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The Length-weight Relationship of *Diplodus vulgaris* (Teleostei, Sparidae) from Benghazi Coast (Libya)

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Abstract: Length-weight relationships (LWRs) were determined for fish species *Diplodus vulgaris* from the Benghazi coast along the eastern Mediterranean Sea coast of Libya. Samples were collected using trammel nets. The parameters *a* and *b* from the LWR formula W = *aLb* were estimated. The values of the exponent *b* of the length-weight relationships in all categories range between 2.295 in September to 3.208 in August. The total number of fish samples investigated were 290, from which 179 were males, 41 females and 70 fishes immature. The sex ratio male to female were 4.3:1. In January, August and Females the slope "b" close to equal 3, were the categories exhibited isometric relationship, in September, October and November were slope "b" not equal 3, which the categories exhibited negative allometric relationship. The mean observed length of male was 18.29 cm at mean observed weight 114.8 g, and mean observed length of female was 19.15 cm at mean observed weight 133.97 g.The general equation for the length-weight relationship for both sex was: $W = 0.03835L^{2.77}$, for male was: $W = 0.036\ L^{2.74}$, for female, $W = 0.016\ L^{3.02}$.

Key words: *Diplodus vulgaris*, allometric, ismeteric, Benghazi coast, sex ratio.

1. Introduction

The relation between the length of fish and the weight used since before year 1930, first was described by the cubic parabola [1]. But after that another equation was used instead of cubic parabola called general parabola, it gives better results [2]. The values of a and b differ between species, through the year and through the spawning season [3]. The relation between length (L) and weight (W) of fish is very important for estimating growth rates, age structures, and stock conditions; comparing life histories of fish species between regions; and assessing the condition of fish and other components of fish population dynamics [4].

With the knowledge that, in the Mediterranean sea there are 25 species of family sparidae, of which 14 species inhabiting the Libyan coast, such as *Diplodusvulgaris* [5]. The common two-banded seabream, *D. vulgaris* is a demersal species distributed in the Mediterranean and Black Seas and along the eastern Atlantic coast from France to Senegal, including the Madeira, the Azores and the Canaries Archipelagos. It is also present from Angola to South Africa [6]. It can be found close to rocky and sandy bottoms to a maximum depth of 60 m. Juveniles often live in coastal lagoons and estuaries [7] and it is considered a resident species in artificial reefs [8]. Mainly caught by line and hooks, generally recognize as commercial value, frequently in huge catch inhabiting the eastern coast of Libya [9].

Although there were many studies dealt with different aspects of Libyan fisheries for family sparidae and for the species *D. vulgaris*, almost concentrated on general biology, as food and feeding habits, reproduction, length weigh. But no study concentrated on studied the length weight as such during all months of year.

The main aims of the present study are to determine the relationship between length and weight during sex and months.

2. Material and Methods

The study area is located on the east coast of the

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Libyan line, include all coast of Benghazi and areas around which located between 32°36′ N and 20°03′ E on the Mediterranean Sea (Fig. 1). The coast line slope is characterized by strongly phenomena lagoon marshes and sand dunes (Guda, 1973). Just line a depth of 20 m from the coast line in front of the city of Benghazi more than 5 Ikm, however. This area includes seven fishing associations and many fishing companies. In the eastern part of Libya (Benghazi region) a list of bony fishes came up with a total of 201 species belonging to seventy one families and fifteen orders [10].

The data and information was gathered from the areas around and near Benghazi coast, 32°36′ N and 20°03′ E on the Mediterranean sea (Fig. 1), because it has been consider the largest areas in the east coast, The areas is packed with a large number of fisherman, reach 1,200. Also all kinds of fishing were practice there, all these reasons made the availability in collecting fishes sample, than other areas. Trammel and gill nets are still working in the area till now.

The relationships between body weight and total length for the species *D. vulgaris* were established following Gulland [2], for the whole total sample, monthly and by sexes (male and females). The constants "a" and "b" were obtained from the equation:

$$W(i) = q*L(i)^{b}$$

Where W(i) is the body weight, L(i) is the total length "a" and "b" are constants. The exponential equation was converted into a linear by logarithmic transformation.

$$\text{Ln } W(i) = \ln q + b*\ln L(i)$$

or

$$Y(i) = a + b*X(i)$$

Where Y(i) = ln W(i), x(i) = ln L(i) and a = ln q.

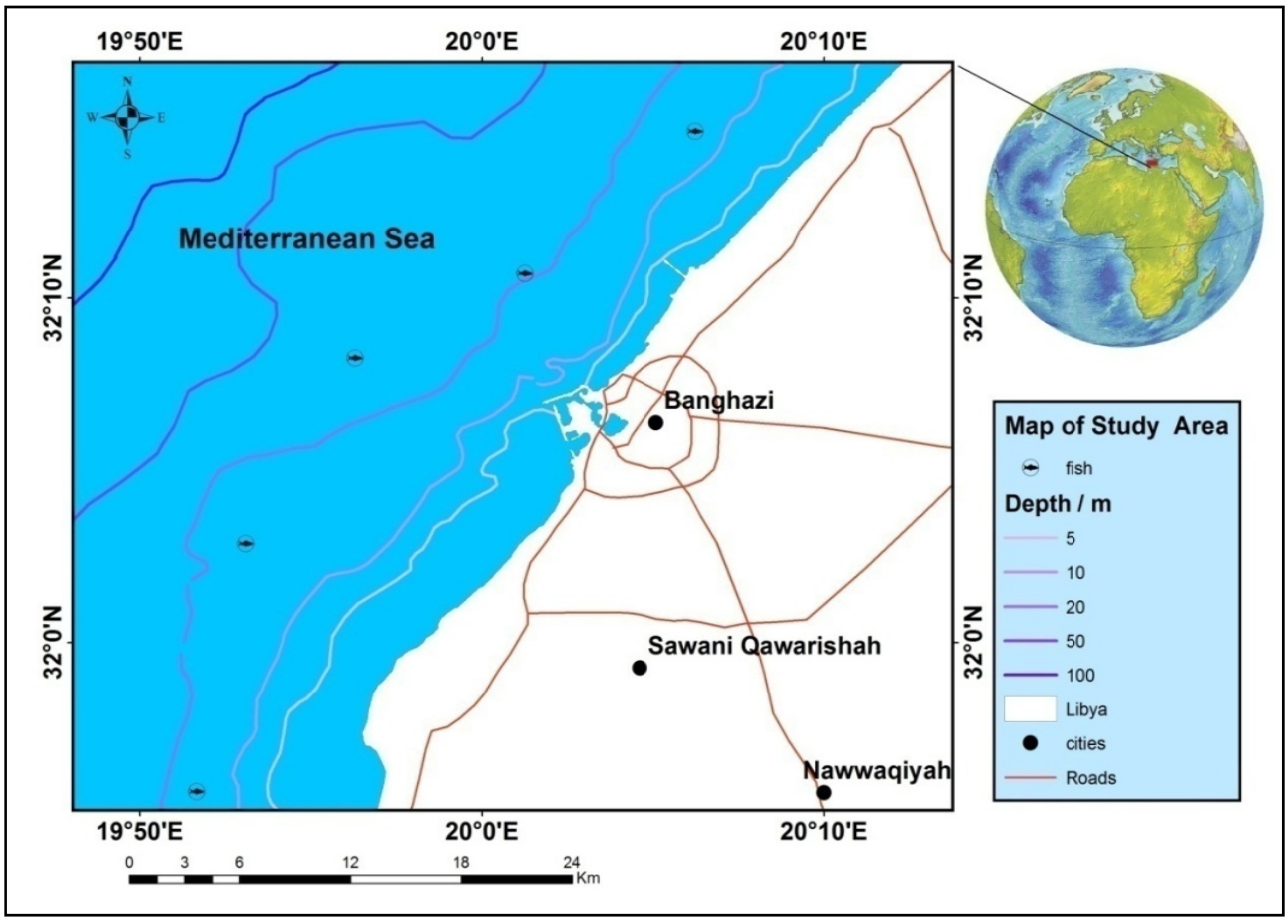

Fig. 1 The study area in Benghazi coast.

3. Statistical Analysis

The Effect of Sex and Months:

General linear model was performed to determine the effects of the sex of fish and the month of captured using SPSS computer software (2012), release 20. Duncan Multiple Range Test was used to estimate the differences between means.

4. Results

From table 1 and 2, it is appeared that, the total number of fish samples investigated were 290, from which 179 were males, 41 females and 70 fishes immature. The sex ratio male to female were 4.3:1. The mean observed length of male was 18.29 cm at mean observed weight 114.8 g, and mean observed length of female was 19.15 cm at, mean observed weight 133.97 g. The correlation coefficient "r", which measured the association between Length-weight regression parameters was estimated for all months, males, females and the whole sample are presented in Table 1 and Figures 2, 3 and 4, r seems to be high correlation in all categories r□0.5. The length-weight relationships were found significant ($P < 0.001$) in the all groups. The slope "b" in all categories range between 2.295 in September to 3.208 in August. In January, August and Females the slope "b" close to equal 3, were the categories exhibited isometric relationship, in September, October and Novemberwere slope "b" not equal 3, which the categories exhibited negative allometric relationship and for the other months, males, and both sex showed positive allometric relationship were seen. However, allometry. was very small with coefficients close to 3 and there were no statistically significant differences in slopes or intercepts between males and females. The analysis of variance (Table 2) indicated a high significant effects of months on both total length and total weight, while the sex had no significant effects on the bellow mentioned traits. The general equation for the weight-length relationship for both sexes was: $W = 0.03835L^{2.77}$

For male was: $W = 0.036\ L^{2.74}$ and For female: $W = 0.016\ L^{3.02}$.

Within columns, means had different superscripts differed significantly ($P < 0.05$).

Table 1 The relationship between Weight (Y) and Length (X) monthly, by sexes and for whole for *Diplodus vulgaris* from Benghazi coast 2014-2015.

Month	Equation	a	b	R	Significance
December	Y = 2.966X - 1.708	-1.708	2.966	0.986914	$P < 0.001$
January	Y = 3.112x - 1.881	-1.881	3.112	0.98488	$P < 0.001$
February	Y = 2.646x - 1.313	1.313-	2.646	0.96280	$P < 0.001$
March	Y = 2.573x - 1.243	-1.243	2.573	0.91214	$P < 0.001$
April	y = 2.983x - 1.752	-1.752	2.983	0.98590	$P < 0.001$
May	y = 2.623x - 1.246	1.246-	2.623	0.95864	$P < 0.001$
June	y = 2.8811x - 1.5782	-1.5782	2.8811	0.9219	$P < 0.001$
July	y = 2.9486x - 1.7083 R = 0.9219	-1.7083	2.9486	0.9571	$P < 0.001$
August	y = 3.208x - 2.071	-2.071	3.208	0.954986	$P < 0.001$
September	y = 2.2956x - 0.8531 $R^2 = 0.963$	-0.853	2.295	0.9813256	$P < 0.001$
October	y = 2.3529x - 0.9896 $R^2 = 0.9128$	-0.9896	2.3529	0.896102	$P < 0.001$
November	y = 2.489x - 1.1738 $R^2 = 0.9422$	-1.173	2.489	0.9705668	$P < 0.001$
male	y = 2.741x - 1.442	-1.442	2.741	0.9787747	$P < 0.001$
female	y = 3.016x - 1.791	-1.791	3.016	0.98640762	$P < 0.001$
whole	y = 2.722x - 1.416	-1.416	2.722	0.97570487	$P < 0.001$

Table 2 Mean observed weight and length and calculated weight and length for *D. vulgaris* from Benghazi coast 2014-2015.

Categories	Mean observed weight (g+-S.D.)	Mean observed length (cm+-S.D)	Mean calculated weight (g)	Mean calculated length (cm)
Effect of month				
December	71.89 ± 24.9^{a}	15.71 ± 1.8^{a}	78.917	15.19
January	115.55 ± 58.8^{bc}	17.97 ± 2.9^{b}	114.5	18.03
February	155.45 ± 45.05^{de}	20.89 ± 2.3^{d}	173.77	20.07
March	111.55 ± 115.8^{bcd}	17.86 ± 4.8^{bc}	109.46	18.03
April	103.23 ± 7.7^{bc}	17.67 ± 3.3^{b}	109.29	17.3
May	101.81 ± 61.8^{bcd}	16.67 ± 3.7^{b}	93.00	17.223
June	50.1 ± 12.7^{a}	13.63 ± 1.1^{a}	53.24	13.33
July	148.46 ± 54.8^{cde}	20.38 ± 2.5^{cd}	162.27	19.73
August	192.6 ± 53.5^{ef}	22.56 ± 2.08^{de}	215.03	21.68
September	207.25 ± 42.02^{f}	23.90 ± 2.1^{e}	252.30	22.26
October	77.4 ± 18.5^{a}	15.76 ± 1.6^{a}	79.61	14.94
November	94.62^{ab}	18.26 ± 1.9^{bc}	119.70	16.77
Effect of sex				
Male	114.8 ± 66.96^{a}	18.29 ± 3.4^{a}	120.25	17.94
Female	133.97 ± 78.10^{a}	19.15 ± 3.8^{a}	136.57	19.017
Over all mean	106.78 ± 73.24	17.53 ± 3.8	106.91	17.52

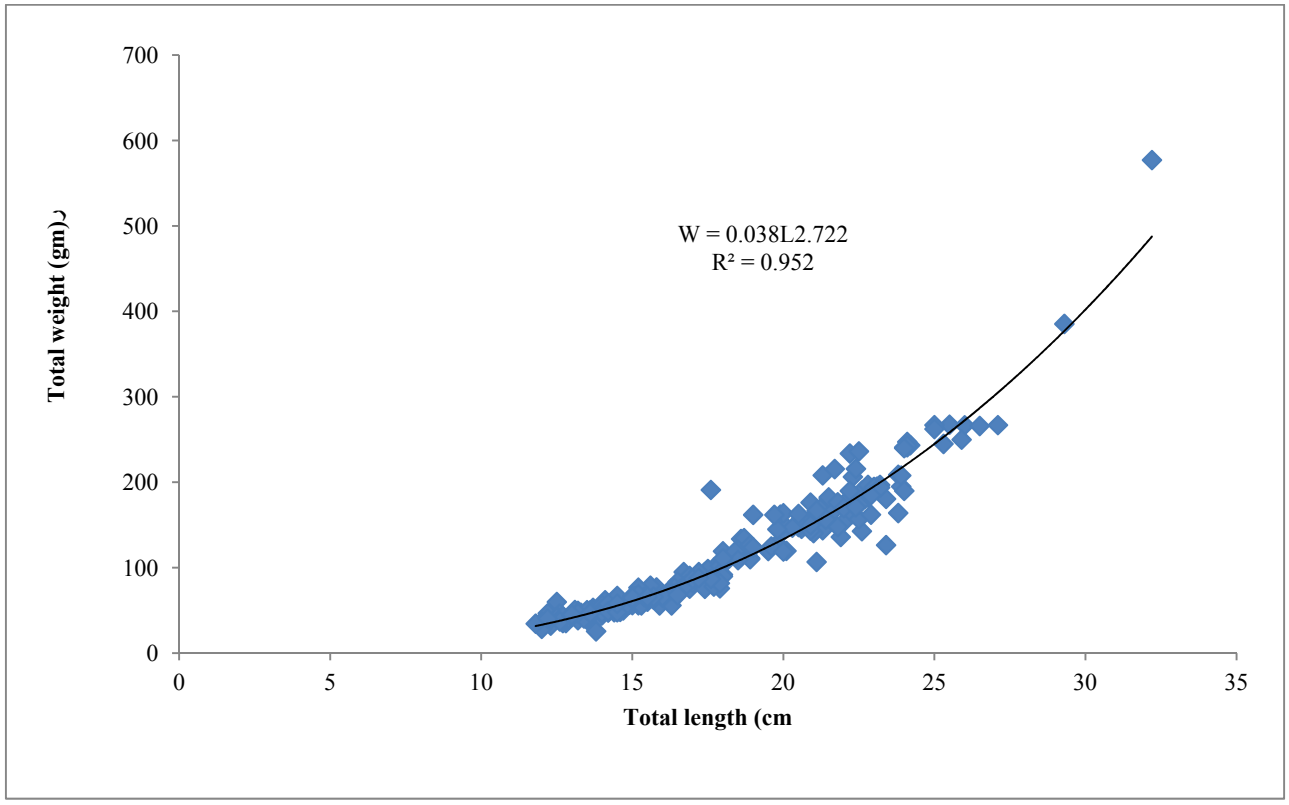

Fig. 2 The relationship between total weight (gm) and total length (cm) for both sexes for *D. vulgaris* from Benghazi coast 2014-2015.

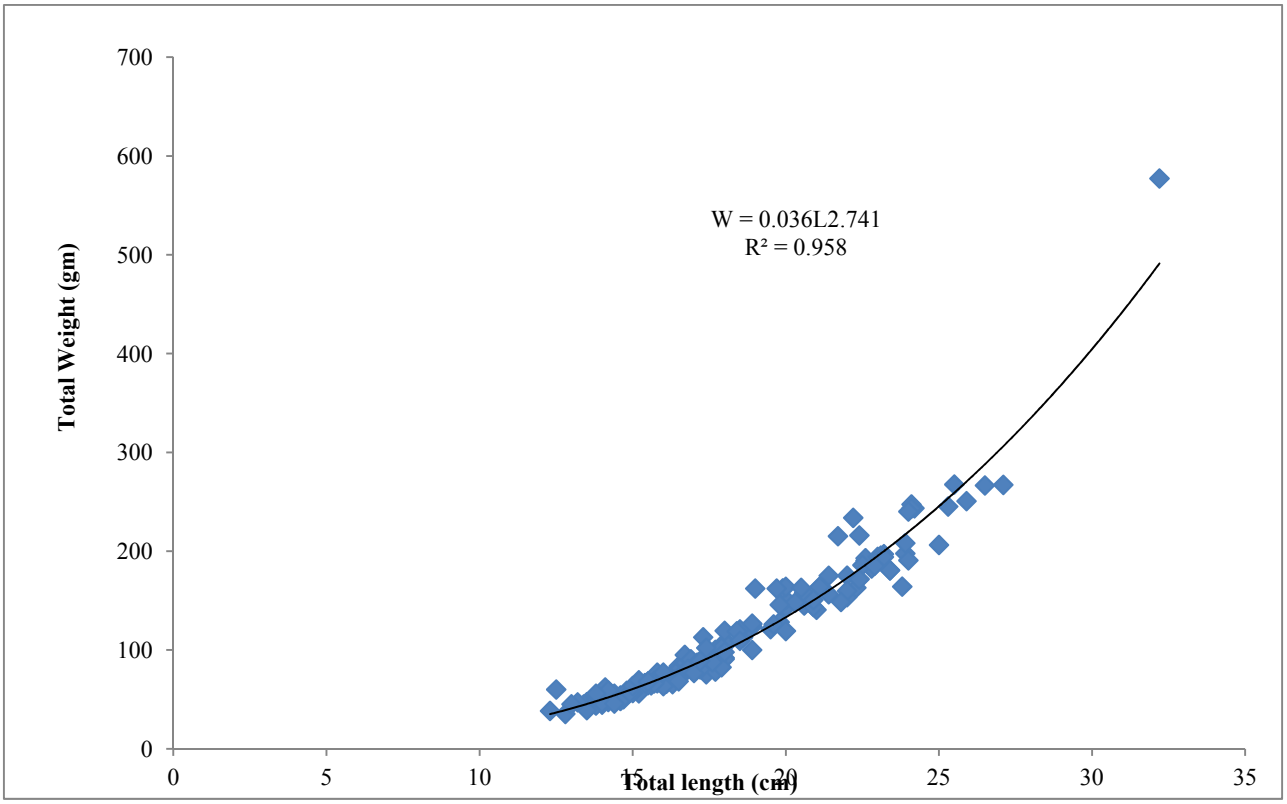

Fig. 3 The relationship between total weight (gm) and total length (cm) of male for *D. vulgaris* from Benghazi coast 2014-2015.

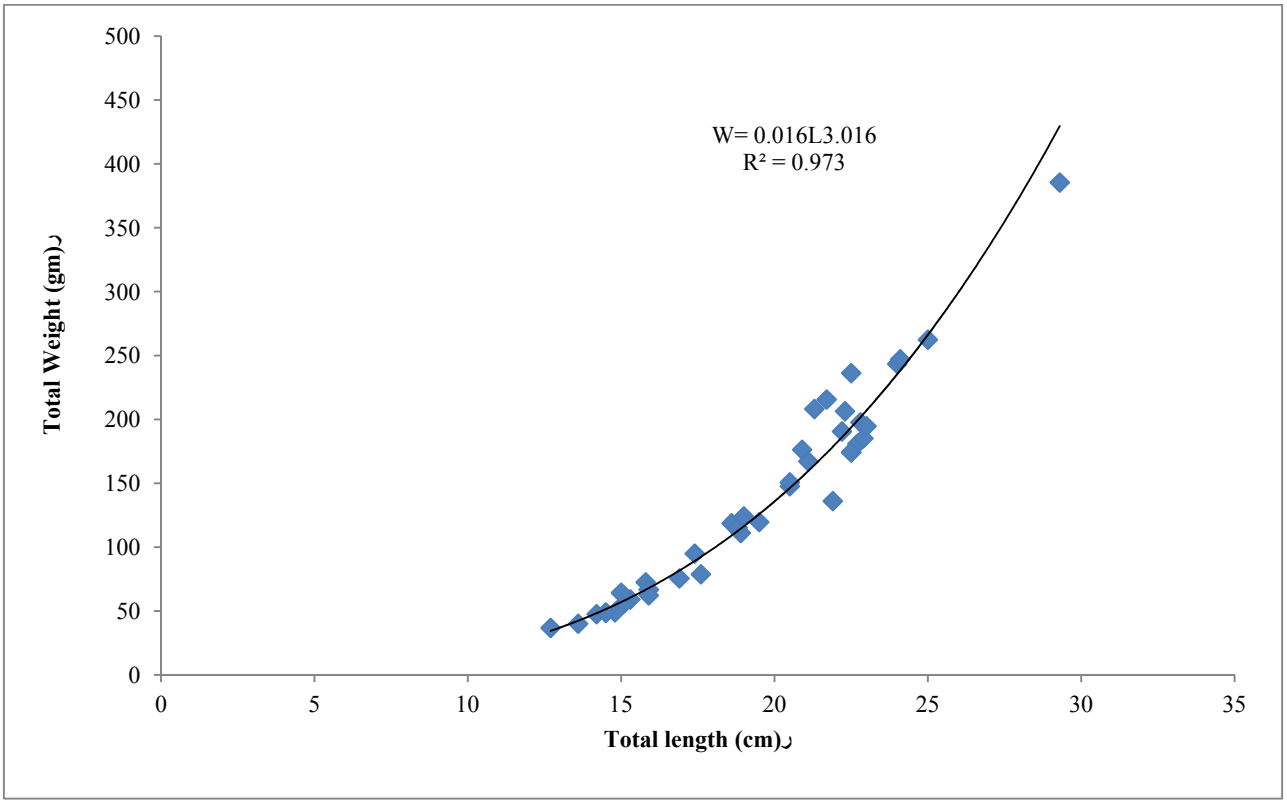

Fig. 4 Weight-length relationship for female for *D. vulgaris* from Benghazi coast 2014-2015.

5. Discussions

The percentage of sex ratio male to female in this a study was 4.3:1, with favor of male. Our results on this study compare with the results of Taieb, *et al*. 2013, from Tunisia sea, he, recognized that the sex ratio for the species *D. vulgaris* was 1:1.66, and with Dulcic, *et al*. 2011, from the Eastern Adriatic Sea, they mentioned 1.22:1, with favor to male, these variation in results me be due to different in locations or types of gears used in captures of this species in its areas ranges. Sadovy and Shapiro, they mentioned that the percentage of males to females varied with size of fish and also by season and months [11].

The length-weight relationships a practical index of the condition of fish. In fisheries studies; the condition factor is an essential biological parameter needed to understand the suitability of the environment for good living of fish [12]. In the present study the Length-weight regression parameters estimated for all months, male, female and both sex were showing different result in slope "b" and showed high correlation coefficient "r" between total weight and total length of species *D. vulgaris*, presented in table1 and Figs 2, 3 and 4. The length-weight relationships were found significant ($P < 0.001$) in the all groups. In January, August and Females, were exhibited isometric relationship, in September, October and November were exhibited negative allometric relationship while for the other months, males, and both sex showed positive allometric relationship. However, allometry was very small with coefficients close to 3 and there were no statistically significant differences in slopes or intercepts between males and females. This finding recognized by many authors [4] were suggested that the pattern of weight relative growth may fluctuate over the year according to factors such as food availability, feeding rate, gonad development or spawning period.

In the present study, the value of the exponent "b" for both sex for species *D. vulgaris* was found to be (2.8), male (2.7) and female (3.0) which indicated slight positive allometry with both sex and male, while for female which indicate isometric growth. This value was lower for values of (both sex and male) and similar with some values than the values of "b" of *D. vulgaris* which is estimated by Mahmoud [13] in Abu Qir Bay Egypt, (2.9), in Gulf of Tunis (3.05 both sex, 3.058 for male and 3.078 for female) [14], in the Gulfof Lion (3.123) [15] and in the Egyptian Mediterranean water (3.003) [16]. The differences in b value observed for the species across areas may be attributed to the different atrophic conditions [17]. In fact, the Mediterranean Sea, and the Eastern Basin in particular, is considered as one of the most oligotrophic regions in the world in terms of both primary productivity and chlorophyll a concentrations [18].

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