

Length-weight relationship of Deep-water Rose shrimp, *Parapenaeus longirostris* (Lucas, 1846) in the Western Moroccan Mediterranean

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ABSTRACT

Deep-water rose shrimp *Parapenaeus longirostris*(Lucas, 1846), is one of the main target species of the coastal trawl fleet working in the western Moroccan Mediterranean and an important species of crustacean landings in M'diq port . Despite of that, studies on biological characteristics of shrimp in this region are scarce. Hence, this study was aimed to evaluate the length-weight relationships of *P. longirostris*. Specimens were collected from the coastal trawlers in a monthly sampling over a period of twelve month between April 2017 and April 2018 at M'diq port, western Moroccan Mediterranean, and the length-weight relationships of the shrimp were estimated using linear regression. Results from the present study indicated that the all morphometric relationships of *P. longirostris* showed a negative allometric growth pattern ($b < 3$). The growth exponent (b) for females, males, and combined sexes ranged from 2.296 to 2.834, and the regression coefficient 'r²' ranged from 0.932 to 0.978 during the period of the study. The regression coefficient (b) of females, males, and combined sexes were significantly different from isometric growth at $P < 0.05$.

INTRODUCTION

Length-weight relationship (LWR) has an important implications for fishery management (Erzini, 1994; Guo *et al.*, 2014). LWR is needed for studies on maturity and yield estimates by analytical models, estimating growth rates, age structure and other aspects of shrimp population dynamics (Anastasiadou, 2008; Nahavandi *et al.*, 2010). Variability in the LWR is a feature that can reflect fluctuations in the uptake and allocation of energy. These morphometric variations can be affected by many factors such as food, stress (overcrowding and disease), or reproductive cycle (Pauly, 1990; Chu

et al., 1995). LWR varies among species, sexes, sampling sites and seasons (**Chu *et al.*, 1995; Nahavandi *et al.*, 2010**).

The deep-water rose shrimp, *Parapenaeus longirostris* (Lucas, 1846) is an epibenthic decapod crustacean showing a wide geographical distribution from the eastern Atlantic (from Portugal to Angola) to the Mediterranean Sea (**Holthuis, 1987**), and occurring on deep sandy–muddy bottoms, preferably between 100 m and 500 m of depth (**Tursi *et al.*, 1999; Abello *et al.*, 2002; SAMED, 2002**). In the Mediterranean, it is more abundant in the sandy-muddy depths between 100 and 400 m (**Fischer *et al.*, 1987; Holthuis, 1987**), although this species showed a wide bathymetric distribution between 20 to 750 m in depth (**Tom *et al.*, 1988**). Maximum total length of females *P. longirostris* females is 190 mm, and of males is 160 mm (**Holthuis, 1980**). However, males are usually 80 mm to 140 mm long and females 120 mm to 160 mm long. Larger specimens are caught mainly in deeper waters. The growth rate varies between the sexes. Size distribution and growth parameters indicate a life cycle of 3-4 years and males and females of *P. longirostris* reach maturity in the first year of life in the Mediterranean Sea (**Frogliia, 1982**).

Size-weight relationship is of great importance in fishery assessments and fish study. However, there is no available data of the length-weight relationship on *Parapenaeus longirostris* (Lucas, 1846), which is one of the main target species of the coastal trawl fishing, in the Western Moroccan Mediterranean. The study therefore, aimed at providing information of the length-length and length-weight relationships on *P. longirostris* in that region.

MATERIALS AND METHODS

Samples *P. longirostris* were collected from M'diq harbour between April 2017 and April 2018. Total length (TL) was measured using a caliper as the distance from tip of rostrum to tip of telson, and carapace length (CL) from the orbital margin to the posterior dorsal edge of the carapace. Weight (W) was measured using a digital balance with a precision of 0.01 g. The relationships between total length-weight, carapace length-weight and total length- carapace length were estimated separately for males, females and sex pooled, by using the power equation $W = a L^b$ (**Sparre *et.al.*, 1989**), where W is weight of shrimp (g), L is total length or carapace length of shrimp (mm), a is constant and equal the intercept of the straight line, and b is exponent value coefficient of growth (slope), indicating isometric growth when $b = 3$, but when b is not equal to 3, allometric pattern of growth occurs, which may be positive if >3 or negative if <3 . This equation was log transformed (variables W and L), to estimate the parameters 'a' and 'b' by using least squares method according to the following formula: $\log W = \log a + b \log L$ (**Pauly, 1983**).

Linear relationship as $Y = a + bX$ suggested by **Ivanov and Krylov (1980)** was used for the carapace length- total length relationship. The coefficient of determination (r^2) was used as an indicator of the quality of the linear regression (**Scherrer, 1984**).

Interaction between the variables was tested for significance to give the correlation coefficient. In order to test whether 'b' values obtained in the linear regressions were significantly different from the isometric value (3), by Student's t test was done and expressed by the following equation (**Zar, 1996**) ; $t = (b-3)/S_b$ Where, b = regression coefficient of log transformed data ,and S_b = standard error of b.

Study area

study area was conducted in the western coast of Moroccan Mediterranean ,between coasts of the city of M'diq and those of village of El Jebha , which is between the latitude 35.21° and 35.68° north and longitude 4.66° and 5.32° west (Fig.1).

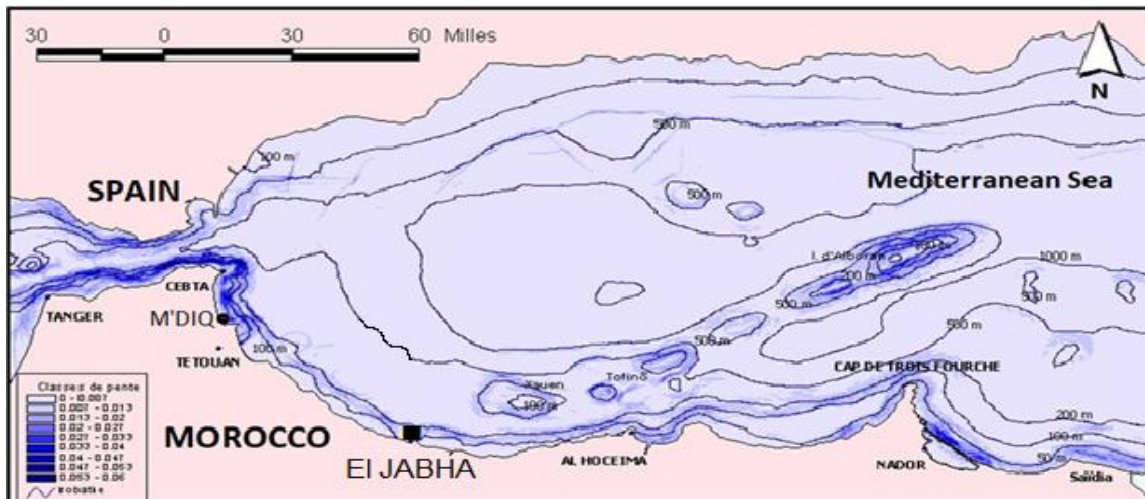


Fig 1: Western coast of Moroccan Mediterranean

RESULTS

A total of 892 females ranged from 15 to 62 mm in carapace length (CL) and between 58 and 187 mm in total length (TL), and 618 males ranged in carapace length from 15 to 45 mm and 75 to 165 mm in total length, were analyzed to find out the relationships between carapace length - total weight, total length-total weight and total length-carapace length of *P. longirostris*.

The males were predominant in the smaller size classes lower (< 30 mm). On the other hand, female number increased gradually in the larger size classes (> 30 mm) (Fig. 2). No male was observed with carapace length of more than 45 mm.

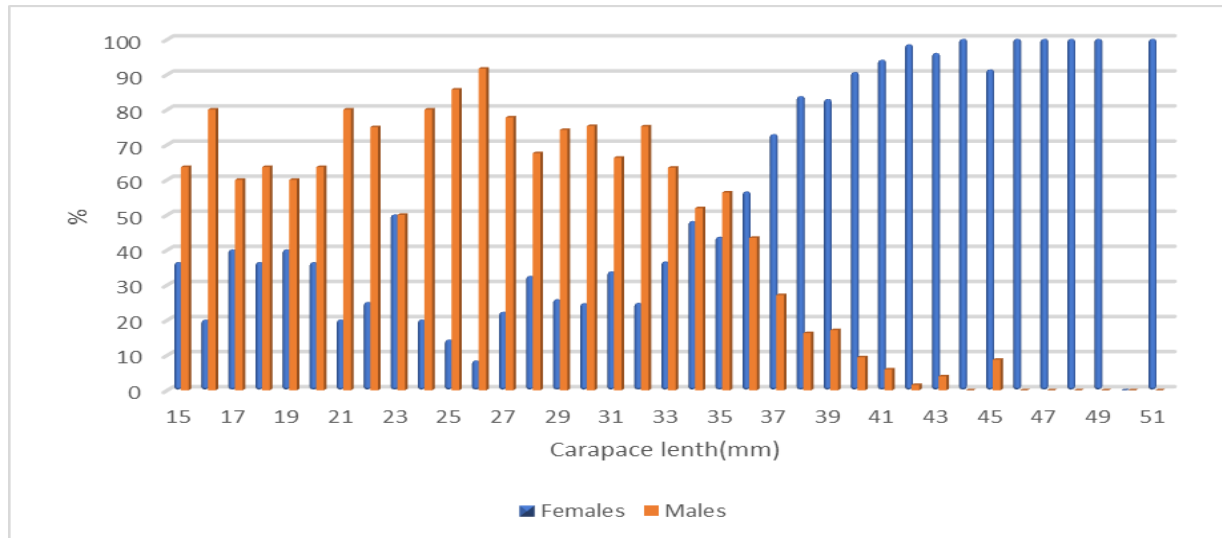


Fig. 2. Annual size frequency distribution of male and female of *P. longirostris* from the coastal waters of Moroccan Mediterranean April 2017 to April 2018

The length- weight relationships and the total length-carapace length relationship for males, females and combined sexes were calculated and are given in Table 1.

Table1: Biological characteristics of *P. longirostris*. Total weight - Carapace length and total length carapace length relationships.

| Sex | Numbers | The equations | R ² | Growth type | t-test sig |
|----------------|---------|-----------------------------------|----------------|---------------|------------|
| Females | 892 | $W = 0,0000426 \times TL^{2,583}$ | 0.931 | Allometric(-) | * |
| | | $W = 0,00368 \times CL^{2,296}$ | 0.985 | Allometric(-) | * |
| | | $TL = 32.748 + 2.888 CL$ | 0.945 | Allometric(-) | * |
| Males | 681 | $W = 0,000205 \times TL^{2,710}$ | 0.951 | Allometric(-) | * |
| | | $W = 0,00475 \times CL^{2,305}$ | 0.963 | Allometric(-) | * |
| | | $TL = 32.621 + 2.875 CL$ | 0.853 | Allometric(-) | * |
| Combined sexes | 1504 | $W = 0,0000119 \times TL^{2,834}$ | 0.932 | Allometric(-) | * |
| | | $W = 0,00340 \times CL^{2,312}$ | 0.978 | Allometric(-) | * |
| | | $TL = 31.728 + 2.911 CL$ | 0.904 | Allometric(-) | * |

* significant differences from 3 ($P < 0.05$).

The calculated curves of TL-TW, CL-TW relationship, and TL-CL for males, females and combined sex are presented in figures 3,4,5,6 and 7.

The values of parameter b of the length-weight relationships for females, males, and combined sexes were ranged between 2.305 and 2.710. while 'a' value varied from 0.0000119 to 0,00475 and the regression coefficient 'r²' ranged from 0.932 to

0.978 during the period of the study. The estimated 'b' values of regression equations (TL-TW) were 2.875, 2.888 and 2911 for males, females and combined sexes respectively.

The exponential values for total length-weight relationship and carapace length-weight relationship in males, females and combined sexes, indicate that there is a significant deviation from the isometric growth pattern (negative allometry). Applying the t test, it was confirmed that 'b' significantly differs from 3, in the three groups at 1% level.

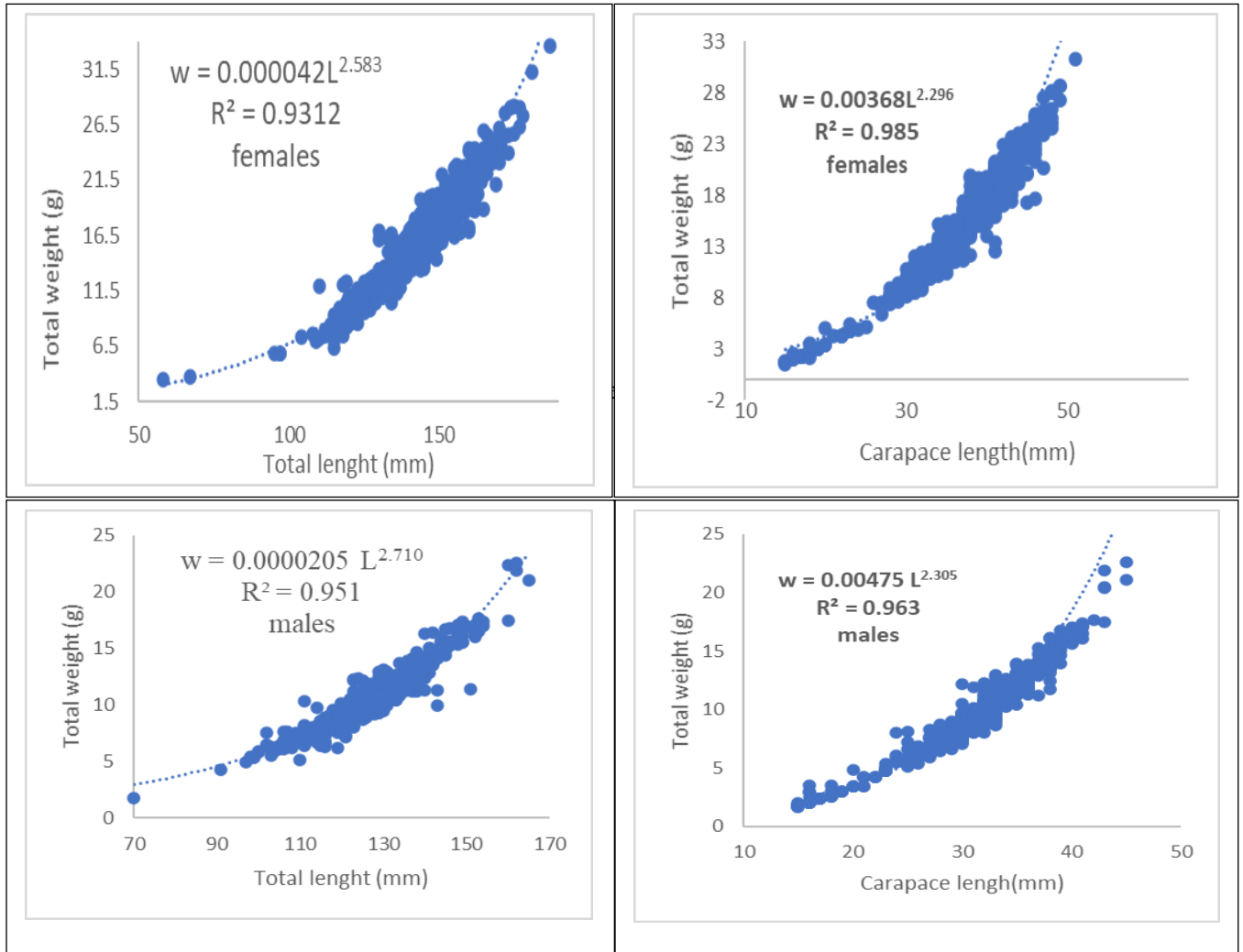


Fig.4: Relationships between total length - total weight and carapace length - total weight in males of *P. longirostris*

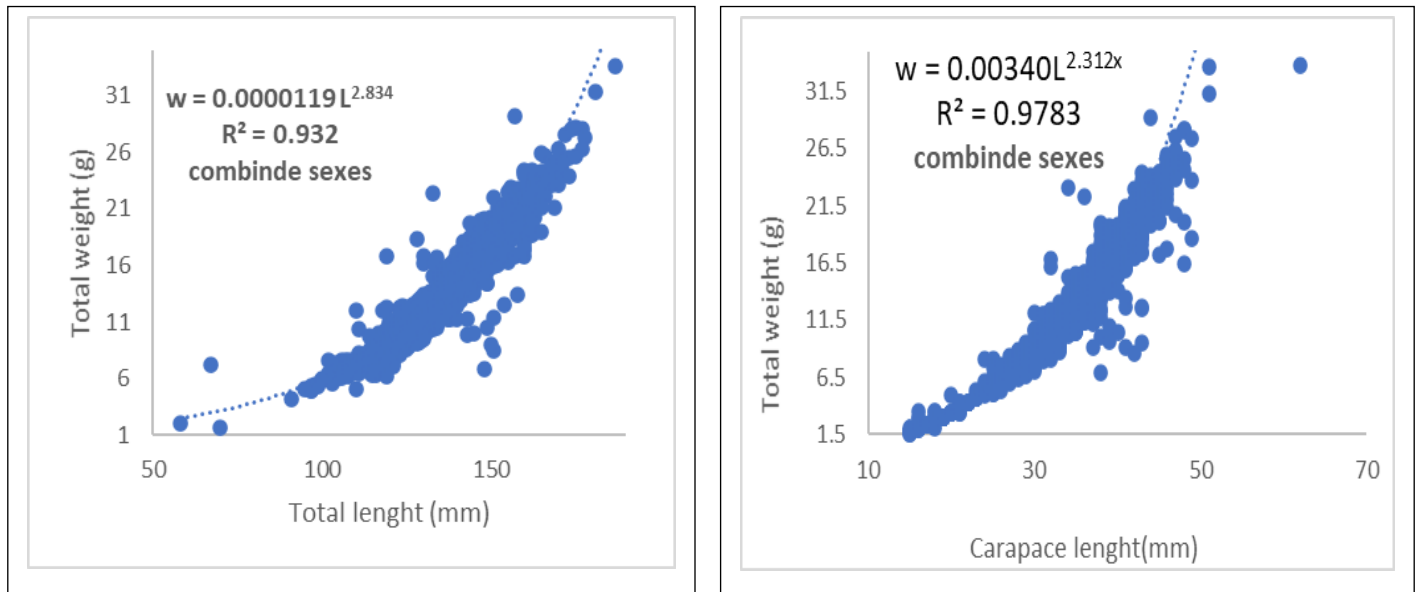


Fig .5. Relationships between total length - total weight ,and carapace length - total weight in pooled females and males of *P. longirostris*

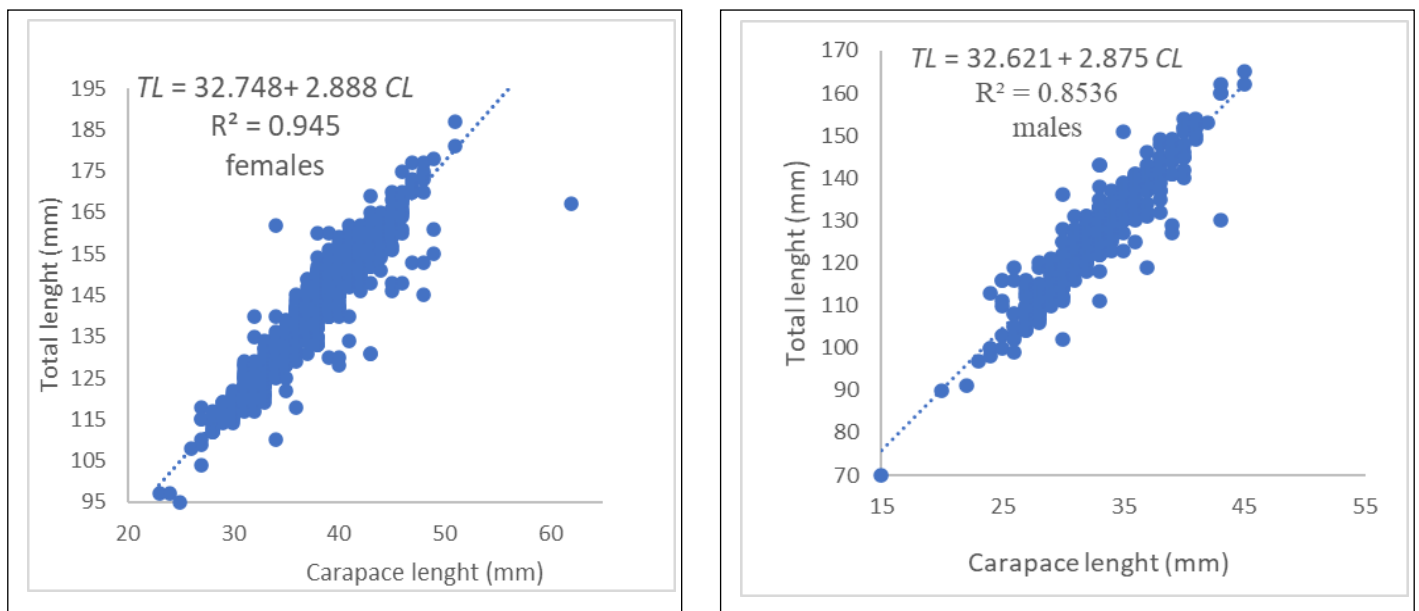


Fig.6 : Total length and carapace length relationship in females and males of *P. longirostris*

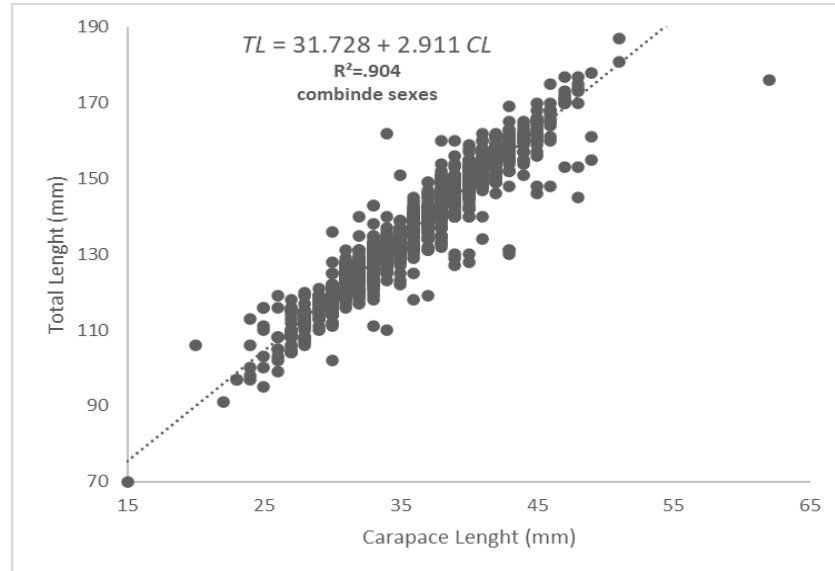


Fig.7: Total length and carapace length relationship combined sexes of *P. longirostris*.

DISCUSSION

A characteristic of the size-weight relationship in fishes and decapods is that the value of the exponent b around 3 is considered ideal for individuals which maintain a constant body shape. However, in many cases the cube law is apparently not obeyed as the organisms change their shape during growth. If b value is different from 3, growth is said to be allometric (negative if $(b < 3)$ or positive if $(b > 3)$). Thus, some indication of the condition of organisms in a population can be obtained from the length-weight equation. (Rajool Shanis, 2014). In the present study the value of exponent for males, and females of *P. longirostris* in length-weight relationship were below 3 indicating decreasing growth rate in relation to length. Jayachandran and Joseph (1988) observed that weight of most of the crustaceans is close to the cube of the length. The parameters of the size-weight relationships estimated in this study suggest a negative allometry for both sexes, and are almost similar to those recorded by other authors in the Mediterranean, Levi *et al.* (1995), Kasalica (2005), García-Rodríguez *et al.* (2009), Guijarro *et al.* (2009), Dereli and Erdem (2011), Marković (2012) and Kapisris *et al.* (2013), and in the Atlantic Ribeiro-Cascalho and Arrobas (1987), Sobrino and García (1994) and INRH (2016) (Table 2). In the other hand, the parameters of total Length-carapace length linear relationship estimated are nearly similar to those calculated by Sobrino (1998) for the Gulf of Cadiz, where the values of the allometry coefficient b were also lower than 3, especially in the males. However, some studies cannot be compared with each other because of lack of standardization of methods. Biswas (1993) suggested that differences in b values could be a result of gear selective influence, and other factors such as sex, gonadal development, nutritive conditions in the environment

of fish, physiological conditions of the fish at the time of collection and seasonal fluctuations in environmental parameters.

Table 2. Summary of the allometric coefficient b of the length-weight relationships and length-length relationships of the *P. longirostris* in different localities.

| Author | Locality | Sex | a | b | Relation |
|---|------------------------------------|----------|---------|--------|-----------------|
| Levi et al. (1995) | Sicilian Channel (Mediterranean) | Combined | 0.0061 | 2.2664 | $W=aL^b$ |
| Ribeiro-Cascalho and Arrobas, (1987) | Southern Portugal | Female | 0.0055 | 2.31 | $W=aL^b$ |
| | | Female | 5.954 | 0.87 | $TL = a + b*CL$ |
| | | Male | 0.0075 | 2.19 | $W=aL^b$ |
| | | Male | 5.454 | 0.90 | $TL = a + b*CL$ |
| Sobrino and Garcia (1994) | Coast of Morocco | Female | 0.0094 | 2.12 | $W=aL^b$ |
| | | Male | 0.0022 | 2.56 | $W=aL^b$ |
| Kasalica (2005) | South Adriatic (Montenegrin coast) | Female | 0.0039 | 2.33 | $W=aL^b$ |
| | | Male | 0.0029 | 2.41 | $W=aL^b$ |
| García-Rodríguez <i>et al.</i> , (2009) | Gulf of Alicante | Female | 0.0023 | 2.6774 | $W=aL^b$ |
| | | Male | 0.0028 | 2.4956 | $W=aL^b$ |
| | | Combined | 0.0019 | 2.6113 | $W=aL^b$ |
| Guijarro <i>et al.</i> (2009) | Western Mediterranean | Female | 0.0022 | 2.5626 | $W=aL^b$ |
| | | Male | 0.0024 | 2.5335 | $W=aL^b$ |
| | | Combined | 0.0022 | 2.5682 | $W=aL^b$ |
| Dereli & Erdem 2011 | Aegean Sea | Female | 0,0012 | 2,7054 | $W=aL^b$ |
| Marković, (2012) | South Adriatic (Montenegrin coast) | Female | 2.5715 | 0.0019 | $W=aL^b$ |
| | | Male | 2.3302 | 0.0038 | $W=aL^b$ |
| | | Combined | 2.5918 | 0.0017 | $W=aL^b$ |
| Kapiris <i>et al.</i> , (2013) | South Adriatic Sea | Female | | 2.309 | $W=aL^b$ |
| | | Male | | 2.032 | $W=aL^b$ |
| INRH, (2016) | Moroccan Atlantic | Female | 0,0033 | 2,44 | $W=aL^b$ |
| | | Male | 0,0032 | 2,43 | $W=aL^b$ |
| | | Combined | 0,0024 | 2,531 | $W=aL^b$ |
| Present study | Moroccan Mediterranean | Female | 0,00368 | 2,296 | $W=aL^b$ |
| | | Female | 32.748 | 2.888 | $TL = a + b*CL$ |
| | | Male | 0,00475 | 2,305 | $W=aL^b$ |
| | | Male | 32.621 | 2.875 | $TL = a + b*CL$ |
| | | Combined | 0,00340 | 2,312 | $W=aL^b$ |
| | | Combined | 31.728 | 2.911 | $TL = a + b*CL$ |

The estimated 'b' values were between 2.710 and 2.583 (TW -TL), and between 2.296 and 2.305 (TW -CL) for males and females respectively. Males had higher b values than females. Similar higher 'b' values for males were reported by **Sobrino and Garcia (1994)** and **Kasalica (2005)** Table 2.

The regression coefficient (r^2) gives an idea about the correlation between length and weight. If it is around 1, it means that length and weight are perfectly correlated. In the present study, correlation coefficients differ from 0.853 to 0.985. The higher (r^2) values than 0.90, indicate the increase in length will contribute with increase in weight.

CONCLUSION

It could be concluded that, this study provides the first basic information on length-weight parameters for *P. longirostris* collected from M'dq, Western Moroccan Mediterranean. The LWRs of *P. longirostris* followed a negative allometric trend. The parameters as shown in this study could be employed to study the growth and population dynamics of *P. longirostris* exploited from M'dq region. This study could assist fishery management scientists in carrying out future ecological studies in line with the strategies of conservation and management.

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