

Biometric Relationships of *Villorita cyprinoides* (Gray) from Vembanad Lake, Kerala, India

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Abstract

Length-weight and other biometric relationships of the black clam *Villorita cyprinoides* collected from two stations of Vembanad Lake were compared in this study. In clams of both the stations, the growth in length was accompanied by increase in weight ($b=1$, isometric growth). The length-width (L-B) and length-height (L-H) relationships of *V. cyprinoides* from both the stations were positively allometric ($b>1$). All relationships involving weights of one part to weight of the other part (Total Weight (TW) -Meat Weight (MW), TW-Shell Weight (SW), SW-MW) showed negative allometry ($b<1$) for clams of station 1 and positive allometry for clams of station 2. The values of the correlation coefficients, r for various biometric relationships studied were very close to unity.

Introduction

Clams are commercially important molluscan fishery resource, fished for their meat and shell in India. The State of Kerala leads India in the production of clams with estimated annual landings of about 66,000 tonnes in 2008-09 (CMFRI, 2009). The black clam, *Villorita cyprinoides* (Gray, 1825) (Family, Corbiculidae) contributes 45,000 tonnes, or about two-thirds of this total. Most of the annual production of black clams, about 25,000 tonnes, comes from Vembanad Lake where almost 4,000 fishermen harvest them. During 2009-10, India exported 560 tonnes of clam meat in frozen, dried, freeze-dried and cooked forms, earning a foreign exchange of US\$ 1 million (MPEDA, 2010)

Vembanad Lake is the largest brackish water lake on the west coast of India. Narrow and sinuous in the north and much broader in the south, the lake parallels the coast of the Arabian Sea. It is 96 km long and 14 km wide at its widest point and has a surface area of 24,000 km². It consists of estuaries, lagoons, some manmade canals, marshes, and mangroves. Two major rivers, the Pamba and the Periyar, and four smaller rivers that all originate in the Sahya Mountains to the east, flow into the lake. The lake opens to the Arabian Sea through two locations, one at Azheekode, that is at least 100 m wide and fairly deep, and the other at Kochi Gut, that is 450 m wide. Broad wetlands surround the lake. They are included in the wetlands of international importance, as defined by the Ramsar Convention for the Conservation and Sustainable Utilisation of Wetlands in 2002, in part

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because they support more than 20,000 waterfowl in the winter. The lake has both brackish and nearly freshwater environments. They are separated from each other by a man-made bund or barrier at Thanneermukkom, which runs across the middle of the lake. Constructed in 1974 and functional since 1976, it is about 2 km long. The government keeps the barrier open to allow brackish water to flow to the southern part of the lake for 6 months, but then closes it for 6 months from December to May each year. The closure of the barrier is to prevent the entry of substantial amounts of salt water to the southern area because high salinity reduces the production of rice in paddy fields off the southeast side of the lake.

Allometry is the study of the relationship between two measurable variables, or in most general sense, allometry is the study of size and its consequences (Reiss, 1989). Length-weight relationships have several uses namely, the estimation of weight from length for individuals and for length classes (Anderson and Gutreuter, 1996), the conversion of growth in length equations to growth in weight, for prediction of weight at age and subsequent uses in stock assessment models (Pauly, 1993). In addition, the length-weight relationships allow life history and morphological comparisons between species or between populations of a species from different habitats and or regions. Once the allometric relationship is established, shell measurement is a sufficient surrogate to estimate biomass and total flesh production (Gimin et al. 2004). Bivalve shell growth and shape are influenced by abiotic (exogenous/environmental) and biotic (endogenous/ physiological) factors. A variety of environmental factors are known to influence shell morphology and selective proportions of many bivalve species, such as latitude (Beukema and Meehan, 1985), depth and type of bottom (Claxton et al. 1998), tidal level (Dame, 1972), type of sediment (Newell and Hidu, 1982) and burrowing behaviour (Seed, 1980).

The clams for this study were collected from northern and southern part of the Thanneermukkom barrier to understand if any differences occur in the biometric conditions of the clam population due to the salinity fluctuations caused by the opening and closure of the barrier. The black clams reproduce at 10 to 12 ppt. They spawn twice a year, from May to August and from January to late March (Arun, 2005). A change in salinity is the most important factor that triggers spawning. The construction of the Thanneermukkom Bund has drastically affected the growth and reproduction of black clams.

Materials and Methods

In this study, a comparison is done on the length-weight and other biometric relationships of *V. cyprinoides* collected monthly from northern (Station 1- $9^0 44' 34''$ N and $76^0 24' 87''$ E) and southern (Station 2 - $9^0 37' 32''$ N and $76^0 22' 55''$ E) parts of the Vembanad Lake (Fig. 1) during 2009. A total of 3,140 and 1,258 clams were collected (Fig. 2) from station 1 (locations 1-5) and 2 (locations 6-8) respectively by diving and hand picking, out of which, 480 clams from both the stations were taken for biometric observation. The maximum dimension of the anterior – posterior axis was recorded as shell length and the maximum lateral axis as shell width. The maximum

distance between the valves when they are closed was considered as height. All the measurements were made to the nearest 0.1mm using digital vernier calipers. The total weight, wet meat weight and shell weight were recorded to the nearest of 0.1 g using a top loading digital balance.

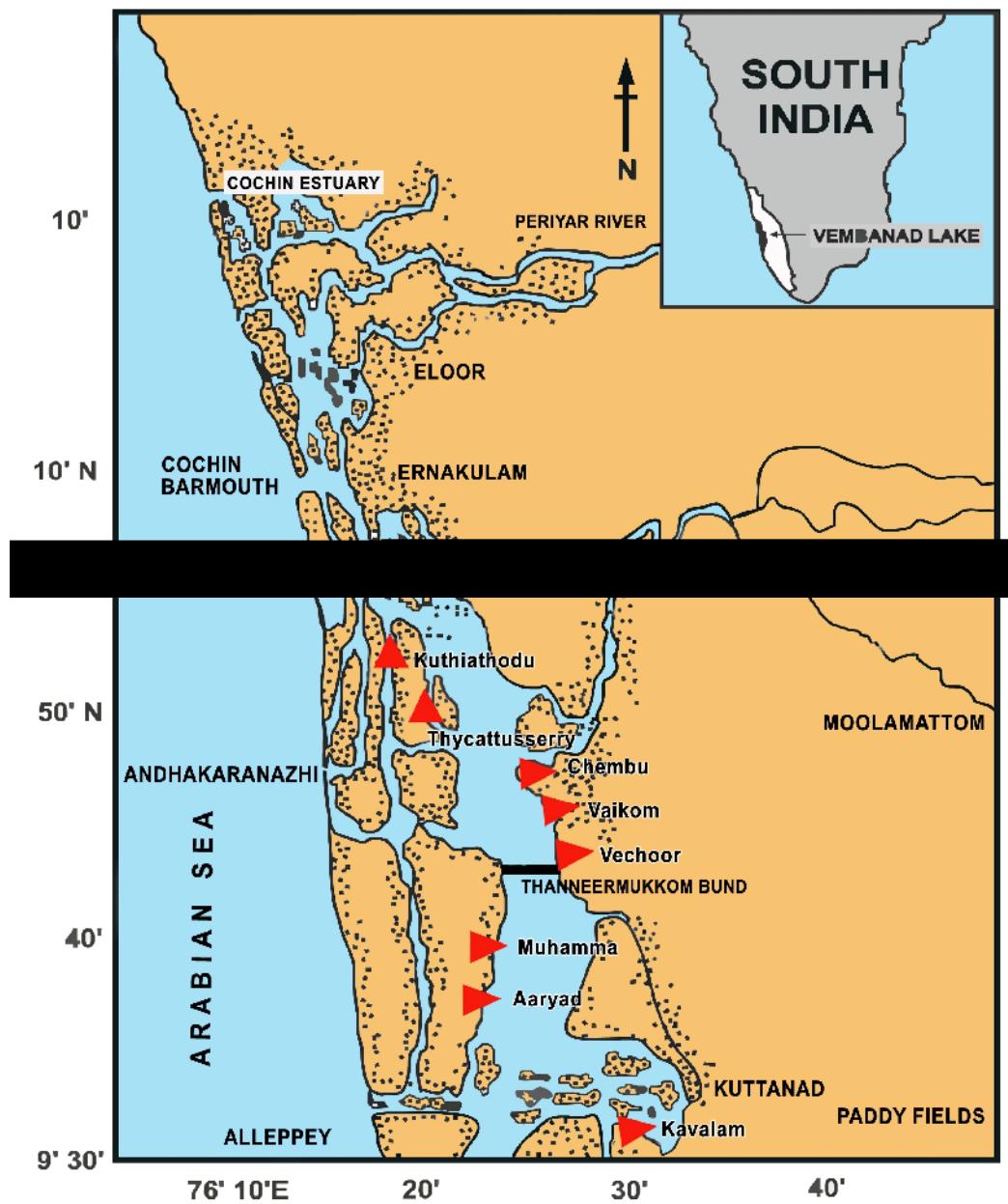


Fig.1. Map of Vembanad Lake showing the sampling stations and Thanneermukkom Barrier.

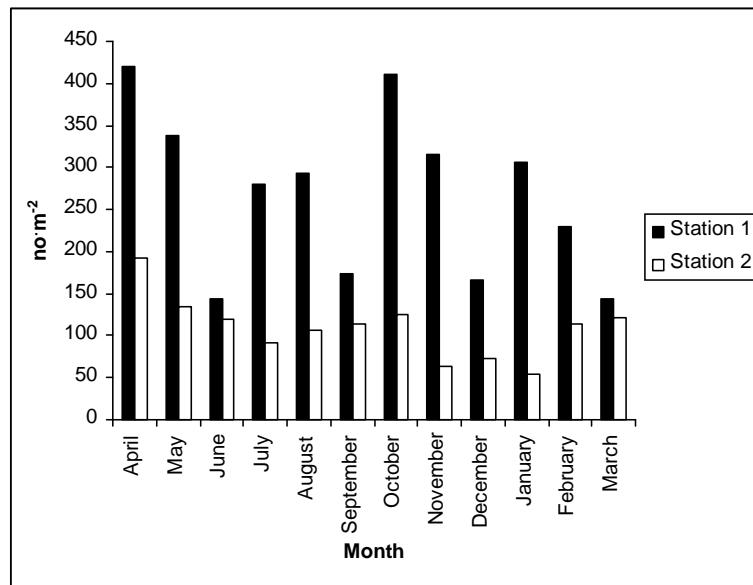


Fig. 2. Population density of black clams in two different stations from April 2009 to March 2010.

The length-weight (L-W) relationship was determined by the expression $W=aL^b$, where, W = wet weight (g)

L = length (mm)

a = intercept (initial growth coefficient)

b = slope (relative growth rates of the variables)

The estimation of the morphometric relationship between these variables was made by adjustment of a linear function to the data (Ricker, 1973).

$$\text{Log } Y = \text{Log } a + b \text{ Log } X,$$

Where, Y = width (B), weight (W) or height (H)

X = length (L)

The parameters, a and b of the morphometric relationships were estimated by linear regression analysis (least squares method) and the association degree between variables was calculated by the determination coefficient (r^2). The 95% confidence limits of b and the significance level of r^2 were also estimated. The biometric relationships between total length-width (L-B), total length- height (L-H), total weight-meat weight (TW-MW), total weight -shell weight (TW-SW) and shell weight- meat weight (SW-MW) were also determined using MS Excel routines.

In order to confirm if the values of b obtained in the linear regression were significantly different from the isometric value ($b=3$), a t-test (H_0 , $b=3$) with a confidence level of $\pm 95\%$ was applied and was expressed by the following equation (Sokal and Rohlf, 1987).

$$t_s = (b-3)/S_b$$

Where, t_s = t-test value

b =slope

S_b =standard error of the slope, b

Subsequently, the comparison between the obtained value of the t-test and the tabled critical value of the t-test, allowed the determination of the statistical significance of the b value and its inclusion in the isometric range ($b=1$) or allometric range. In length-weight relationships, growth could be characterised as positive allometric when $b>3$ and negative allometric when $b<3$. In length-length relationships, when $b>1$ the growth is positive allometric and when $b<1$, the growth is negative allometric.

Results and Discussion

The results obtained for the length-weight and biometric relationships along with some sample descriptive statistics are given in Table 1 and 2 and Figs. 3 and 4. The minimum length of the clam collected from station 1 was 13.3 mm and the maximum length was 43.5 mm with respective weights of 0.91 g and 14.32 g. The minimum and maximum length of clams collected from station 2 was 22.5 mm and 45.2 mm respectively with corresponding weights of 5.65 g and 29.65 g. In *V. cyprinoides* of both the stations, the growth in length is accompanied by weight increase and it followed the Cube law (isometric growth, $b=3$). The parameter b for *V. cyprinoides* from station 1 was 3.0115 and from station 2 was 3.0346. Similar b values have been reported for *Donax cuneatus* (Talikhedkar and Nagabhushanam, 1976), *Donax semistriatus*, *Ensis siliqua*, *Venerupis rhomboides*, *Spisula subtruncata* and *Macra corallina corallina* (Gaspar et al. 2002) and *Marcia opima* (Suja and Muthiah, 2008). Biometric growth was observed in all other relationships such as L-B, L-H, TW-MW, TW-SW and SW-MW.

Table 1. Biometric relationships in *V. cyprinoides* from station 1.

Allometric relation	Regression equation	Regression Coefficient	Relationship (<i>t</i> test)
Length on total weight (L-TW)	LogY= 0.2941+3.0115LogX	0.905	Isometric
Length on width (L-B)	LogY= 0.4113+1.1341LogX	0.848*	+ Allometry
Length on height (L-H)	LogY= 0.5890+1.0572LogX	0.913*	+ Allometry
Total weight on meat weight (TW-MW)	LogY= 0.4422+0.8403LogX	0.942*	- Allometry
Total weight on shell weight (TW-SW)	LogY= 0.4377+0.7746LogX	0.956*	- Allometry
Shell weight on meat weight (SW-MW)	LogY= 0.2408+0.8232LogX	0.885*	- Allometry

*Significant, (*p*<0.05)

N=number of clams collected = 440, Lmin: 13.3mm; Lmax: 43.5 mm; Lmean: 33.9 mm; SE: 0.287.

Table 2. Biometric relationships in *V. cyprinoides* from station 2.

Allometric relation	Regression equation	Regression Coefficient	Relationship
Length on total weight (L-TW)	LogY= -0.1943+3.0346LogX	0.955	Isometric
Length on width (L-B)	LogY= 0.2290+1.0447LogX	0.940*	+ Allometry
Length on height (L-H)	LogY= -0.8814+1.1419LogX	0.974*	+ Allometry
Total weight on meat weight (TW-MW)	LogY= -0.7982+1.0862LogX	0.867*	+ Allometry
Total weight on shell weight (TW-SW)	LogY= 0.7813+1.1585LogX	0.919*	+ Allometry
Shell weight on meat weight (SW-MW)	LogY= 0.4541+1.0633LogX	0.817*	+ Allometry

*Significant, (*p*<0.05)

N=number of clams collected = 432, Lmin: 22.5 mm; Lmax: 45.2 mm; Lmean: 35.2 mm; SE: 0.214

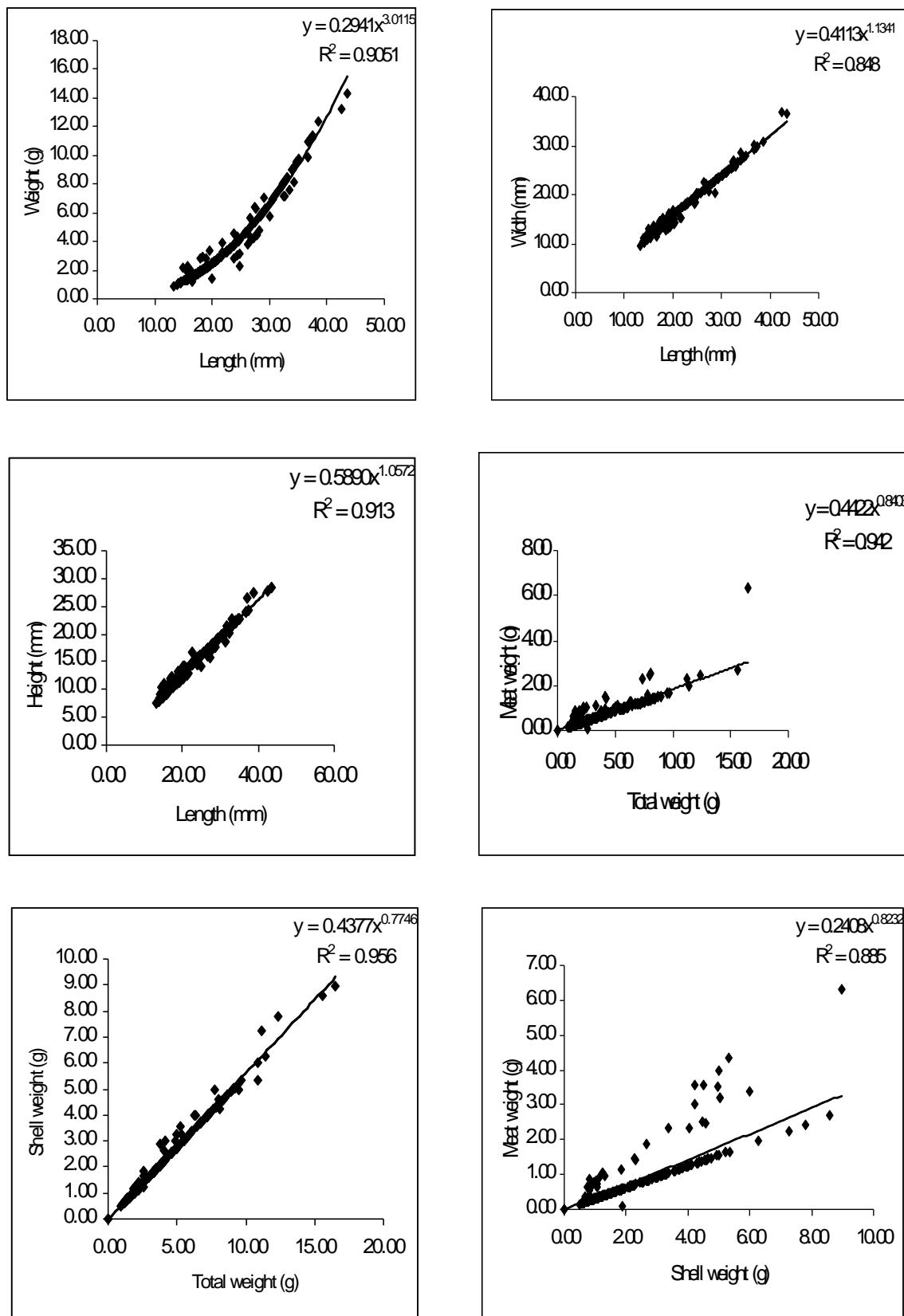


Fig. 3. Biometric relationships in *V. cyprinoides* from station 1.

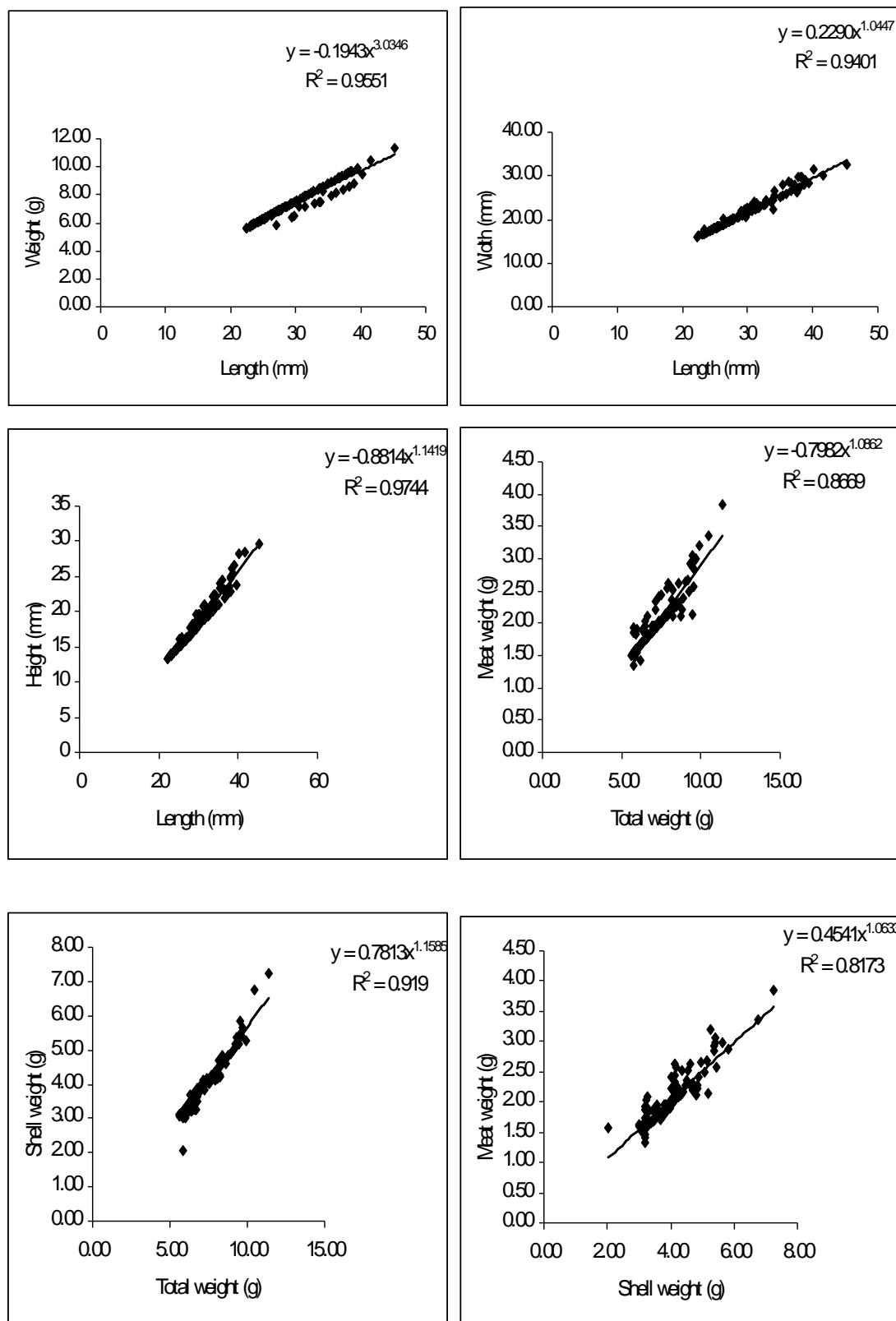


Fig. 4. Biometric relationships in *V. cyprinoides* from station 2.

The length-width and length- height relationships of *V. cyprinoides* from both the stations were positively allometric. This means that the increase in width and height is superior to increase in length. In practice this means that during ontogeny bivalve shells become progressively higher and wider in order to counter involuntary dislodgement, turbulence and currents (Hinch and Bailey, 1988). A positive allometry for relationships involving heights and other linear measurements has been observed in *Perna viridis* (Narasimham, 1981), *D. semistriatus*, *Spisula solidula*, *S. subtruncata* and *Ensis siliqua* (Gaspar et al. 2002).

All relationships involving weights of one part to weight of the other part (TW-MW, TW-SW, SW-MW) showed negative allometry for clams of station 1 and positive allometry for clams of station 2. This indicates that increase in meat weight and shell weight is superior to increase in total weight for clams collected from station 1, whereas increase in total weight is superior to increase in meat weight and shell weight for clams collected from station 2. Station 2, which is the southern part of the lake, remains fresh during December – May of a year due to the closure of the Thanneermukkom barrier. The reduction in salinity at this station may be the reason for reduced meat weight and shell weight of black clams collected. The changes on the relative proportions of bivalve shells during growth are generally associated with the maintenance of a suitable physiological ratio in relation to environmental conditions (Rhoads and Pannella, 1970).

In this study, the values of the correlation coefficients, r for various biometric relationships studied are very close to unity as reported by Narasimham (1981) and Gaspar et al. (2002) which shows high degree of correlation.

Conclusion

The black clam, *V. cyprinoides*, is the most important clam species landed in India. The State of Kerala has been, by far, the leading producer of the species. The stock of black clams in Vembanad Lake seems to be declining slowly in the southern part of the lake because the water salinity has been decreasing due to the Thanneermukkom barrier. The construction of the Thanneermukkom Bund has drastically affected the growth and reproduction of black clams. The salinity fluctuations in the southern part of the lake caused by the opening and closure of the barrier influence the biometric conditions of the clam. A positive allometry for relationships involving heights and other linear measurements was observed for clams collected from both parts of the lake. Increase in meat weight and shell weight is superior to increase in total weight for clams collected from the northern part, whereas increase in total weight is superior to increase in meat weight and shell weight for clams collected from the southern part. The reduction in salinity at this station may be the reason for reduced meat weight and shell weight of black clams collected from the southern part of the lake.

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