# Carapace length-weight relationships of Panulirus homarus from North coast of Gulf of Oman

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**Abstract**

The present study was performed to describe the carapace length-weight relationships of spiny lobster Panulirus homarus from the north coast of the Gulf of Oman. A total of 140 species were measured, consisting of 8 males and 59 females between September 2019 to August 2020. The carapace length and total weight range of the whole sample was recorded as 59 g - 106 g and 46 mm-71mm, respectively. Regression equations for carapace length and body weight for male, female and total P. homarus population were W = 0.002 CL 2.8268, W = 0.004 CL 2.6534, W = 0.004 CL 2.7407, respectively. The carapace length-weight relationship was also highly significant ($p < 0.05$) with a high determination coefficient ($r2 = 0.89$), with a 95% confidence interval for b from 2.6018 to 2.8746. The test of the allometric coefficients "b" of the carapace length – body weight relationship showed negative allometric growth for males, females, and sexes combined. The current study provided the baseline data about carapace length – body weight relationship of spiny lobster from the north coast of Gulf of Oman. Such data is valuable for establishing a monitoring and management system of these fish species.

**Keywords:** carapace length-weight relationship; allometric growth; Panulirus homarus; Gulf of Oman.

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## Introduction

The spiny lobsters, Panulirus homarus belong to the family of Palinuridae found in tropical and warm to temperate waters and is an economically important spiny lobster along the Southern coast of Iran (Sistan and Baluchistan province) (Ajdari and Mirzaei, 2022). In this region, lobsters are attractive for fisheries development because of their high value and marketability and their simplicity of harvesting, leading to over-exploitation of this species and consequently a negative impact on sustainability.

In the last three decades, lobster fishing has been an essential source of food and income to a large part of the fishers population in the southern region of the Gulf of Oman. Lobster fishing increased from 42 tons to 1 ton between 1989 and 2004 on the South Coast of Iran and was subsequently banned by the Fisheries authority due to overfishing pressure. While Oman had similar conditions in lobster stocks, its catch increased from 400 tons to 430 tons during one year (2015-2016) (Ajdari and Mirzaei, 2022).

The study of the relationships between carapace length and lobster weight is the basis of studies related to stock assessment, physiology and ecology (Szuwalski et al., 2016, Groeneveld, 2000). Estimating the weight variations from the known length groups is helpful in identifying the size, reproduction season, population health, and feeding habits in the population (Blackwell et al., 2000, Brock, 1954). Furthermore, to assess the stock and estimate population size, the relationships between carapace width and weight are necessary (Paul et al., 2021), As long as all of these studies employ a fully standardized sampling methodology to enable such comparisons. A way to verify this is to use the angular coefficient (b) of the LW equation, which determines animal growth type (Pope et al., 2010).

Fisheries and species monitoring and the conservation of natural resources rely on the relationship between length and weight. For future studies on the regional natural resources ecology, length-weight relationships can also be used as baseline data (Irons et al., 2007). Furthermore, comparing length-weight relationships in different populations of the same species in different environments may overly indicate the population's health (Possamai et al., 2020). Le Cren (1951) and Ricker (1975) used the length-weight relationship to determine whether fish grew isometrically or allometrically. In addition to fish, the length-width-weight relationship is appropriate for evaluating crustaceans and other aquatic organisms (Wanjari et al., 2021).

On the other hand, it has been demonstrated that their environment greatly affects lobsters' growth. Therefore, information derived from different geographic regions can be inaccurate (Chittleborough, 1975). Thus, it is important to establish the Carapace length – weight relationship for lobsters in the local area. This study aims to determine the carapace length-weight relationship parameters (a, b, r2) for spiny lobster P. homarus from the north coast of the Gulf of Oman.

## Material and methods

Lobster samples were obtained monthly from September 2019 to August 2020, from

fishermen who used unselective fishing gears such as gill nets and traps at Ramin (25° 15' 58" N, 60° 44' 44" E), Pozm (25° 18' 49" N, 60° 18' 05" E), and Pasabandar (25° 02' 54" N, 61° 25' 03" E) along the north coast of Gulf of Oman (Sistan and baluchestan province).

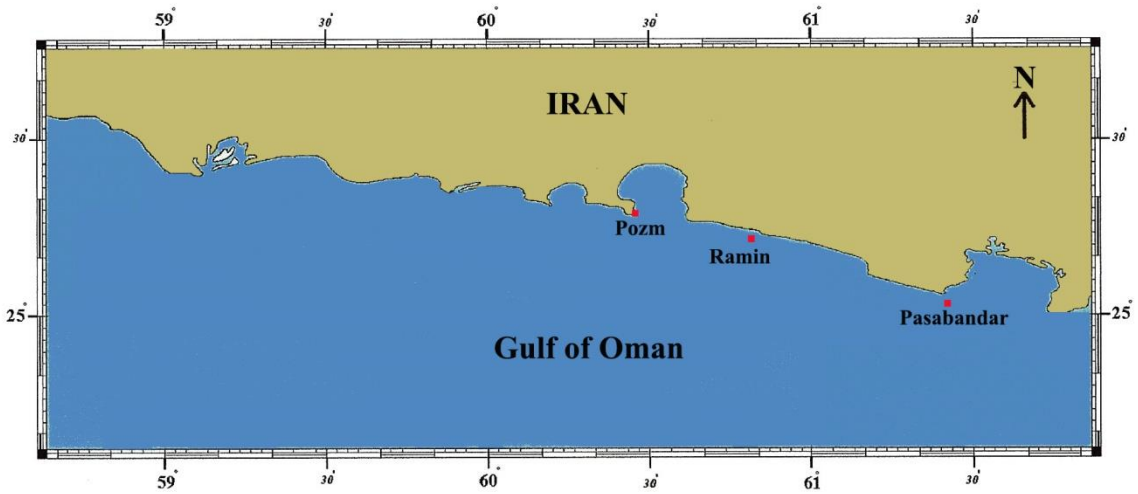


**Figure 1: Sampling locations of P. homarus in the north coast of Gulf of Oman**

Lobsters collected from three locations were taken to the laboratory, pooled and considered as one population. The carapace length (+ 0.01mm) and total weight (+ 0.01 g) were recorded separately. Carapace length was measured with Vernier calipers from orbital notch to the hind edge of the carapace along the mid dorsal line and body weight (W) with an accuracy of 0.1 g using a digital balance.

The relationship between the Carapace length-weight, expressed by the equation

$W = aCL^b$ (Rickter, 1973).

where

W = weight (g),

CL is the carapace length,

"a" is a constant

"b" is the growth exponent or slop b.

The data were converted on natural log to fit linear or straight line of log length and log weight. The equation can be demonstrated logarithmically as Log W = log a+ b log L (King, 1995). Coefficient of determination (R 2) was adopted in order to determine the strength of the relationship in the linear regression.

Logarithm transformation of Carapace length - weight relationship was calculated using the formula: W = log a + b log CL

where,

W is the total weight (g),

CL is the Carapace length (mm)

(a) the intercept

(b) the slope or allometric growth coefficient.

Linear relationships between carapace length and body weight were assessed for males, females and total P. homarus population by the computer based linear regression analysis. The following equation (Pauly 1984) was used to compare the calculated b values to the b value of isometric growth (b=3) (Pauly,

1984):

$$t = \frac{sd \log L}{sd \log W} . \frac{|b-3|}{\sqrt{1-r^2}} . \sqrt{n-2}$$

Where

sd log CL = standard deviation of the log carapace Length values,

sd log W = the standard deviation of the log W values,

n= the number of lobsters used in the computation.

In a table, when t is greater than n - 2 df, the value of b will be different from 3.

## Results

Descriptive Statistics for population analysis of P. homarus are given in Table 1. A Total 140 species were measured consisting of 81 males and 59 females. The carapace length and total weight range of the whole sample was recorded as 59 g - 106 g and 46 mm-71mm, respectively. Highest mean weight (106 g) and highest carapace length (71 mm) were recorded for males compared to females.

**Table 1: Results of descriptive Statistics for male, female and total population of P. homarus**

| Parameter | Sex | No | Min | Max | Mean | Sd |
|---|---|---|---|---|---|---|
| **Carapace length (mm)** | Female | 81 | 46 | 65 | 56.22 | 4.09 |
| **Carapace length (mm)** | Male | 59 | 47 | 71 | 56.49 | 4.9 |
| **Weight (g)** | Female | 81 | 100 | 261 | 179.2 | 36.8 |
| **Weight (g)** | Male | 59 | 106 | 316 | 184.1 | 47.5 |

Carapace length (L) to body weight (W) relationships in P. homarus captured were W = 0.002 CL 2.8268 for males and W = 0.004 CL 2.6534 for females (figure 1). According to the t-test applied to b, male and female lobsters had a negative allometric growth type (b<3), further statistical analysis of the regression coefficients between male and female lobsters showed no significant difference (p>0.05), which indicated that in general male and female lobsters have similarities in length and weight gained. Therefore, the data were combined and provided a regression equation W = 0.004 CL 2.7407, which indicates the type of negative allometric growth.

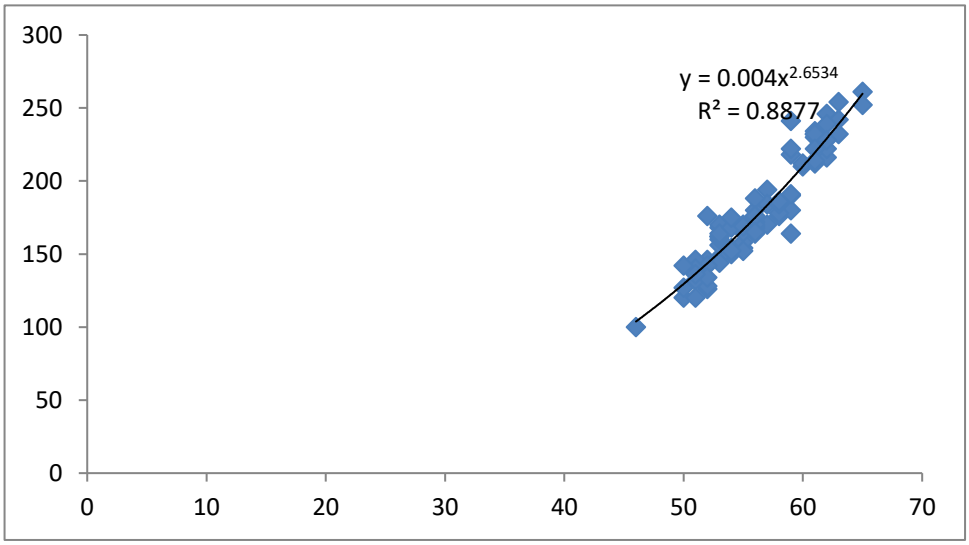


**Figure 2. Carapace length weight relationship of female P. homarus**

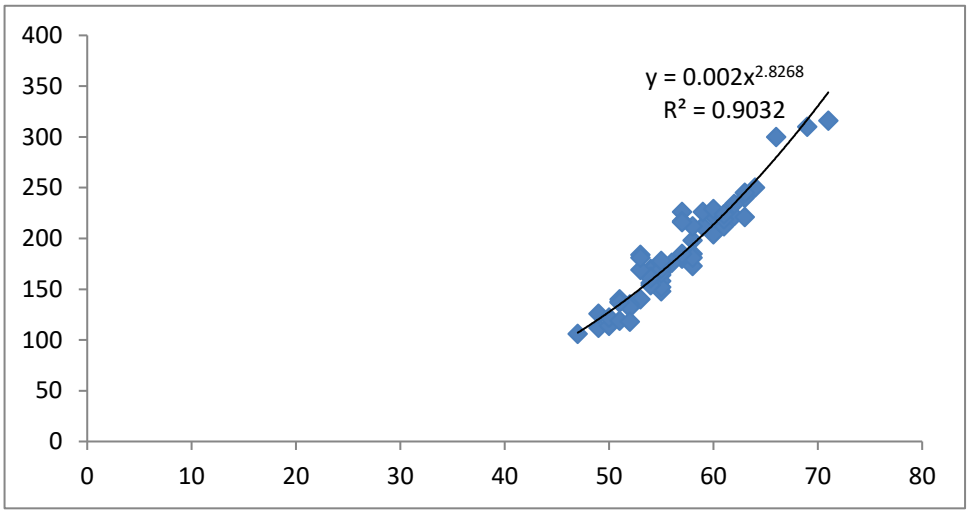


**Figure 3. Carapace length weight relationship of males P. homarus**

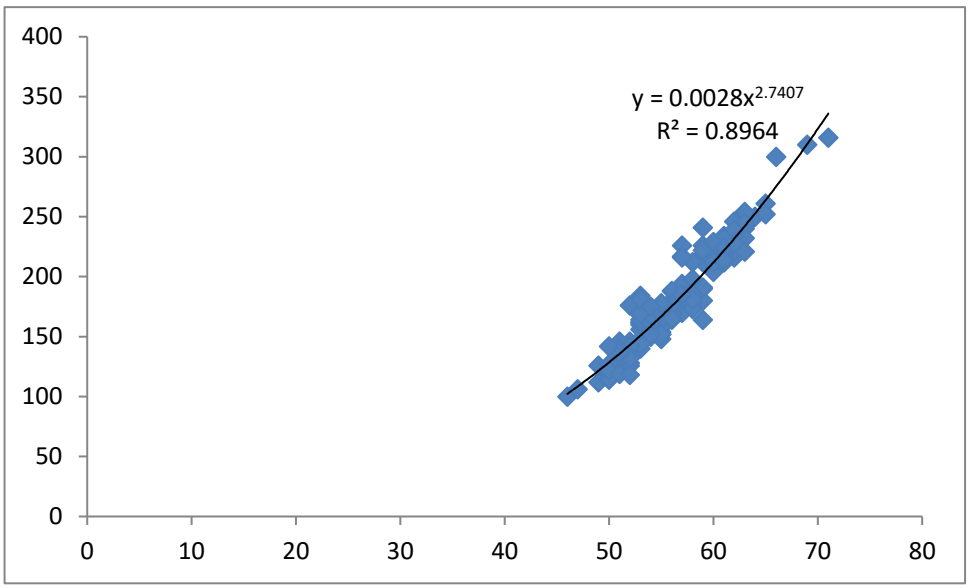


**Figure 4. Carapace length weight relationship of combine sexes of P. homarus**

The carapace length-weight relationship was also highly significant ($p < 0.05$) with a high determination coefficient ($r2 = 0.89$), with a 95% confidence interval for b from 2.6018 to 2.8746. The estimated b-value of the carapace length-weight relationship of P. homarus was within the expected range. In addition, the results of the Student's t-test showed that the b-value was significantly different than 3, proving that the growth of P. homarus is allometric (Table 2).

**Table 2. Results of the linear regression models of P. homarus population**

| | S.E | C.I. | Upper | Lower |
|---|---|---|---|---|
| **b0** | 0.33 | 0.5496 | -5.3061 | -6.4054 |
| **b1** | 0.08 | 0.1364 | 2.8746 | 2.6018 |
| **A** | 1.39 | 1.73 | **0.0049614** | **0.0016527** |
| **B** | 0.08 | 0.14 | **2.8746** | **2.6018** |

## Discussion

The findings of this study indicate that all the 'b' values for females, males, and the entire population are below 3.0. Additionally, the student t-test results showed that both male and female 'b' values and the total population were significantly different from 3.0 ($p<0.05$), indicating negative allometric growth. The current study showed allometric regression coefficients for lobsters ranged from 2.6534-2.8268. In contrast, the allometric coefficient for P. homarus caught at the Kanniyakumari coast (India) was 2.58 (Meenakumari et al., 1986), and the allometric coefficient of lobsters from the southern coast of Sri Lanka was 2.15 (Senevirathna et al., 2012). Accordingly, lobsters in the Gulf of Oman were higher in allometric coefficient than lobsters in nearby countries.

This finding is contrary to previous studies in the Gulf of Oman, which have suggested a significant difference between the b values obtained for the male and total population from number 3, which show an allometric growth, while in female spiny lobsters, "b" value did not show a significant difference from 3 ($P < 0.05$) which show isometric growth of the female species (Mohammad Reza Mirzaei et al., 2016). Furthermore, there is a different relationship between carapace length and body weight based on gender for this species in Tanjung Kasuari water (Situmorang et al., 2021). Allometric growth is exhibited by male lobsters, where the length of the carapace grows faster than the weight of the body. In contrast, female lobsters exhibit isometric growth, where the length of the carapace grows as fast as the weight. Kadafi et al. (2006) found allometric growth patterns in male lobsters in the waters of Ayah (Kebumen), and Ongkers et al. (2014) found isometric growth patterns in female lobsters in the Latulahat waters (Ambon) . In another study, Senevirathna et al. (2012) found that male and female sand lobsters grow at different rates in Sri Lankan waters. Female lobsters grow at an isometric rate, while male lobsters grow at an allometric rate. This result may be explained by the fact that even for the same species, the growth coefficient may differ depending on the geographical location. Ozaydin and Taskavak (2006) have found that the b value in the length-weight relationship can vary between habitats, even daily.

Taskavak and Bilecenoglu (2001) also revealed that the parameter ‘b’ could vary between seasons despite the variability between habitats. It has also been reported that photoperiodism affects lobster growth (Brown and Caputi, 1985). Briones-Fourzán and Lozano-Álvarez (2003) also noted that growth rate is strongly related to temperature and photoperiod for Panulirus lobsters. In addition to these factors, the value of 'b' is affected by age, body shape, sex, maturity stage, season, temperature, salinity and available nutrients (Moutopoulos and Stergiou, 2002). Therefore, the reason why there are differences in the growth patterns between males and females in a single population may be due to sex differences.

Another important finding was that, in general, Panulirus lobsters in various studies exhibited negative allometric growth types. It is possible that the reason for this result can be explained by the fact that when aquatic species grow up, they become slimmer if they exhibit negative allometric growth or fatter if they exhibit positive allometric growth (Wooton, 1992). There are also several possible explanations for negative allometric growth patterns, including overcatch, competition, and trophic potential (Situmorang et al., 2021). Furthermore, It has been found by Barradas-Ortiz et al. (2003) that male Panulirus lobsters with a negative allometric pattern grow faster than female lobsters. This discrepancy may partly be explained by lobster's ovarian maturation, which stunts its growth (Hunt and Lyons, 1986). According to Tully et al. (2001), energy directed towards spawning preparation in female lobsters, in male lobsters with negative allometric growth, is used to increase body length.

In conclusion, this study has identified the carapace length-weight relationship in P. homarus shows that the growth pattern of this species in the north coast of the Gulf of Oman is negatively allometric, and there is a high level of correlation between carapace length and body weight. Furthermore, males are in better condition than females. The findings of this study providing a deeper insight into developing appropriate regulations to manage the fishery practices of P. homarus in this region.

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