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# Allometric relationship of shortneck clam *Paphia malabarica* (Chemnitz, 1782) along Aare-Ware rocky shore of Ratnagiri, Maharashtra

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## Abstract

**Studies on length-weight and other allometric relationships of shortneck clam, *Paphia malabarica* were carried out in samples ranging between size 5-50 mm. Clams were collected fortnightly during May 2014 to April 2016 from Aare-Ware rocky shore of Ratnagiri coast, Maharashtra. Length -total weight relationship in males and females were significantly different (p <0.05). The rates of growth in all other relationship studied were significantly difference. In length-height, length -depth, length -total weight and length -wet weight relationship, it showed negative allometric growth. Negative allometry indicated that width and depth increase were inferior to length increase.**

***Key words*:** *P. malabarica*, Aare-Ware, allometric growth, length-weight relationship

## 1. Introduction:

Bivalvia, the second largest class in the Phylum Mollusca, are distinctive within the mollusca in that they are almost always completely enclosed within their shells. They are laterally compressed, typically with shells divided in two halves or valves, hinged together dorsally by an elastic, chitinous, external or internal ligament. The bivalve shell probably originated from an evolutionary split of a single ancestral, cap-like shell along a longitudinal line. Bivalves form valuable fisheries in various parts of the coasts of the India providing food, lime, pearls and decorative shells. Bivalves are, also a rich source of bioactive compounds that are used in medicinal preparations (Nayar and Rao, 1985). The growth of bivalves is estimated mostly by the shell dimensions and rings or the volume of the animal (Deval, 2001).

In India, the allometric relationships of several bivalves have been studied by Alagarswami (1966), Parulekar *et al*. (1973), Alagaraswami and Chellam (1977), Mohan and Damodaran (1981), Mohan *et al*. (1984), Rao (1988) and Gaspar (2001). The studies on length-weight relationship of *Paphia malabarica* were done by Rao (1988) from Mulky Estuary in Dakishna Kannada, dimensional variations by Appukuttan (1993) from Ashtamudi Estuary in south Kerala and by Thomas (2013) from Dharmadom estuary in Karnataka. In the present study, the regression equations were calculated

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separately for male and female and the relationships were statistically compared between sexes.

**2. Materials and methods:**

*P. malabarica* were collected fortnightly from the intertidal zones of the sampling sites at Aare-Ware rocky shore of Ratnagiri, Maharashtra (Lat. $16.9902^0$ N, Long. $73.312^0$ E) from May 2014 to April 2016. A quadrate of size 50 × 50 cm was used along fixed transact lines in the exposed intertidal area at low tide and the clams were handpicked. They were cleaned and wiped dry. A total of 1250 clams ranging in size from 5 to 50 mm were measured from Aare-Ware rocky shore located along the south-west side of Ratnagiri (Map 1).

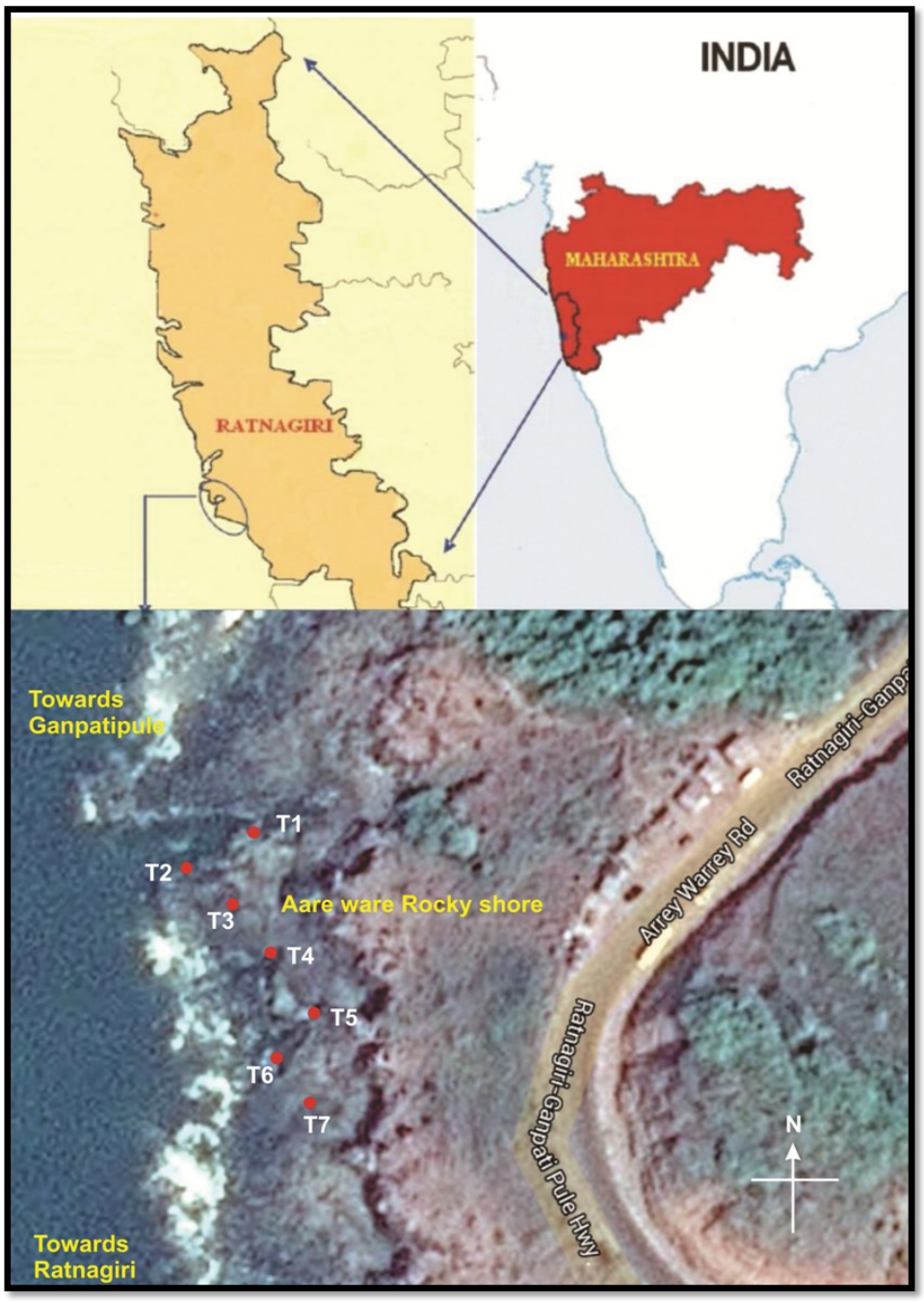
From the samples, morphometric parameters like shell length (the maximum distance along axis of the valves), height (from the tip of umbo to the posterior margin of the shell), depth (the maximum thickness between the two valves when they are closed) and length - weight parameters like total weight, wet meat weight and dry weight were recorded at fortnightly intervals following the method adopted by Leal (2013). Shell length of each specimen was measured with accuracy of 0.1 mm using vernier calipers.

Regressions of height, depth, total weight, wet weight and dry weight on shell length were studied by the simple equation for linear regression Y = a Xb, where Y is taken as height (Ht.), depth (D.), total weight (Wt.), wet weight (WWt.) and dry weight (dWt) "a" and "b" are constants to be determined empirically. The estimation of length-weight relationship was done as per Pauly (1983) by using equation $W = aL^b$, (where 'a' and 'b' are constants). Analysis of variance technique was used to test for significant difference in relationship between sexes at

5% level as per Zar (2005). For length-weight, regression analysis was performed using Data Analysis package in EXCEL software. The coefficient of determinant ($r^2$) was determined to know the degree of the relationship between two variables.

**3. Results and discussion:**

Relationships between length, height, depth, total body weight, wet weight and dry weight were studied in total 1250 specimens of *P. malabarica* from Aare-Ware rocky shore. The constants were determined from the morphological data. The relationships between length and height, length and depth, length and total weight, length and wet weight, length and dry weight were calculated. The regression equation were tested for equality through analysis of variance




**Map 1 - Sampling location at Aare-Ware rocky shore, Ratnagiri, Maharashtra**

(ANOVA) student 't' test showed significant difference at 95 % confidence level and b value for the same, indicated negative allometric growth. The comparative account of various relationships between

different morphometric and length-weight measurements have been indicated by Fig. 1- 5 against shell length and Table 1 indicates values of their constants (a and b) and determination of coefficient ($r^2$).

Morphologically, the individuals could be classified into two groups as small with less height and thickness, and long individuals with more height and more thickness. Similar linear relationship has also been reported for bivalve species (Durve and Raja, 1965; Thippeswamy and Joseph, 1992; Thippeswamy and Hemachandra, 2008). Negative allometry indicated that height and depth increase were inferior to length increase. Similar results were observed by Thomas (2013) in length-width and length-depth where negative allometric growth in *P. malabarica* was reported. Nagvenkar *et al*. (2014) has worked on *P. malabarica* from Zuari and Mandovi estuaries at Chicalim and Nerul of west coast of India. The morphometric relationships between length-breadth and length-depth variables were found to be linearly related. However, the relationship between length-total weight, length-shell weight, length-wet weight and length-dry weight showed a nonlinear isometric pattern at both stations.

Length-weight relationships of males and females of clam *P. malabarica* were also studied. During the study, 377 males and 390 females were recorded from Aare-Ware shore.

The regression equation between male and female were tested for equality through analysis of variance (ANOVA), in which slopes and elevations were compared. Student 't' test was conducted for pooled samples to test whether the correlation coefficients differ significantly or not. The value of 't' calculated for pooled samples of slopes were 3.9627 which showed significant difference at 95% confidence level and elevations was 0.9023 which did not showed significant difference at 95% confidence level. The 'b' value for the same indicated negative allometric growth. Independent statistical analysis of their length and weight relationship gave the following equations. The length–weight relationships for males, females and indeterminates are represented in the Fig. 6 to 8.

**Logarithmic relationship between length and weight in males, females, indeterminates and total of *P. malabarica* of Aare-Ware rocky shore:**

Males : Log W = Log (-2.9872) + 2.4510 Log L ($r^2$ = 0.71)

**Table 1. Allometric relationships between morphometric and length-weight relationship of *P. malabarica.***

| Sr. No | Parameters | Equation | a | b | $r^2$ | n |
|---|---|---|---|---|---|---|
| **Morphometric relationship** | | | | | | |
| 1 | Height (Ht.) on length (L) | D= -1.6956 + 0.7302 L | -1.6956 | 0.7302 | 0.6441* | 1250 |
| 2 | Depth (D.) on length (L) | Wd= -0.1249 + 0.5268 L | -0.1249 | 0.5268 | 0.7256* | 1250 |
| **Length-weight relationship** | | | | | | |
| 3 | Total weight (Wt) on length (L) | Log Wt = Log (-2.8184) + 2.3366 Log L | -2.8184 | 2.3366 | 0.6366* | 1250 |
| 4 | Wet weight (Wwt) on Length (L) | Log Wwt= Log (-1.4376) + 1.2586 log L | -1.4376 | 1.2586 | 0.4984* | 1250 |
| 5 | Dry weight (Dwt) on Length (L) | Log Dwt=Log (-0.2980) +0.0735 Log L | -0.2980 | 0.0735 | 0.0350* | 300 |

$r^2$ = correlation coefficient, n = number of specimens

*Significant ($P<0.05$)

**Ht= -1.6956 + 0.7302 L**

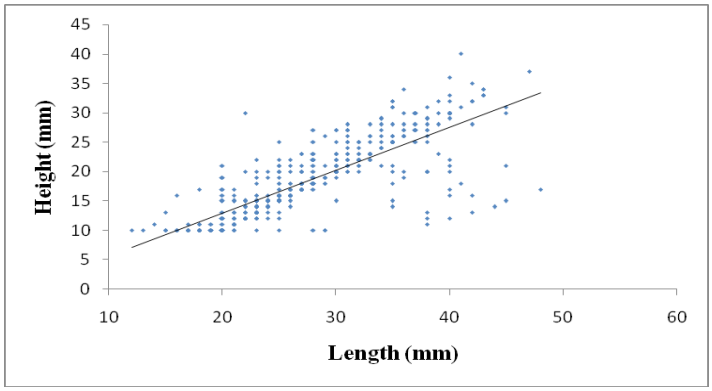



**Fig. 1. Linear relationship between length and height in *P. malabarica***

**D= -0.1249 + 0.5268 L**

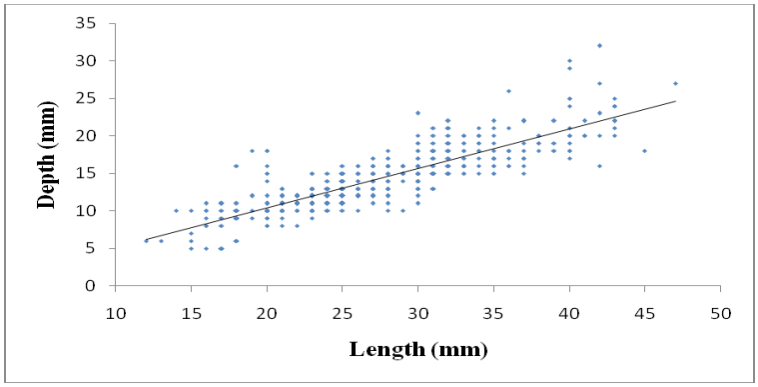



**Fig. 2. Linear relationship between length and depth in *P. malabarica***

**Log Wt = Log (-2.8184) + 2.3366 Log L**

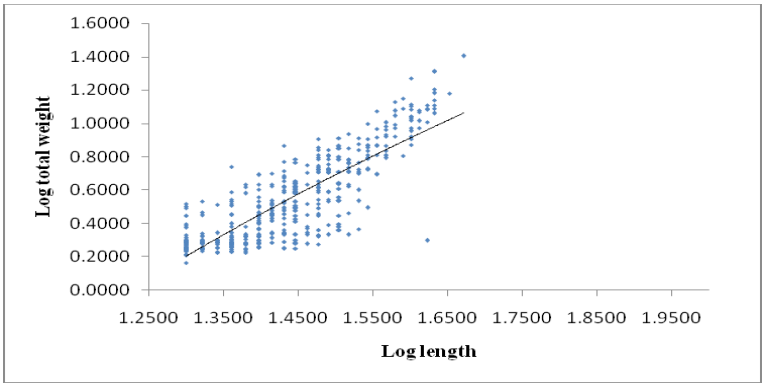



**Fig. 3. Logarithmic relationship between length and total weight in *P. malabarica***

**Log Wwt= Log (-1.4376) + 1.2586 log L**

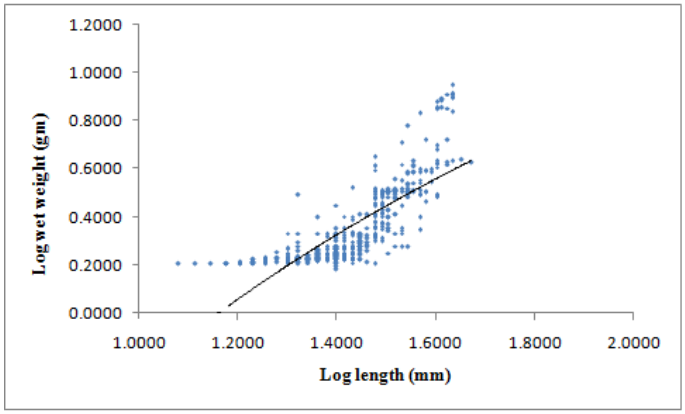



**Fig. 4. Logarithmic relationship between length and wet weight in *P. malabarica***

**Log W = Log (-2.9872) + 2.4510 Log L**

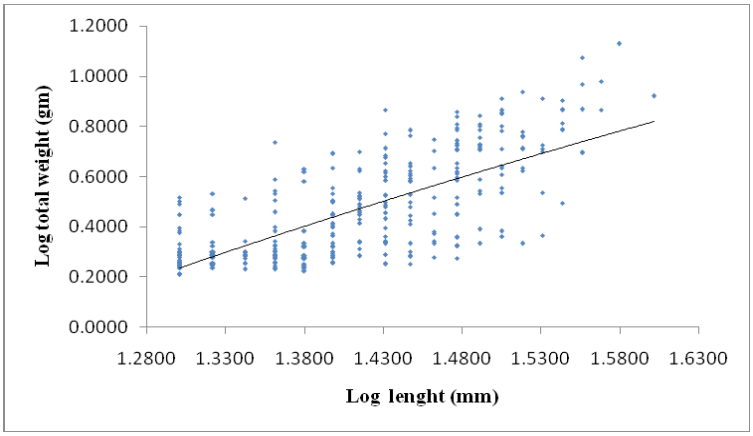



**Fig. 5. Logarithmic relationship between length and total weight in the males of *P. malabarica***

**Log W = Log (-2.2200) + 1.9029 Log L**

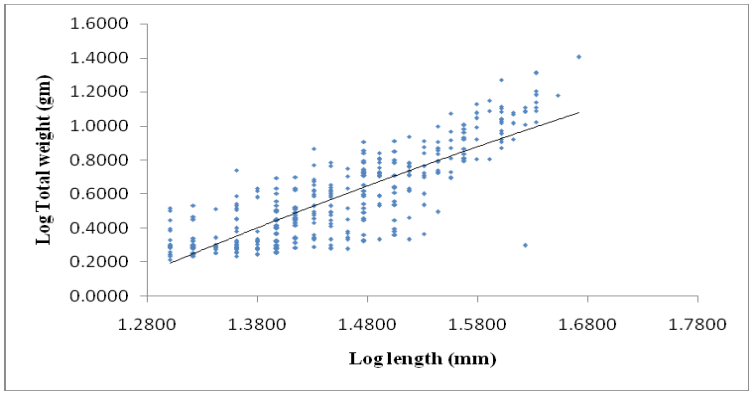



**Fig. 6. Logarithmic relationship between length and total weight in the females of *P. malabarica***

Females : Log W = Log(-2.2200) + 1.9029 Log L ($r^2 = 0.41$)

Indeterminates : Log W = Log (-2.5226) + 2.1157 Log L ($r^2$= 0.38)

Total : Log W = Log (-2.8184) + 2.3366 Log L ($r^2$= 0.64)

Mohite (2010) estimated the length-weight relationship of male and female for *P. malabarica* at two stations, viz. Bhatye and Shirgaon along Ratnagiri coast. The equations were given as, Shirgaon: Males : Log W = Log (- 0.64) + 3.07 (r= 0.93) Log L and Females: Log W = Log ( - 0.362) + 2.57 Log L (r= 0.93); Bhatye: Males: Log W = Log (-0.297) + 2.493 Log L (r= 0.83) and Females: Log W = Log (-0.306) + 2.475 Log L (r= 0.90) that showed allometric growth and it was found that in all the above correlations "r" is significant (P< 0.05). Similar work was done by Sawant (2012) for *M. meretrix* at Ratnagiri coast of Maharashtra. Thomas (2013) reported length-weight relationship and other allometric relationships for shortneck clam *P. malabarica* from Dharmadom estuary in Kerala. Length-weight and total weight-flesh weight relationship in males and females were significantly different (p <0.01). The rate of growth in all other relationship studied was not significantly different between sexes. Nagvenkar *et al*. (2014) reported the nonlinear relationships between length-total weight, length-shell weight, length-wet tissue weight, and length-dry weight at Chicalim and Nerul of west coast of India.

In the present study, the morphometric and length-weight relationships show variatios which could be attributed to variations in the habitat and hydrological conditions observed at Aare-Ware rocky shore. The information on different allometric relationships could be used as an important input from management point of view for bivalve fishery.

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