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Research Article

STUDY OF LENGTH AND WEIGHT RELATIONSHIP OF *LITOPENAEUS VANNAMEI* (BOONE, 1931) FROM EAST COAST OF INDIA

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ABSTRACT

Length-weight relationship and allometric factor for the imported *L. vannamei*broodstock shrimps to the entire Tamilnadu shrimp hatcheries were statistically pooled and investigated. There were 155 and 156 of both female and male brooders were used for the present investigation and about three sampling were performed in different intervals. Among the pooled data studied, females found bigger than male brooders in utmost all the hatcheries. The regression relationship of both the sexes showed significant as P<0.05. It has been proved that, the allometric pattern of growth for 4 different hatcheries located in between Chennai to Pondicherry coast. Both the allometric pattern and P-value for both male and female brooders showed significant (P<0.05). Similarly the relationship pattern for both the sexes were also studied using ANOVA and ANCOVA values showed statistically significant as P<0.005.

Keywords: Morphometric Characteristics, *Litopenaeusvannamei*, Broodstock, ANOVA & ANCOVA

INTRODUCTION

The length-weight relationship has vital importance in fisheries science. It helps in establishing mathematical relationship between the two variables, enables conversion of one variable to describe growth in the wild (Abohweyere and Williams, 2008; Deekae and Abowee, 2010), to determine possible differences among different stocks of the same species (King, 2007), delineate the stocks and comparative growth studies (Peixoto*et al*., 2004). Although shrimp body weight is commonly recorded for culture management purposes (e.g. estimations of growth rate, feed conversion ratio, harvest weight, and productivity), the application of morphometric relationships could be a simple alternative to estimate body weight from length measurements that are less variable and more easily measured in the field (Primavera *et al*., 1998). Therefore, the use of morphometric measurements and mathematical models in aquaculture is highly encouraged because that is the most precise and complete way of analysing growth data (Hopkins, 1992).

Morphometric traits used to describe penaeid growth usually include carapace length, total length, and body wet weight (Dall*et al*., 1990). Although shrimp body weight is commonly recorded for culture management purposes (e.g. estimations of growth rate, feed conversion ratio, harvest weight, and productivity), the application of morphometric relationships could be a simple alternative to estimate body weight from length measurements that are less variable and more easily measured in the field (Cheng and Chen, 1990; Primavera *et al*., 1998).

At the present wide-ranging, shrimp farmers are more concerned about the biomass of the cultured shrimp that they record only the body weight, whereas biologists and researchers prefer morphometric measurements, which are not subjected to wide variations (Primavera *et al*., 1998).There are many well documented morphometric studies, which provide evidence for stock discreteness (Corti and Crosetti, 1996; Turan, 2004). The most common body measurements in penaeid shrimps are carapace length, body length and total length. Sexual dimorphism, morphological differences between the sexes mediated by the action of sex hormones is a dominant condition among crustacean species, group in which females often grow larger and reach larger sizes than males (Gopal*et al*. 2010). Although sometimes morphological discrimination can be conspicuous in other sexual differentiation is quantitative and qualitatively accessed only through statistics analysis based on comparative morphometric techniques (Bertin*et al.* 2002). Morphometry includes analysis of body shape or particular morphological characteristics (Begg and Waldman, 1999). Resolute analysis of shape through geometric morphometric methods has been successfully applied in several aquatic species (Cadrin and Silva 2005) with the purpose of population analysis and biogeography (Hopkins and Thurman, 2010, Giri and Loy, 2008).

The improvements and innovations in the farming of the white shrimp *Litopenaeusvannamei* since the early 1990s have resulted in this species dominating global shrimp production since 2000. A major factor contributing to the successful expansion of the *L. vannamei* industry has been the development of domesticated, selectively bred stocks in breeding programs (Briggs *et al*., 2005; Clifford and Preston, 2006).

Presently an effort has been made to analyse the length-weight and length-length relationships of *L.*

*vannamei*from different destinations to Indian shrimp hatcheries in particular to Tamil Nadu which are located in the East coast of India.

MATERIAL AND METHODS

Morphometric data of length-weight relationship of *L. vannamei* were obtained from different shrimp hatcheries situated between Chennai and Pondicherry coast. A total of 313 specimens (157 males and 156 females) ranging in size from 79 to 138 mm males and 79 to 160 mm females were used for the present study. The total length (TL) was measured to the nearest millimetre from the tip of the rostral spine to the apices of the sub median spines of the telson by a graduated measuring scales whereas the weight was taken to the nearest 0.01g using an electronic balance. Specimens with broken telson and rostrum were discarded. Similarly soft or moulted animals were not used in the present study.

The length-weight relationship was calculated separately for each category based on the methodology of Le Cren (1951). The hypothetical and parabolic equation used by him is $\mathbf{W=aL^{b}}$.Itslogarithmic transformation is$\mathbf{\log_e W= \log_e a + b\log_e L}$ **i.e., y=a+bx**according to Ramasesaiah and Murty, (1997). Where, 'w' represent weight in g and 'a' and 'b' the constants which were estimated by method of least squares.

The linear equation was fitted separately for males and females of *L. vannamei*. Analysis of covariance (ANCOVA) was employed to test the significance of differences between regression co-efficients (b) at 5% level in both the sexes (Hoda, 1976). The t- test was employed to test whether the regression co-efficient (b) departed significantly from expected hypothetical cubic value 3.

RESULT

The estimated co-efficient of length-weight relationship and other statistical detail of *L. vannamei* brooders are consolidated in **Table 1** and **2.** The logarithmic values of observed length and corresponding weights of males and females are plotted in **Figs 1** and **2** respectively. Similarly the observed values of length-weight of male and female *L. vannamei* are plotted in **Fig 3** and **4.** The regression plot of the data indicated a linear relationship between two variables.

The logarithmic equations derived for male and female of the *L. vannamei*broodstock prawns collected in different hatcheries evaluated are given below.

For males : $\log_e Wt= -5.1504+3.2605 \log_e Lt$

For females : $\log_e Wt= -5.9894+3.6546 \log_e Lt$

The parabolic relations derived are

For males : $Wt= 0.0007Lt^{3.2605}$

For females : $Wt= 0.0004Lt^{3.6546}$

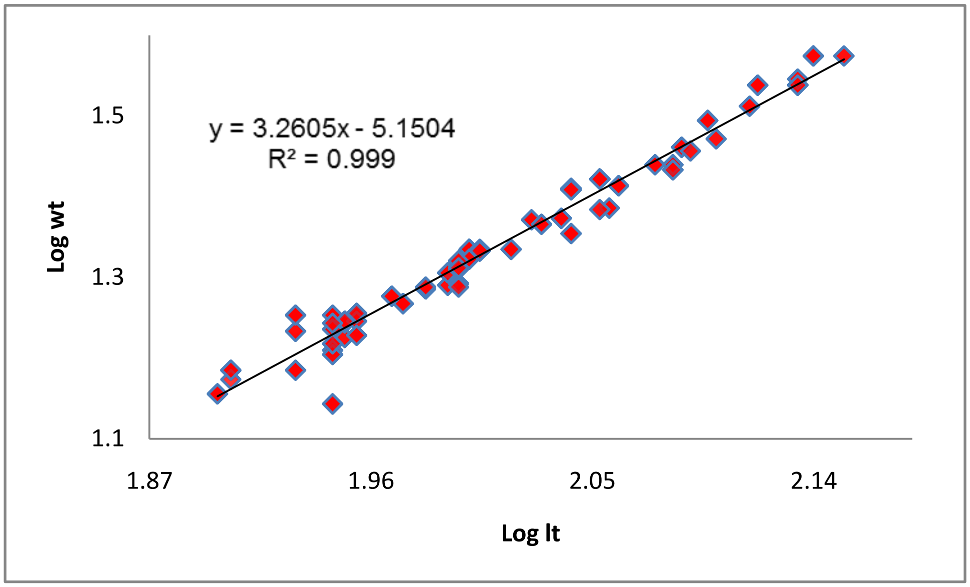

Figure 1: Logarithmic relationship between length and weight of *L. vannamei* male broodstock

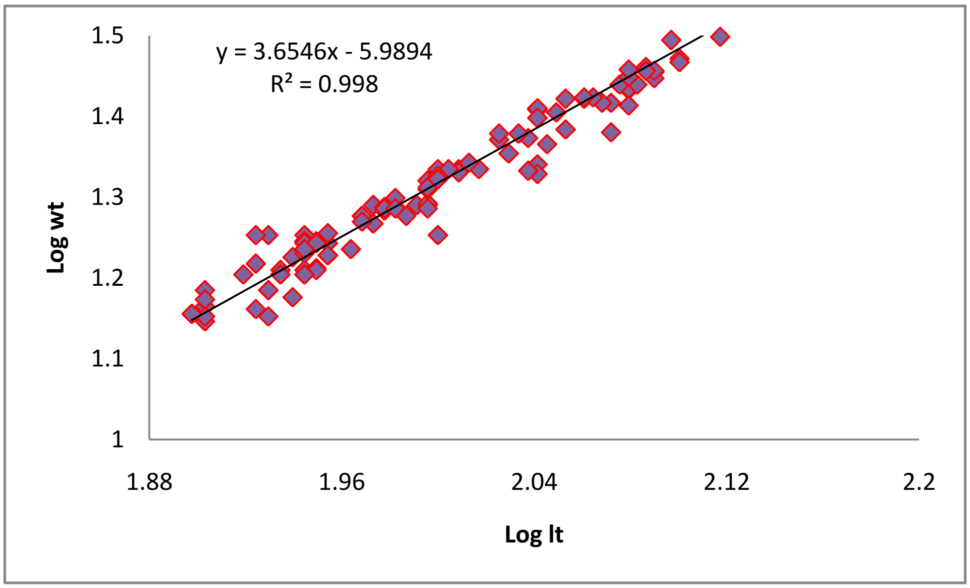

Figure 2: Logarithmic relationships between length and weight of *L. vannamei* female broodstock

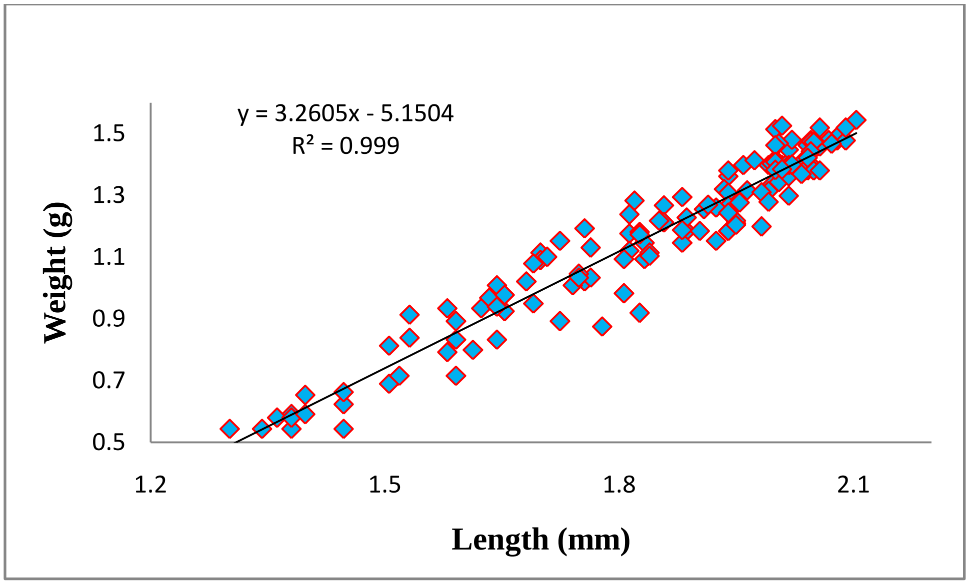

Figure 3: Parabolic relationship between length and weight of *L. vannamei* male broodstock

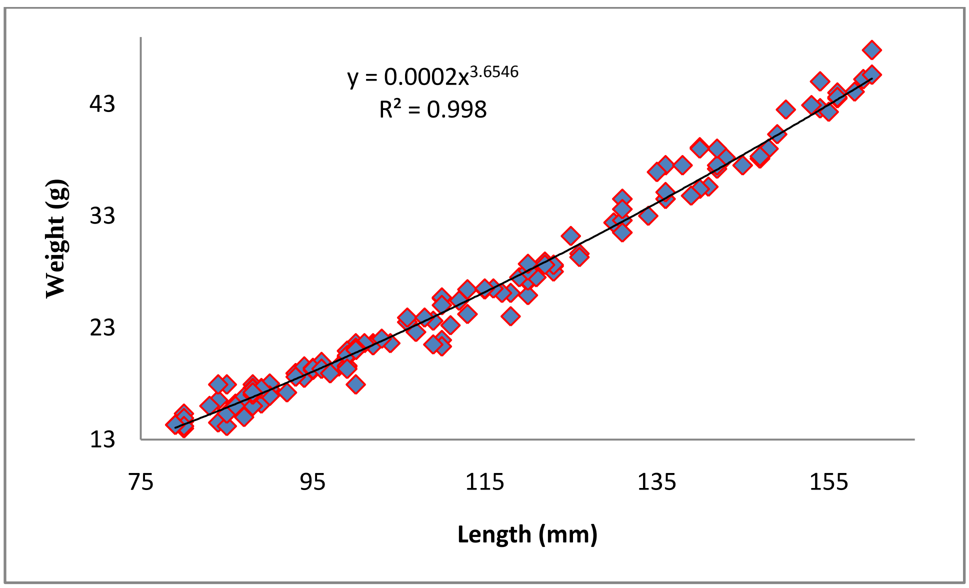

Figure4: Parabolic relationship between length and weight of *L. vannamei* malebroodstock

Category	**Df**	**Sum of squares and products**				**Errors of estimation**	
		x^2	**Xy**	**y^2**	**B**	**Df**	**Ss**
M	156	6.1950	7.8618	10.6918	3.26	155	0.71484
F	155	1.2232	2.0240	3.3869	3.654	154	0.03795
T	311	7.4183	9.8858	14.0787		309	0.75279

Table 1: Regression analysis data for length-weight relationship of male and female*L. vannamei*broodstock

Sources of variation	**Df**	**Sum of squares**	**Mean squares**	**F**	**P**
Deviation from individuals regression	308	0.75279	0.002444		
Differences between regression	1	12.7461	12.7461	5214.99	P<0.05

Table 2: Analysis of covariance showing difference between regression of length-weight relationship of male and female *L. vannamei*broodstock

Analysis of covariance used to test the difference in regression coefficients between males and females revealed significant difference (F=5214.99, P<0.005). The t-test revealed the value of regression coefficient 2.654 obtained with 157 males did not depart significantly from the cube value (3) at 5% level (t=1.73, P<0.05). However, the regression coefficient 3.26 obtained with 156 females departed significantly from the cube value (t=3.85, P<0.05). Therefore, allometric pattern of growth was noticed in both the sexes of male and female *L. vannamei*broodstock prawns that were collected from 4 different shrimp hatcheries located between Pondicherry and Chennai coast. These brooders were completely imported from different countries of origin. The origin of broodstock prawns to these shrimp hatcheries is unknown, furthermore the above shrimp hatcheries importing *L. vannamei* brooders from multi destinations instead importing from single destination for their nauplii production.

DISCUSSION

Extremely significant differences in the total length-weight ratio and condition factors were noticed in the *L. vannamei*broodstock collected from different hatcheries along Pondicherry and Chennai coastal of Tamil Nadu. From the present investigation the total length and weight ratio of both male and female brooders of these hatcheries were: Males (3.2605) and Females (3.6546).This is the result found to be closely coinciding with allometric relationships reported in the white shrimp *Penaeussetiferus* (Anderson and Lindner, 1958) and between carapace and total lengths in the wild penaeid*Plesiopenaeusedwardsianus* (Formoso*et al*., 1980). Chow and Sandifer (1991) described the bodies of older *L. vannamei* as longer, thicker, and heavier in proportion to carapace length than those of younger shrimp. In accordance, the present results showed that animals from the broodstock production group tended to have longer and heavier bodies than grow out individuals with the same carapace length. The relationships between body length and body weight or body length-carapace length have been found to differ between sexes in several penaeid species (Liao, 1988).

Morphological distinction by structural analysis between male and female*L. vannamei*adults to the structures analyzed was evidenced. The detection of differences in size at maturity from changes in the allometry of sexual characteristics is a common example of interspecific heterochrony identification. Many decapod crustaceans exhibit accentuated changes until sexual maturity as a result of discontinuous growth (Cadrin, 2000).

Differential morphological characteristics present in the cephalothorax were shown conspicuously differentiated between the sexes of *L. vannamei*. Such changes have been identified in several crustaceans (Tzeng, 2004; Anastasiadou*et al*., 2004; Anastasiadou and Leonardos, 2008). One of dimorphic of the characters were observed from females with presence of large abdomens, selectively important condition for species that do not show parental care (Thiel, 2003). The same pattern of sexual dimorphism appeared in number of species of commercially important penaeid shrimps (Bray and Lawrence 1992, Primavera *et al.* 1998, Hoang *et al.* 2003). It has been suggested that in *L. vannamei*the shape of the abdomen represents a key factor in the competition for food (Hansford and Hewitt, 1994).

Environmental changes affected not only the growth but also the shape of *L. vannamei* (Chow and Sandifer, 1991). Under our culture conditions, differences in morphometrics among culture phases may also reflect variability in environmental parameters (e.g. temperature and salinity), feeding and rearing conditions (e.g. stocking densities) employed for each culture phase. While shrimp growth was commonly reported in terms of body weight, length measurements have been considered a less variable and easier means to record in the field (Primavera *et al*., 1998). Although knowledge of the size structure at different culture stages is important for management decisions, instead of direct weighing, shrimp body weight can be inferred from body length that were more readily measured (Cheng and Chen, 1990).

In *Penaeusduorarum*, Kutkuhn (1962) reported that females had a greater carapace length and body weight than males of the same total length and this difference became more pronounced in larger size groups. Choe (1971) noted no difference observed in the body length and weight between sexes in *Penaeus japonicas,* but he sampled only relatively small shrimp. From our experience, the growth of penaeid shrimp species seems to be allometric with differences between sexes.

A pervious study evaluating the size of *L. vannamei* families at the different ages found no significant phenotypic correlation between harvest and broodstock weights (Argue *et al*., 2000) and suggestive of genotype by age interaction. Argue *et al*., (2000) proposed that growth in *L. vannamei* may have a different genetic origin of pre and post-harvest. Apparently, due to inter-family variation the effects of reproductive maturation on the growth between harvest and broodstock age.

Morphometric relationships of length and weight have been determined mainly in adults of several penaeid species, and this has resulted in erroneous extrapolation in juvenile shrimp (Dall*et al*., 1990). Primavera *et al*. (1998) found that life stage was the most striking difference for both length-length and length-weight relationships in cultured *P. monodon*. Wider ranges of size need to be investigated in order to determine how the relationships change with shrimp size or life stage (Chow and Sandifer, 1991).

Though, the use of total length to determine length-weight morphometric relationship has been widely applied for wild and captive penaeids at different life stages and environmental conditions (Chu *et al*., 1995; Primavera *et al*., 1998). The correlation with present study were more consistent with an earlier study evaluating size (3.2605) and growth traits of *L. vannamei* reared in indoor systems (Perez- Rostro and Ibarra, 2003)

Attempts to identify differences in the morphometric traits and to correlate such traits with geographic location have been made for some penaeid shrimp species for fisheries managements or genetic resources (Huang *et al*., 1989). Potential problems in comparing morphometric traits of the hatchery lots utilized in the present study include differences in post larval age at introduction, unequal survival, and unknown numbers of parents for each tons. It is extremely possible that heterogeneous environments at different localities may cause morphometric differentiation among local samples. A similar resemblance has been observed in the present study, differences were apparent in morphometric traits between the shrimp hatcheries located between Pondicherry and Chennai coast. Present study evidenced the application of morphometric relationship between total length and body weight is the most suitable for cultured *L. vannamei*. The use of a general conversion equation from total length to body weight could simplify management during the nursery and grow out culture phases, as well as the selection of appropriate broodstock size for reproduction purposes.

The selection of brooders for breeding program is commonly based on the information derived from genetic evaluations of sibling performance in commercial pond environments. For growth traits in *L. vannamei*, correlations between performances in different rearing systems or when exposed to different dietary and environmental regimes have often been found to be high (Perez-Rostro and Ibarra, 2003; Gitterle*et al*., 2005), suggesting that genetic growth selections made in broodstock environments will typically yield parallel improvements in commercial ponds. Other studies have reported in the lower correlations (or the presence of significant genotype×environment interactions) for growth of shrimp reared under different environmental regimes (Coman*et al*., 2004; Jerry *et al*., 2006; Ibarra and Famula, 2008).

There are significant differences in growth, morphometric traits, and beginning of male sexual maturity reported here among shrimp lots from different commercial hatcheries suggest the possibility of genetic differences among the lots, although the traits measured were largely influenced by environmental factors. Unfortunately, we lack detailed information on the genetic background and number of parents for each lot. However, at the time of animals acquired hatcheries were thought to be operating with closed broodstock populations (i.e., no wild animals were being introduced to the breeding stock).

Primavera *et al*. (1998) reported for *P. monodon*that morphometric dimorphism due to sex was observed only after the broodstock stage in captivity when females had a greater weight gain per unit length. Araneda et al. (2012) was previously reported the *L. vannamei*was cultured in freshwater (0 ppt) at three densities (90, 130 and 180 shrimp m−2) and comparisons made of the resulting growth, length–weight relationship and condition factor data.

The present study clearly indicated however the need for developing separate morphometric relationship for males and females of *L. vannamei*during broodstock stage. Several author's reports have supported the importance of morphometric character relationship between the male and female of *L. vannamei* species.

CONCULSION

This is an attempt concluded that the morphometric relationship of *Litopenaeusvannamei* has studied through length-weight of males and females. Also maximum 313 specimens are used in the different destinations of Indian shrimp hatcheries in particular Tamil Nadu, East coast of India for the present investigation. This attempt will helps to identify the species variations at molecular level and it can be used to breed true to type especially for this species *L. vannamei*.

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