ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.352
IJFAS 2016; 4(3): 168-172

www.fisheriesjournal.com
Received: 11-03-2016
Accepted: 12-04-2016

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Length weight relationship and condition factor of *Penaeus monodon* (Fabricius, 1798) from Digha coast, West Bengal, India

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Abstract
The present paper studies the length - weight relationship and condition factor of *Penaeus monodon* landed at Digha coast, West Bengal, India during 2011-2013. A total of 633 numbers of *P. monodon* were examined of which 391 were females and 242 were males. The length – weight relationship of *P. monodon*; males, females and combined were: $W=0.076636L^{2.40936}$, $W=0.026828L^{2.38872}$ and $W=0.018629L^{2.60916.}$ Length-weight relationship revealed the exponent ranging from 2.245 to 2.572 for males, 2.287 to 2.489 for females and 2.525 to 2.692 for combined sexes, respectively. Growth exhibited negative allometry for both with mean exponents b = 2.245 for males, b = 2.793 for females and b = 2.60916 for combined sexes. Highest average condition factor observed was of 1.5 in July of males and 1.7 in January of females and lowest of 1.2 in March of males and 1.4 in Feb, March, Aug and Sept of females.

Keywords: Length –weight, condition factor, *Penaeus monodon*, Digha, India.

1. Introduction
The Indian Tiger prawn *Penaeus monodon* Fabricius 1798 is the largest species among the penaeid prawns and is commonly known as "Jumbo Tiger Prawn" in the Indo-Pacific region (Rao, 2013) [23]. In West Bengal it is known as Bagda chingdi. It is widely distributed in the Indian waters but forms a substantial component of the prawn landings from the sea and the estuaries of the east coast. *P. monodon* has been recorded in all the maritime states of India (Mohamed, 1970) [18]. However, it supports commercial fishery only along the east coast between Cuddalore and the Sunderbans (Rao *et al*., 1993) [16]. Length-weight relationship is very important in fishery biology and stock assessment of aquatic species (Gulland, 1983; Enin, 1994; Stergious and Moutopoulos, 2001) [2, 1, 3]. It is also useful for a wide number of studies such as estimating growth rates, age structure and other aspect of fish and shrimp population dynamics (Tsoumani *et al.,* 2006) [4]. It is important in fishery management for comparison of growth studies (Moutopoulos and Stergiou, 2002; Hossain *et al.,* 2006) [5, 6]. LWR compares the life histories of aquatic species between the regions and differences between separate unit of stocks from the same species (Petrakis and Stergiou, 1995; King, 2007) [8, 7]. Condition factor is also a very useful index for monitoring of feeding intensity, age, and growth rates in fish (Ndimele *et al.,* 2010) [24]. It is strongly influenced by both biotic and abiotic ecological conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live (Anene, 2005) [25]. Several researches have studied the length-weight relationship of *P. monodon* from Chilika lake of Odisha (Rao, 1967) [19], Kakinada coast of Andhra Pradesh (Lalita Devi, 1987) [20] and Buguna Creek of Nigeria (Yakub and Ansa, 2007) [9]. However, there is no published information available till date on length weight relationship and condition factor of *P. monodon* from Digha coast of West Bengal, India. So the present study is to provide information on the length weight relationship and condition factor of *P. monodon* from Digha coast, India.

2. Materials and Methods
A total of 633 samples of *P. monodon* were collected from commercial catches of Digha Mohana landing centre caught by trawlers from Bay of Bengal in West Bengal during 2011-2013. The collected samples were washed thoroughly and excess water from the body removed

using a blotting paper. After sex wise sorting, the total length, carapace length and total weight were recorded. The total length was measured from tip of the rostrum to the tip of the telson, to the nearest millimeter, keeping the abdomen fully stretched. Carapace length was measured from orbital notch to the posterior margin of the carapace along the mid-dorsal line by using millimeter scale. The individual weight of samples was recorded to 1 g by using an electronic balance (ZL: 200630014473.3). The length–weight relationship (LWR) was estimated by using the equation $W= aL^b$ (Le Cren, 1951) [10]. A logarithmic transformation was used to make the relationship linear: log W = log a + log b L. The relationship between carapace length, total length and weight was determined for males, females and sex pooled separately by transforming the values of both variables to logarithmic values and fitting a straight line by the method of least squares. The significance of regression was tested by ANOVA. The regression coefficients for male and female were compared by analysis of covariance (ANACOVA) (Snedecor and Cochran, 1967) [11] for insight in the variations in the 'b' values. The growth pattern (isometric or allometric) was determined from the value of 'b' using least square regression and tested for significant difference through ANACOVA. The Student's *t* test (Snedecor and Cochran, 1967) [11] is done to find out whether the *b* values for males, females and sex pooled are significantly different from 3, using the formula [t=b-3/ Sb], where b= regression coefficient and Sb= Standard error of 'b'

2.1. Condition Factor (K) The Fulton's condition factor (K) determines the physical and environmental condition of fish or shrimp (Le Cren, 1951) [10]. It is used for comparing the condition, fatness, or well-being of fish or shrimp. The condition factor (K) for *P. monodon* was calculated using the following equation, $K =100\ W/L^3$ (Gayanilo and Pauly, 1997) [12]; where K= condition factor, W= weight of fish (gm) and L= length of fish (cm). The significance of condition factor was tested by ANOVA.

3. Results

The total numbers of *P. monodon* examined were 633; of them 391 were females and 242 were males during 2011-2013. Maximum carapace length recorded was 9.5 cm and minimum carapace length recorded was 3.5 cm, maximum total length recorded was 27.7 cm and minimum total length recorded was 12.5. cm and maximum weight recorded was 261 g and minimum weight recorded was 47 g during the investigation period.

3.1. Total length - total weight relationship: The regression equation for length –weight relationship of *P. monodon*; males, females and combined was as follows:

Male: Log W = -1.115568777 + 2.40925 logL (r = 0.88214)

Female: Log W = -1.0369821 + 2.38872 logL (r = 0.920514)

Combined: Log W = -1.340527 + 2.60916 Log L (r=0.925811)

Length - weight relationship revealed the exponent ranging from 2.245 to 2.572 for males, 2.287 to 2.489 for females and 2.525 to 2.692 for combined sexes, respectively. Growth exhibited negative allometry in all the sexes with significant differences ($b<3$, $p<0.05$). The scatter diagrams for the length weight relationship for males and females are illustrated in Figures (1-6) respectively.

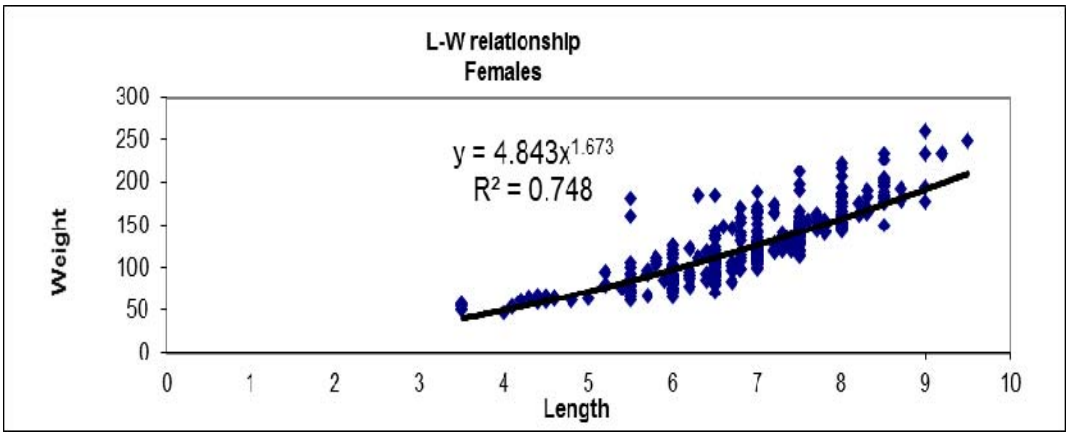

Fig 1: Carapace length –Weight relationship of female's *P monodon* from 2011-2013

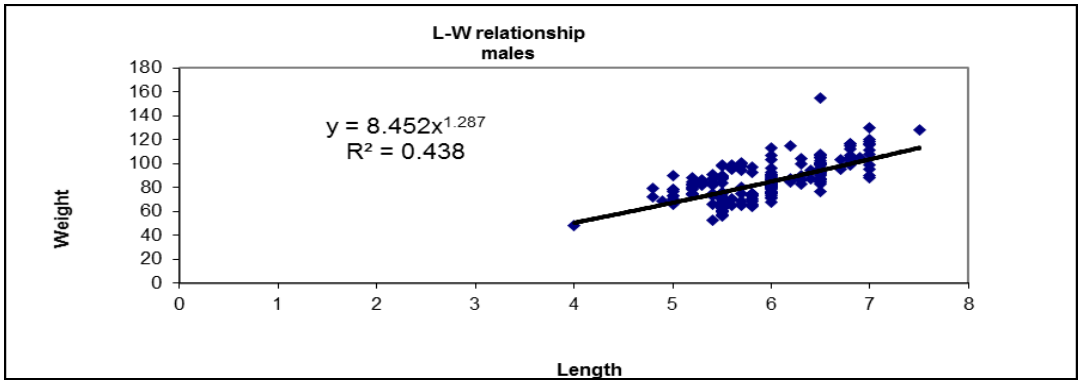

Fig 2: Carapace length – Weight relationship of males *P monodon* from 2011-2013

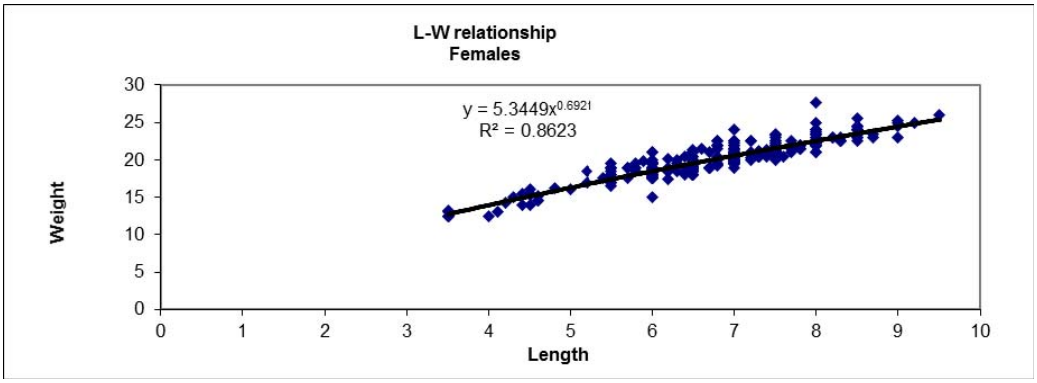

Fig 3: Carapace length-Total length relationship of females *P monodon* from 2011-2013.

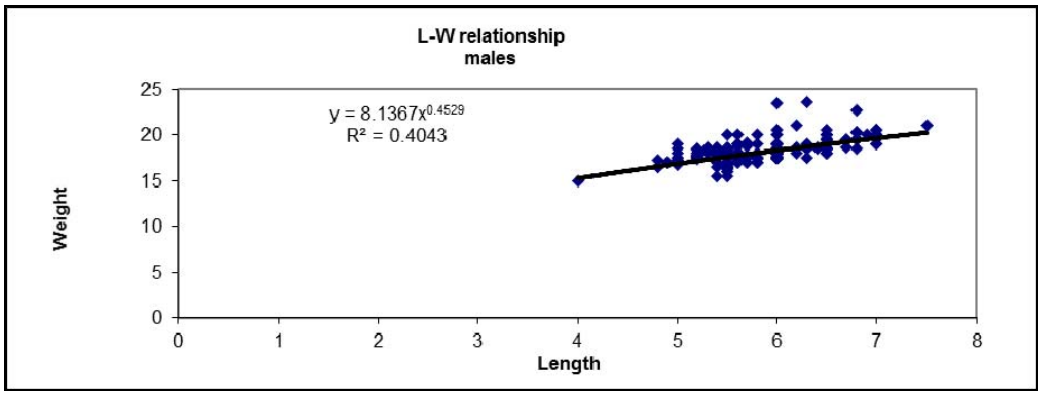

Fig 4: Carapace length-Total length relationship of males *P monodon* from 2011-2013.

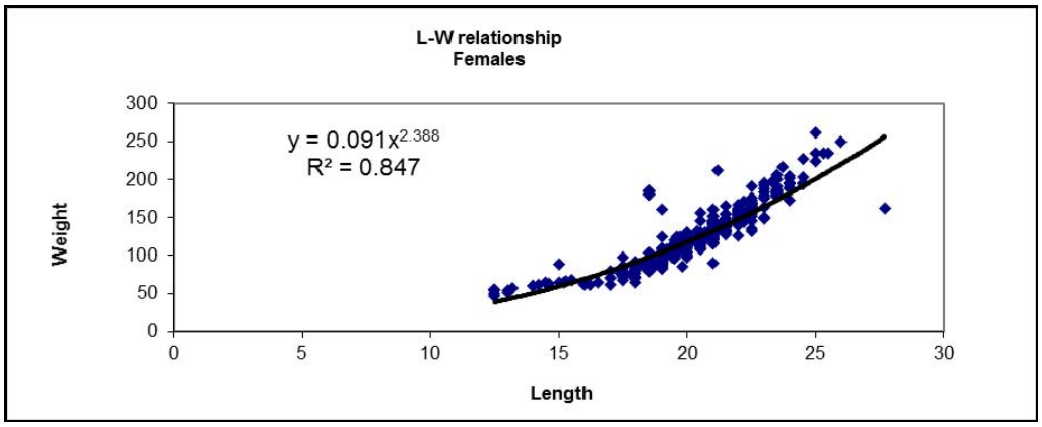

Fig 5: Total length- Weight relationship of females *P monodon* from 2011-2013

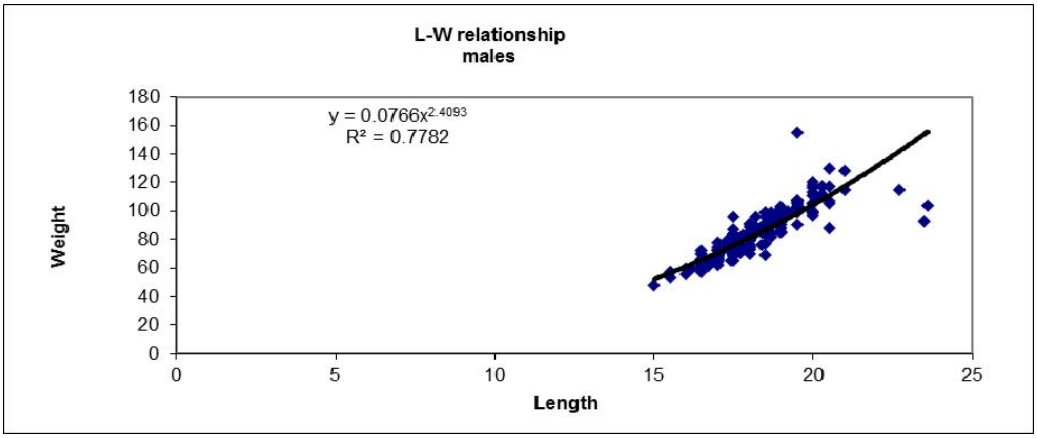

Fig 6: Total length- Weight relationship of males *P monodon* from 2011-2013.

3. 2. Carapace length-weight relationship

The regression equations for the carapace length-weight relationship for males, females and pooled were calculated as under:

Males Log W= 0.92698 + 1.28763 Log CL (r = 0.661846)
Females Log W = 0.68519 + 1.673308 Log CL (r = 0.865155)
Pooled Log W= 0.56873+ 1.7918036 Log CL (r = 0.86533)

3.3. Carapace length –total length relationship:

The carapace length and total length relationship of *P. monodon* for males, females and pooled were calculated as below:

Male: Log TL= 0.910448+0.452938 log CL (r =0.63583)
Female: Log TL= 0.727943+0.692095 log CL (r=0.92858)
Combined: Log TL= 0.750318+0.663744 log CL (r=0.90330)

3.4. Condition factor (K): The month-wise condition factor (K) of *P. monodon* (242 males and 391 females) from Digha of Bay of Bengal is presented in Table (1) and Results reveal significant difference (p<0.05) in condition factor between males and females. The highest average condition factor observed was of 1.5 in July for males and 1.7 in January for females and lowest of 1.2 in March for males and 1.4 in the months of Feb, March, Aug, and Sept for females.

Table 1: Average condition factor of *P monodon* from 2011-2013

Month	Males	Females	pooled
Jan	1.4	1.7	1.6
Feb	1.4	1.4	1.4
Mar	1.2	1.4	1.3
Apr	1.4	1.5	1.5
Jun	1.5	1.5	1.5
July	1.3	1.4	1.4
Aug	1.4	1.4	1.4
Sept	1.4	1.5	1.5
Oct	1.4	1.4	1.4
Nov	1.4	1.5	1.5
Dec	1.4	1.6	1.5

4. Discussions

Length-weight relationships are very important in fishery biology and stock assessment of aquatic species. The present study provides information on the length weight relationships of *P. monodon*. The length- weight relationship obtained in the present study agrees with the finding of Gopalakrishnan *et al.,* (2013) [13], who studied the length–weight relationship of *P. monodon* from wild shrimps as log W = −1.444 + 2.485 log L (r^2 = 0.91). Rao (1993) [16] from east coast, estimated the relationship for males as Log W =-5.3399 + 3.1032 log L and for females as log W =-4.8953 + 2.9022 log L. The negative allometric growth observed in both sexes indicated that larger specimens are more elongated. Yakubu and Ansa (2007) [9] have reported positive allometric pattern of growth in Buguma Creek. This variation in growth pattern could be attributed to the fact that length-weight relationship of species varies according to their locality and fishing season (Medina-Reyha, 2001; Prasad, 2001) [14, 15]. Negative allometric growth indicated that the weight increases at a slower rate than the body length. Several factors such as sex, age, stage of maturity, food avalibility, fishing ground and environmental conditions effect on growth (Ama-Abasi, 2007) [17].

Condition factor (K): Mean condition factor 'K' of *P. monodon* greater than 1 implies that they are in good physiological condition (Ajani *et al.* 2013) [22]. The mean condition factor in the present study is1.6, which could be attributed to the presence of gravid females and of different feeding regimes, similar to that reported by Andem *et al.* (2013) [21].

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