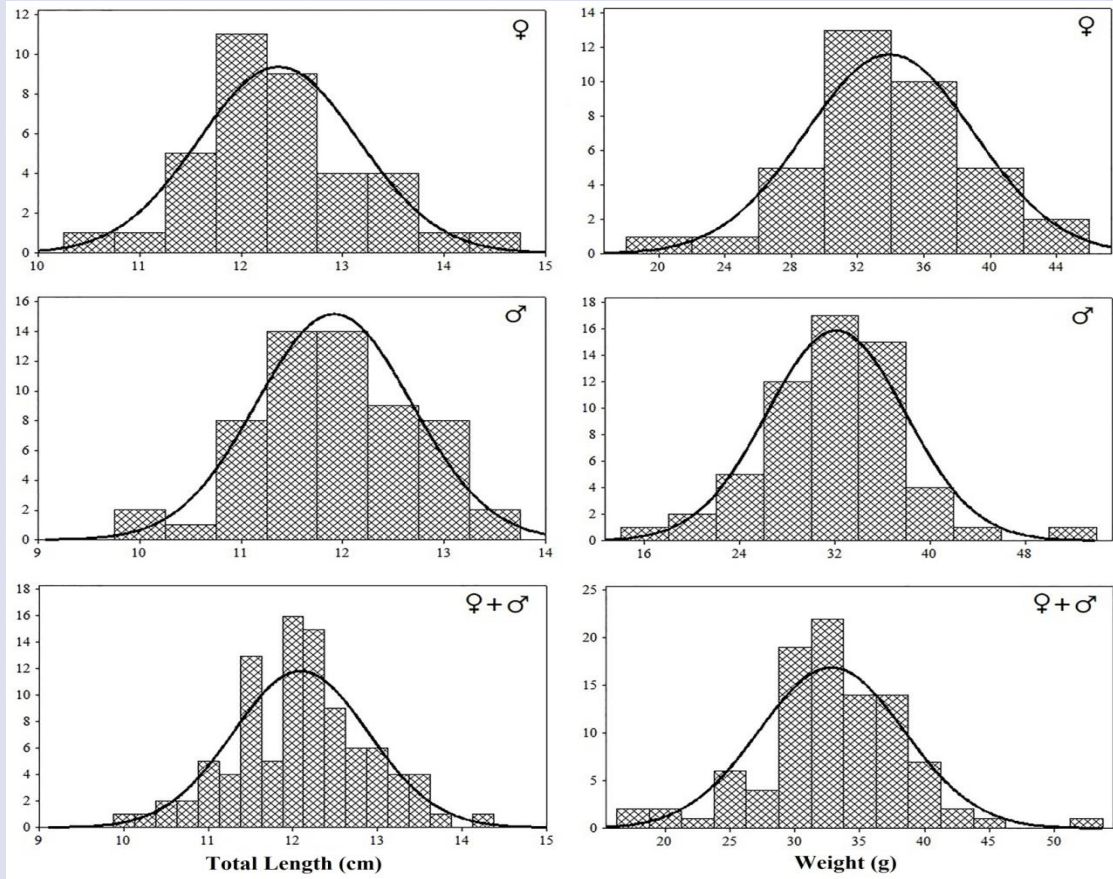


Figure 1. The distributions of length-frequency and weight-frequency for *D. maroccanus* individuals (♀, ♂, ♀+♂)

The length-weight and length-length relationships of *D. maroccanus* (♀, ♂, ♀+♂) were given in Figure 2-3. The LWR was  $W=0.08TL^{2.409}$  ( $R^2=0.79$ ) and the LLRs were

$TL=1.0607FL+0.2804$  ( $R^2=0.94$ ),  $TL=1.1367SL+0.7136$  ( $R^2=0.89$ ),  $FL=1.0631SL+0.494$  ( $R^2=0.93$ ) for all individuals, respectively (Figure 2).

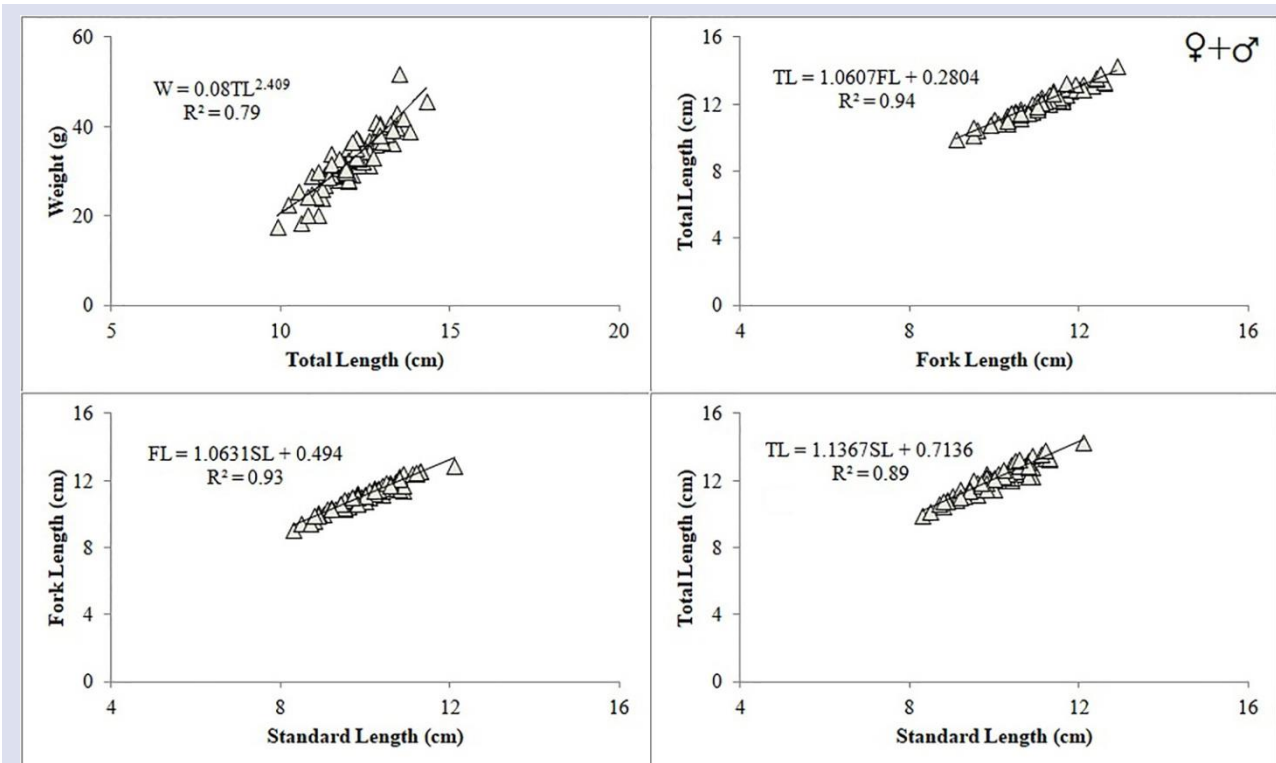


Figure 2. The LWR and LLRs of *D. maroccanus* for all individuals

The LWR was  $W=0.1183TL^{2.247}$  ( $R^2=0.77$ ) and the LLRs were determined as  $TL=1.0225FL+0.7418$  ( $R^2=0.92$ ),  $TL=1.0593SL+1.5395$  ( $R^2=0.88$ ),  $FL=1.0205SL+0.9387$  ( $R^2=0.92$ ) for females, respectively. The LWR was

$W=0.0489TL^{2.613}$  ( $R^2=0.81$ ) and the LLRs were determined as  $TL=1.075FL+0.1075$  ( $R^2=0.94$ ),  $TL=1.1795SL+0.2692$  ( $R^2=0.89$ ),  $FL=1.0921SL+0.2014$  ( $R^2=0.93$ ) for males, respectively (Figure 3).

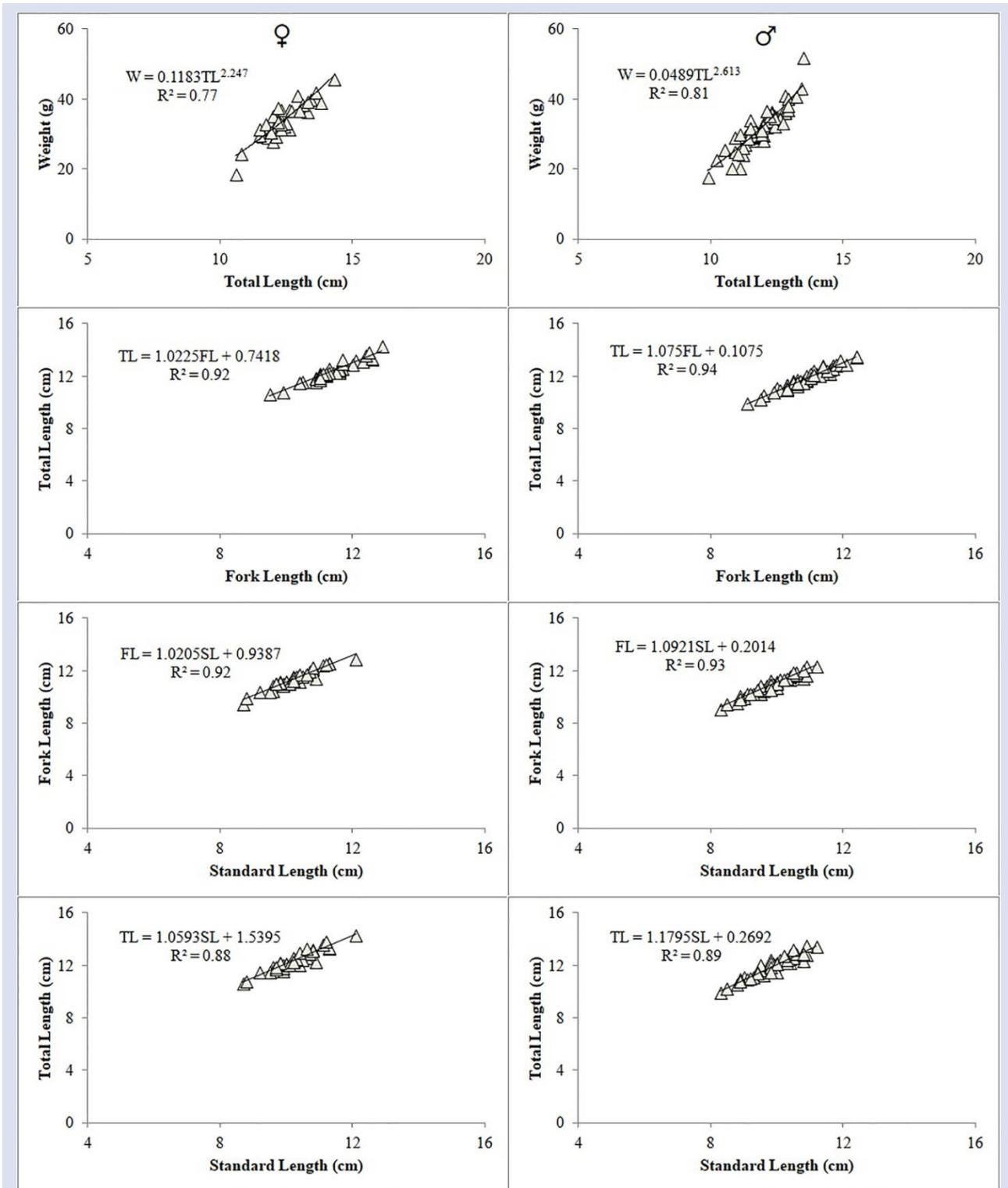


Figure 3. The LWR and LLRs of *D. maroccanus* for females and males

The  $b$  value was  $2.409 \pm 0.003$ , and 95% C.I. of  $b$  ranged between 2.403-2.416 for all *D. maroccanus* individuals. The  $b$  value was  $2.246 \pm 0.005$  for females and  $2.613 \pm 0.004$  for males, respectively. 95% C.I. of  $b$  was

2.236-2.257 for females and 2.604-2.622 for males, respectively. The parameter  $b$  of length-weight relationships was significantly different from 3 (t-test,  $P < 0.001$ ), and it was determined that the growth was

negative allometric for both sexes and all of *D. maroccanus* inhabiting the northeastern Mediterranean Sea.

## Discussion

Morocco dentex has economic importance as with the other members of Sparidae family. It has been determined that there were few studies on *Dentex maroccanus*, especially in the Mediterranean Sea, in the literature [1,6,32]. Therefore, this study represents the first information on sex ratio, length and weight frequency, condition factor, and relationships of length-weight and length-length of *D. maroccanus* in the Mediterranean Sea.

Understanding the relationship between individuals, their environment, and the state of the fish population requires knowledge of the sex ratio [33]. The females and males ratio of *D. maroccanus* (Algeria) was calculated as 49.74% and 46.49%, respectively, and the sex ratio (females:males) was reported as 1:0.9 [6]. [2]

reported female:male ratio was 4.8:1 (%82 for females and %18 for males). The sex ratio of Morocco dentex in İzmir Bay was 67% for females and 33% for males [34]. In the present study, the sex ratio was 0.63:1 for *D. maroccanus* inhabiting the northeastern Mediterranean Sea. The males were more than females according to sex composition (58 males against 37 females). This may be explained by behavioral variations during sex change or by one sex being more susceptible to specific fishing equipment [35]. The sex ratio is expected to be 1:1, but several factors such as environmental conditions, food, and reproductive behavior can change this ratio [36].

*D. maroccanus* showed positive allometric, isometric, and negative allometric growth in previous studies. The *b* value and growth type of *D. maroccanus* from different locations were given in Table 2.

TL-W relationships were  $W=0.012TL^{3.046}$  for females,  $W=0.011TL^{3.067}$  for males,  $W=0.016TL^{3.060}$  for both sexes, and growth type was positive allometric for both sexes and all individuals inhabiting the eastern coast of Algeria population [6].

Table 2. The *b* value and growth type of *D. maroccanus* from different locations (A(-): negative allometric growth, A(+): positive allometric growth, I isometric growth)

<i>b</i>	The growth	Location	References
3.183	A(+)	The northern Aegean Sea	[7]
2.7236	-	Saros Bay	[27]
2.287	A(-)	Aegean Sea	[37]
2.96 (♀)	-	The coast of Kenya	
2.87 (♂)	-	The coast of Kenya	[38]
2.91 (♀+♂)	-	The coast of Kenya	
2.899 (♀)	A(-)	The north Aegean Sea	
3.067 (♂)	A(+)	The north Aegean Sea	[2]
3.012 (♀+♂)	-	The north Aegean Sea	
3.046 (♀)	A(+)	The eastern coast of Algeria	
3.067 (♂)	A(+)	The eastern coast of Algeria	[6]
3.060 (♀+♂)	A(+)	The eastern coast of Algeria	
3.017	I	The north Aegean Sea	[39]
2.924 (♀)	A(-)	The central Aegean Sea	
2.789 (♂)	A(-)	The central Aegean Sea	[34]
2.856 (♀+♂)	A(-)	The central Aegean Sea	
2.246 (♀)	A(-)	The northeastern Mediterranean Sea	
2.613 (♂)	A(-)	The northeastern Mediterranean Sea	This study
2.409 (♀+♂)	A(-)	The northeastern Mediterranean Sea	

In another study, the length-weight relationships were determined as  $W=0.0194TL^{2.924}$ ,  $W=0.0269TL^{2.789}$ , and  $W=0.0228TL^{2.856}$  for females, males, and all individuals in the central Aegean Sea, respectively and the negative allometry was found for both sexes and all samples [34]. In this study, the total length-weight relationships were determined as  $W=0.1183TL^{2.246}$ ,  $W=0.0489TL^{2.613}$ , and  $W=0.08TL^{2.409}$  for females, males, and all individuals, respectively. A different conclusion was obtained in this study. The *b* values were 2.409 for all individuals, 2.246 for females, and 2.613 for males,

and negative allometry was determined for the northeastern Mediterranean Sea population. The females showed a strong negative allometric growth than the males. The males and females of the same population living in the same region may have different growth types. In this case, there has been excessive length growth relative to weight gain [40]. Similarly, [37] reported the *b* value as 2.287 for all individuals in the Aegean Sea. Generally, the *b* value ranged from 2.5 to 3.5 for all fish species [40]. According to [41], *b* value may vary from 2 to 4. Several biotic and abiotic factors affect



the length-weight relationship [40]. In addition, total length range, habitat, sex, the influence of fishing gear, and sample width can change the  $b$  value and growth type [27].

Many fisheries studies use length-length and length-weight relationships to provide information on the growth patterns and condition of fish species [29]. These relationships are useful for fisheries and they allow the calculation of fish conditions [42]. Condition factor is frequently used in fisheries studies. When contrasting two populations that exist under a particular climate, feeding density, and other circumstances, the condition factor provides information [17,41]. In this study, the condition factors of all individuals ranged between 1.49 and 2.25. The mean condition factor of males was higher than females ( $P < 0.05$ ) (Table 1). Similarly, Aura [38] reported that the mean condition factor of males was higher than females in Malindi-Ugwana Bay ( $p = 0.04$ ). Condition factor can vary interspecies and intraspecies depending on diet, sex, age, and environmental conditions [43,44].

There is no investigation on the length-length relationship of *Dentex maroccanus* in Turkish seas. Therefore, the present study is the first research in the northeastern Mediterranean Sea. Length-length relationships help us to estimate the other length by using any of the total, fork, and standard lengths of morphologically damaged fish individuals [10]. It is also one of the very important parameters for comparative studies in fisheries management [15].

## Conclusions

There is no study about the condition factor, LWRs, and LLRs of *Dentex moroccanus* from the northeastern Mediterranean Sea (Mersin Bay). Moreover, for the first time, the LLRs were determined for Morocco dentex population. The information from this study can provide the baseline data for fisheries. The obtained data will make an important contribution to the knowledge of the *D. moroccanus* population living in Mersin Bay. Thanks to data on the length-weight relationship of fish species inhabiting different geographical regions, researchers can compare the growth and condition differences of the same species. Length-weight parameters reported in this study will be used extensively in existing studies of Turkish commercial fisheries. This research may help with the management of *D. maroccanus* natural stocks, which are crucial for both economic and ecological reasons and may have been threatened by pollution and climate change. However, relatively little data is known about this species in Turkey. It is necessary to investigate the age determination and reproduction data of *Dentex maroccanus* in future studies.

## Conflicts of interest

The author stated that did not have conflict of interests.

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