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Assessment of Carapace Dimensions, Condition Factor and Sex Ratio of *Portunus pelagicus* (Linnaeus, 1758), Along the Mangaluru Coast, Karnataka, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

The research examined the correlations between width-weight and length-width relationships in Portunus pelagicus along the Mangaluru coast in Karnataka, India. A total of 607 specimens were collected fortnightly from the Mangaluru fish landing centre from January to December 2022, of

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which 327 were males and 280 were females. The relationship between weight and carapace width for both sexes was determined as y = 2.8661x - 1.0413, with an R-squared value of 0.7252. Conversely, the relationship between carapace length and weight for both sexes yielded the equation y = 2.9571x - 0.1628, with an R-squared value of 0.7449. By using the Chi-square analyses, the male and female ratio was compared. The sex ratio of P. pelagicus was found to be 1:0.88 (Male: Female), showing no significant deviation from the anticipated ratio of 1:1. The condition factor varied between 0.9933 to 1.0427 for males and 1.0047 to 1.0658 for females, exhibiting a range in physiological status across the sexes.

Keywords: Blue swimming crab; Portunus pelagicus, mangaluru coast; sex ratio; condition factor.

1. INTRODUCTION

“The fisheries industry has been acknowledged as a significant source of income and employment because it fosters the expansion of several related industries, provides access to low-cost, nutrient-rich food, and offers livelihoods for many economically vulnerable people” [1]. The socioeconomic development of the nation's fisheries sector is significant [2].

“In addition to supplying nutrition and food security for a considerable portion of the nation's population, India's fishing industry is rapidly expanding and employs more than 28 million people. India, the world's second-largest fish producer, accounts for 7.56% of worldwide production, 1.24% of the nation's Gross Value Added (GVA), and more than 7.28% of its agricultural GVA1”[3]. For millions, fishing and aquaculture remain significant sources of food, nutrition, income, and a way of life.

If the fishery resources are adequately managed, they are naturally renewable and sustainable. It is important to examine the biological parameters, and fisheries stock to determine the growth rate and population size status [4]. “The crabs are decapod crustaceans of the infra order Brachyura, having a broad carapace, stalked eyes and five pairs of legs, primarily found in inshore areas, especially in tropical waters” [5].

There are 7,000 crab species and 98 families in the infra order Brachyura worldwide [6,7]. The three most common crabs in Indian coastal seas are *Portunus sanguinolentus*, *Portunus pelagicus* and *Charybdis feriata*. The most prevalent and economically significant crab from the Karnataka coast is P. pelagicus, an edible species [8]. “*Portunus pelagicus* (Linnaeus, 1758) is a portunid crab belonging to the family Portunidae” [8]. “This family group is also known as swimming crabs” [9]. “*P. pelagicus* is found in various habitats and is distributed from the intertidal zone at around 50- 65 m depth and estuaries to the open sea”[10]. “It also prefers to live on the muddy or sandy bottoms or in the algal and seagrass habitats” [11,12,13]. Blue swimming crab is distributed throughout the Indo-West Pacific [14,15] and the the southwest coast of the Arabian Sea, off Kerala, India[16]. “This species has a high salinity tolerance of about 30-40 ppt” [17,18].

“Knowledge of the population's body weight-length/width relationships is crucial in aquatic ecology, stock assessment biology and physiology. It can compare animal growth, calculate condition factors, and convert lengths into biomass. Earlier studies on the carapace length-weight and width-weight relationship, condition factor and biology have been studied in different areas” [19,20].

The study aimed to examine the associations among carapace length/width-weight, condition factors (Kn), and sex ratio of P. pelagicus sampled from the Mangaluru coast. The study will provide fundamental knowledge of management and exploitation.

2. MATERIALS AND METHODS

2.1 Study Area and Sample Collection

The samples were gathered from the trawl landings of the Mangaluru fish landing center (latitude 12°50'54" N; longitude 74°50'11" E) [Fig. 1], during the study from January to December 2022.

The specimens were transferred to the laboratory, and each was thoroughly washed and rinsed to remove any sticking contaminants. *Each Specimen* was sexed and examined by the morphological characteristics of male and female crabs; the male crabs have narrow and inverted “T” shaped abdomens, while female crabs have broad, round, and Inverted “U” shaped

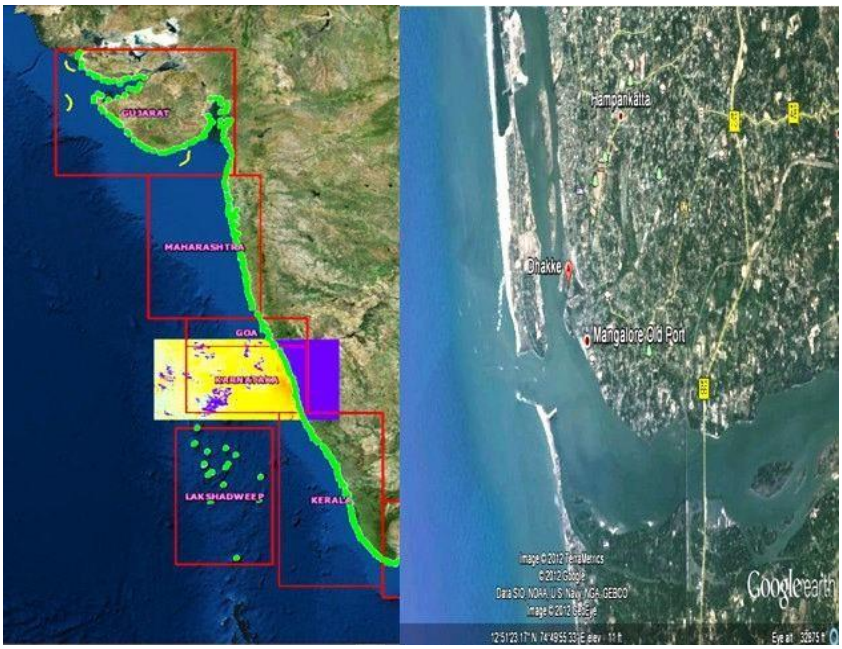

Fig. 1. Map showing study area, Mangaluru fish landing centre, Karnataka, India

abdomens. The crab's carapace (CW) width was assessed using a Vernier caliper, near 0.01 cm from the left to right dorsal spine tip. The crab's body weight (BW) was weighed on an electronic balance nearest 0.01g.

2.2 Estimating Carapace Length/Width - Weight Relationship, Condition Factor and Sex Ratio

The relationship between carapace length/width and weight was determined using the logarithmic form of the allometric growth equation W = aLb [20],

Where, W represents body weight,

L indicates total carapace length/width,

'a' denotes the y-intercept or initial growth coefficient,

'b' represents the slope or growth coefficient.

The least squares method determined the constants 'a' and 'b'. Chi-square analyses were employed to assess the male-to-female ratio [21]. The relative condition factor (Kn) was calculated to determine the well-being of the crab using the formula [20].

$Kn = Wo/Wc$ Where, W_O = observed weight; W_C = calculated weight

3. RESULTS AND DISCUSSION

3.1 Carapace Width-Weight and Carapace Length-Weight Relationship

The results of the carapace width-weight relationship of *P. pelagicus* from 607 specimens consisting of 327 males and 280 females. The males, females, and total individuals of crab exhibited negative allometric growth (b<3), respectively, indicating width grows faster than weight (Tables 1,2 & 3).

If the value of 'b' is less than 3(b-value < 3), it indicates that the carapace width increases more rapidly compared to the crab's weight [20]. The results showed that males were heavier than females in terms of the b-value. Suyani, N. K. et al. [22] documented comparable results in *Portunus sanguinolentus* from the northwest coast of India. Male *P. pelagicus* individuals may allocate additional energy towards growth to safeguard females and enhance their competitive abilities in securing mates. Conversely, females allocate a significant portion of their energy resources towards the production of eggs [23]. The correlation coefficient obtained in this investigation indicated a positive correlation between body weight and carapace width/length throughout the study. The growth of carapace length and body weight in crabs can be influenced by various factors, including

temperature, salinity, ecological conditions, food availability, and intrinsic factors such as sex, age, time, and habitat characteristics Campos, J. et al., [24]. The growth equation for length/width can be converted into a weight growth equation, which can then be incorporated into stock estimation models [24]. Data on the length/width-weight relationship can aid in predicting population size, particularly for management purposes [20,25]. The length-weight relationship is preferable for population assessments [20,25].

Table 1. Carapace width-weight regression analysis of *P. pelagicus* from Mangaluru, Karnataka

Sexes	N	Carapace width (cm)	Weight (g)	a	b	R^2	Growth type
Males	327	7.02 to 15.6	51 to 260 g	0.3116	2.6964	0.7953	-A
Females	280	7.22 to 15.6	20 to 250 g	0.2347	2.5857	0.6551	-A
Total individuals	607	7.02 to 15.6	20 to 260 g	0.2732	2.6410	0.7252	-A

Note: -A = negative allometric growth, N = crab number, a = y-intercept, b = growth coefficient, r^2 = sample correlation coefficient

Table 2. Carapace length-weight regression analysis of *P. pelagicus* from Mangaluru, Karnataka

Sexes	N	Carapace length (cm)	Weight (g)	a	b	R^2	Growth type
Males	327	3.19 to 7.41	22 to 260 g	0.9939	2.7908	0.7522	-A
Females	280	3.29 to 7.24	20 to 250 g	1.5720	2.5681	0.7377	-A
Total individuals	607	3.19 to 7.41	20 to 260 g	1.2829	2.6795	0.7449	-A

Note: -A = negative allometric growth, N = crab number, a = y-intercept, b = growth coefficient, r^2 = sample correlation coefficient

Table 3. Carapace width/length-total weight relationship in males and females of *Portunuspelagicus* (Linnaeus, 1758)

Measurements	Logarithmic equation	Parabolic equation
Males		
Carapace Width-Total Weight	y = 2.8961x - 1.0454	$y = 5.2088e^{0.2579x}$
Carapace Length-Total Weight	y = 3.0119x - 0.201	$y = 3.9778e^{0.5884x}$
Females		
Carapace Width-Total Weight	y = 2.9672x - 1.1828	$y = 4.5103e^{0.2597x}$
Carapace Length-Total Weight	y = 2.8472x - 0.0845	$y = 5.318e^{0.5379x}$
Pooled		
Carapace Width-Total Weight	y = 2.8661x - 1.0413	$y = 5.0985e^{0.2549x}$
Carapace Length-Total Weight	y = 2.9571x - 0.1628	$y = 4.4147e^{0.5706x}$

Table 4. Sex ratio of *P. pelagicus* from Mangaluru, Karnataka

Male	Female	Total	Male: Female	Chi-square	*P*	Remarks
327	280	607	1:0.88	1.72407	0.4622	Not significant @0.05

Table 5. Condition factor (K_n) of *P. pelagicus* from Mangaluru, Karnataka

Sexes	N	Avg. Kn	Kn
Males	327	1.0131	0.9933 to 1.0427
Females	280	1.0169	1.0047 to 1.0658

Fig. 2(a). *Portunus pelagicus* (male)

Fig. 2(b). *Portunus pelagicus* (female)

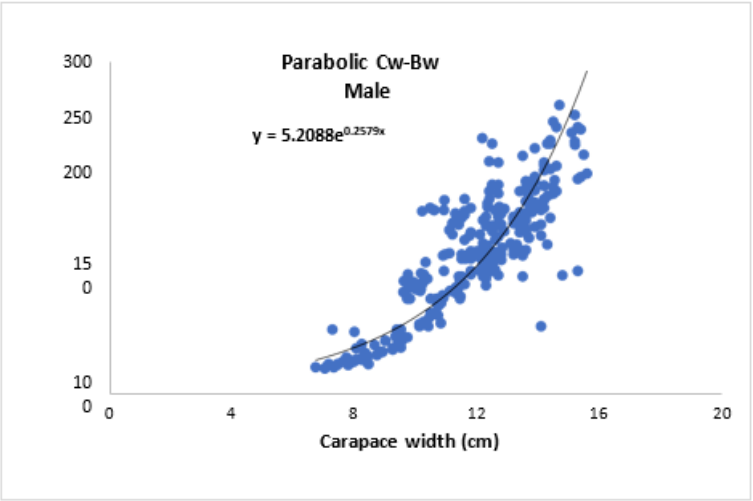

Fig. 3. Carapace width-weight relationship of male *P. pelagicus* during 2022

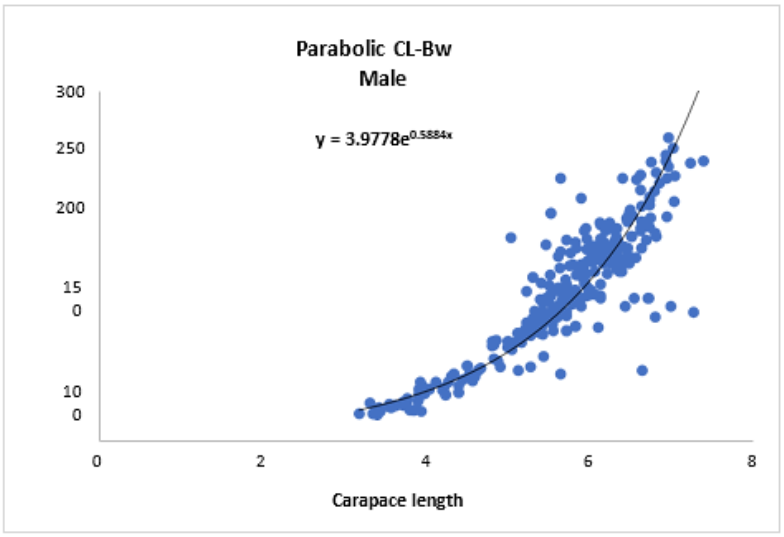

Fig. 4. Carapace length-weight relationship of male *P. pelagicus* during 2022

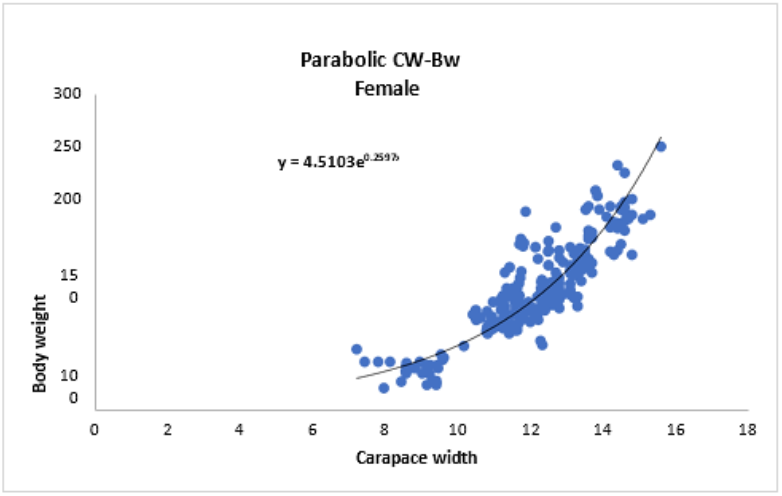

Fig. 5. Carapace width-weight relationship of male *P. pelagicus* during 2022

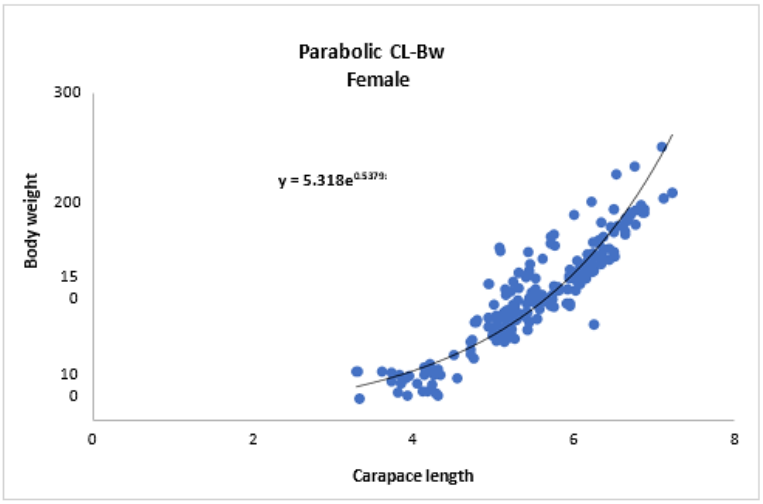

Fig. 6. Carapace length-weight relationship of male *P. pelagicus* during 2022

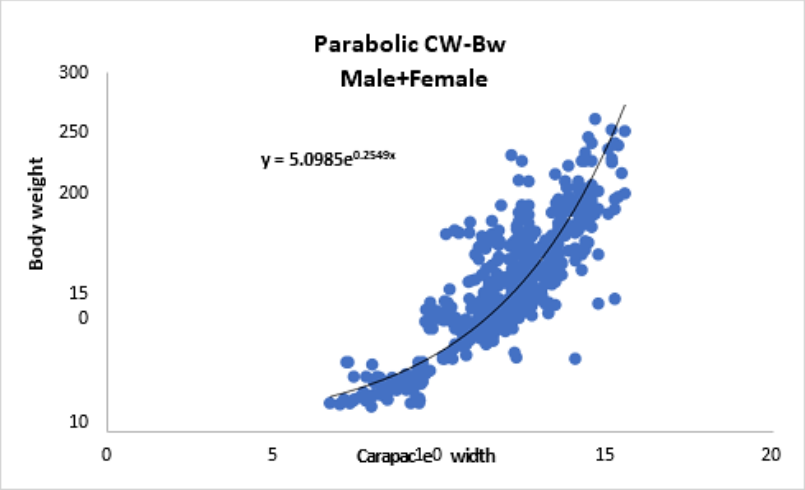

Fig. 7. Carapace length-weight relationship of combine sexes *P. pelagicus* during 2022

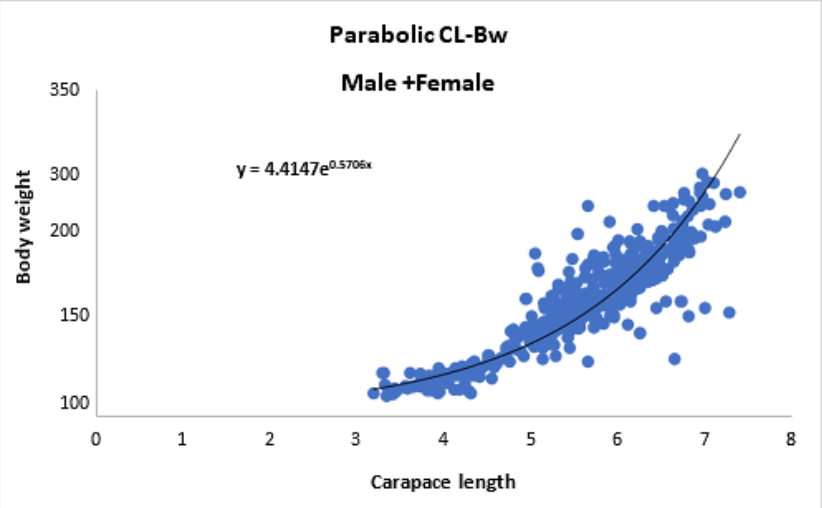

Fig. 8. Carapace length-weight relationship of combine sexes *P. pelagicus* during 2022

3.2 Sex Ratio

The 607 individuals of *P. pelagicus,* consisting of 327 males and 280 female crabs, were used to calculate the sex ratio. The ratio value of male to female was 1:0.88, where the no. of males was higher than females (Table 4). This finding is similar to the findings of research conducted in Australia (subtropics), which shows more males than females [26], and also, in Iran, the number of males was higher than females [27]. The homogeneity of the sex ratio was tested using the Chi-square ($_{\chi}2$) test (Snedecor & Cochran, [28]. The variation in sex ratio was thought to be influenced by crab behaviour, environmental factors and collection techniques [29,30,31,32]. Females were more likely to migrate to deeper waters to spawn [13].

3.3 Condition Factor (Kn)

The condition factor (Kn) is an important biological parameter and index for assessing crab condition, fatness or general well-being [33]. This can be influenced by various factors such as body size, sex, food availability, environment and the sexual cycle [20,21,24].

The study showed that the Kn values of males and females ranged from 0.9933 to 1.0427 and 1.0047 to 1.0658, respectively (Table 5). The Kn value of females was higher than males, indicating that females were in good condition.

The length-weight relationship provides insights into growth patterns throughout development. Conversely, the sex ratio has traditionally gauged

the sustainability of the population's recruitment. At the same time, the condition factor reflects the organism's favourable physical condition for survival and reproduction [26,32,34,35].

4. CONCLUSIONS

The investigation revealed a negative allometric growth pattern (b<3) in male, female, and overall crab populations. The male-to-female ratio stood at 1:0.88, indicating a higher count of males than females. The Kn value of females was higher than males. The study could be useful for crab fishery biologists to estimate the carapace width-weight based on body weight. Length-weight relationship parameters predict the maturity size and determine the crab's maximum and minimum landing size. The study recommends that the crab fishery managers take some management steps to avoid catching a small size of crab at landing sites. A ban period must be implemented during the spawning season to reduce the number of crab species caught in small sizes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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