Indian Journal of Marine Sciences
Vol. 26, June 1997, pp. 224-226

Length-weight and allometric relationship in the pulmonate snail *Cassidula nucleus* Martyn (Pulmonata : Ellobiidae)

A Shanmugam

Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai 608 520, Tamil Nadu, India

Received 5 November 1996, revised 21 March 1997

The parabolic equation $W=aL^n$ was used to study the length-weight relationship of *C. nucleus*. The correlation coefficient (*r*) for both immature and mature snails are found to be significant at 0.001 level. Analysis of covariance showed significant difference between the immature and mature snails in their length-weight relationship. Further, the allometric relationships between the body characters of both immature and mature snails were studied by using the equation Y=bX. For all the combinations, the correlation coefficients were found to be significant at 0.001 level. No isometry has been found in any of the combination of the characters. From this study it is evident that this snail conforms a shell of equi-angular spire model.

The insight on length-weight relationship, particularly in molluscs has both pragmatic and intrinsic value. For example, ecological attention is being focussed mostly on the biomass and productivity parameters of natural populations and length-dry weight conversion equations have found considerable utility[1-5].

Though a number of reports are available on the length-weight and allometric relationship of molluscs, the available information on gastropods, particularly on pulmonate snails are limited[5-11]. Informations on length-weight relationship of pulmonates from mangroves are very much restricted[10,11]. Besides, information on the values of proportionally constants obtained in these types of equation (linear regression) may give valuable insight into the underlying nature of the shell geometry. Hence, an attempt has been made presently in the pulmonate snail *Cassidula nucleus* Martyn (Pulmonata / Ellobiidae) to understand the length-weight relationship and other allometric relationships between various morphological characters.

Mature and immature snails (100 each, of 4.2 to 22.9 mm shell length) were collected from the Pichavaram (lat. 11° 29' N; long. 79° 49' E) mangroves (southeast coast of India) for the present study. The shell characters such as animal length (AL), animal width (AW), aperture length (APL) and aperture width (APW) were measured by a vernier caliper with an accuracy of 0.1 mm. The total live weight (TW), wet tissue weight (WW), shell weight (SW) and the dry tissue weight (DW) were measured by using a single pan electrical balance. The soft body was dried in a hot air oven at a constant temperature of 60°C for 24 h before taking the dry weight.

The parabolic equation $W=aL^n$ used in the study can be expressed in the logarithmic form as:
log W=log a+n log L, i.e., Y=a+bX
where, a=log a, b=n, Y=log W and X=log l which is a linear relationship between Y and X. To find out the differences, if any, between length and weight, the data were subjected to ANOVA. The allometric relationship between two characters can be expressed by the general equation Y=a+bX, where Y=some measures of a part, X=measure of the whole body and b=the slope of the curve. When expressed in logarithmic form log Y=log b+log X[12]

In the present study, using the linear regression technique and correlation coefficient [13,14], the relationship between shell length, shell width, aperture length, aperture width, total live weight, shell weight, wet tissue weight and dry tissue weight of the immature and mature *C. nucleus* were studied in all possible combinations.

The linear equation was fitted separately for the immature and mature *C. nucleus*. The regression equations between total length and total weight of the animals derived separately for immature and

mature *C. nucleus* are:
Immature: $Y=4.2052+1.2282X$
Mature: $Y=-41.0783+4.2608X$

These regression equations are comparable[16] with that of *Helisoma duryi* ($Y=-0.33+2.63X$), *Biomphalaria commerunensis* ($Y=-0.55+2.74X$) and *Melampus ceylonicus* (immature: $Y=-0.234+0.1010X$; mature : $Y=-0.1067+0.2870X$). Whereas equations can be compared with other animals which are having the turbinate shaped shell[11]. The regression equation between animal length and aperture length of the mature *C. nucleus* ($Y=3.0068+0.5390X$) can be compared with that of *M. ceylonicus* ($Y=-0.0592+0.7652X$) and *Nucella lapillus* ($Y=1.21+0.036X$). The correlation coefficients (r) between length and weight for both immature and mature snails were found to be significant at 0.001 level ($r=0.9378$ for immature and $r=0.9914$ for mature) (Fig. 1).

A highly significant difference ($F=1165.858$) was obtained in the regression of weight on length between immature and mature *C. nucleus* when the data was analysed for ANOVA (Table 1).

In the present investigation, the changes in the constant allometry of length-weight relationship are associated with increase in size and sexual maturity as observed in *Pythia plicata*[10], *L. quadricentus* and *N. pyramidalis*[15], *Littorina undulata*[16] and *M. ceylonicus*[11]. In mussels also, the allometry of length-weight relationship was associated with sexual maturity[17, 18].

The linear regression and the correlation coefficients (r) for the various parameters for immature and mature snails are presented in Tables 2 and 3 respectively. It is evident that the correlation coefficient values for various combinations of both the body and shell characters of immature and mature specimen are significant at different levels.

The 'b' values for different combinations of characters which are converted into natural tangent values. The body characters with tangent values above 45° are said to have positive allometry; while values below 45° are referred as negative allometry. The values equal to 45° are classified as isometry which however was not encountered in the present study. However there is a difference in the allometry for some combinations of characters between immature-AW x AL; AW x APL; AW x

Table 1-Analysis of covariance for testing differences in regression between the immature and mature *Cassidula nucleus*

Source of deviation	d.f.	Sum of squares	Mean squares	Observed F
Deviation from individual regression	196	541.74	2.76	1164.58
Differences between regressions	1	3219.63	3219.63	

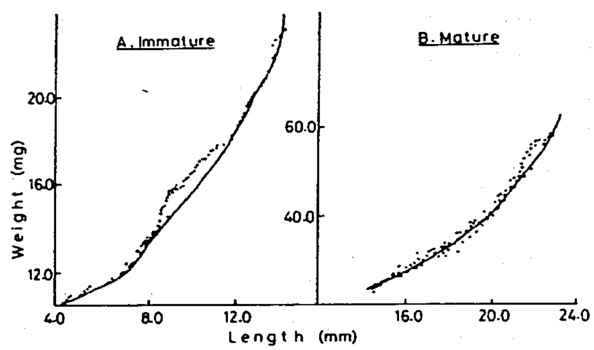

Fig. 1—Length-weight relationship of *Cassidula nucleus* (A—immature, B—mature)

Table 2—Correlation coefficient (r) values for the immature *Cassidula nucleus* significant at 0.001 level

Character	AL	AW	APL	APW	TW	SW	WW	DW
AL	—	0.9378	0.9666*	0.8764	0.9872*	0.9777*	0.8332	0.7158
AW	0.9378	—	0.9776*	0.8454	0.9041	0.9016	0.7293	0.6507
APL	0.9666*	0.9776*	—	0.9185	0.9534*	0.9546*	0.7526	0.7259
APW	0.8764	0.8454	0.9185	—	0.8811	0.9220	0.6013	0.6880
TW	0.9872*	0.9041	0.9534*	0.8811	—	0.9837*	0.8589	0.8403
SW	0.9777*	0.9016	0.9546*	0.9220	0.9837*	—	0.7911	0.8274
WW	0.8332	0.7293	0.7526	0.6013	0.8589	0.7911	—	0.8347
DW	0.8220	0.6507	0.7259	0.6880	0.8403	0.8274	0.8347	—

AL—Animal Length; AW—Animal Weight; APL—Aperture Length; APW—Aperture Width; TW—Total Weight; SW—Shell Weight; WW—Wet Weight; DW—Dry Weight
*$P<0.001$

Table 3—Correlation coefficient (*r*) values for the mature *Cassidula nucleus* significant at 0.001 level.

Character	AL	AW	APL	APW	TW	SW	WW	DW
AL	—	0.9914*	0.9905*	0.9736*	0.9792*	0.9448	0.9194	0.8482
AW	0.9914*	—	0.9766*	0.9569*	0.9832*	0.9206	0.9329	0.8576
APL	0.9905*	0.9766*	—	0.9895*	0.9454	0.9689*	0.8717	0.7861
APW	0.9736*	0.9569*	0.9895*	—	0.9157	0.9700	0.8355	0.7379
TW	0.9792*	0.9832*	0.9454	0.9157	—	0.8703	0.9725*	0.9220
SW	0.9448	0.9206	0.9689*	0.9700*	0.8703	—	0.7559	0.6703
WW	0.9194	0.9329	0.8717	0.8355	0.9725*	0.7559	—	0.9643*
DW	0.8482	0.8576	0.7861	0.7379	0.9220	0.6703	0.9643*	—

AL—Animal Length; AW—Animal Weight; APL—Aperture Length; APW—Aperture Width; TW—Total Weight; SW—Shell Weight; WW—Wet Weight; DW—Dry Weight
*$P<0.001$

TW; SW x AL; WW x AL; WW x APL; WW x TW; WW x SW and DW x APL (positive allometry) ; AL x SW; AL x WW; AW x WW; APL x AW; APL x WW and SW x WW (negative allometry) and mature-AL x SW; AL x WW; AW x AL; AW x TW; AW x WW; APL x AW; APL x WW; SW x WW and WW x TW (positive allometry); AW x APL; SW x AL; WW x AL; WW x SW and DW x APL (negative allometry). This difference may be due to the decrease in the growth rate in the mature animals since most of the energy is utilized for the other physiological activities, particularly for reproduction rather than growth.

From the above statistical results drawn for *C. nucleus*, it can be concluded that this molluscan species also conform to the equiangular spire model as other pulmonate snails such as *P. plicata* and *M. ceylonicus* from the Indian mangroves.

Author thanks the Director and CSIR for the encouragement and financial assistance.

References

1 Mason C. *Oecol*, 5 (1970) 215.
2 Burkey A J, *Ecol Monogr*, 41 (1971) 235.
3 Hughes R N, *J Exp Mar Biol Ecol*, 6 (1971) 167.
4 Paine R T, *Limnol Oceanogr*, 16 (1971) 86.
5 Calow P, *Proc Malacol Soc London*, 41 (1975) 357.
6 Geldiey R, *J Ani Ecol*, 25 (1956) 389.
7 Russell-Hunter W D, *Proc Zool Soc London*, 137 (1967) 135.
8 Berrie A D, *Proc Malacol Soc London*, 37 (1966) 83.
9 Madsen H & F Frandsen, *Hydrobiologia*, 66 (1979) 17.
10 Shanmugam A, *Studies on Pythia plicata (Gray) (Gastropoda : Pulmonata : Ellobiidae) from Pitchavaram mangroves*, Ph.D. Thesis, Annamalai University, India, p.154 (1987).
11 Shanmugam A, *Indian J Fish*, 42 (1) (1993).
12 Wilbur K H & G Owen, in *Physiology of Mollusca*, Vol 1 (edited by K M Wilbur & C M Yonge, (Academic Press New York) 1964, 211.
13 Simpson G G, A Roe & R C Lewontin, *Quantitative zoology* (Harcourt, Brace and Co.,Inc New York) 1960, pp 440.
14 George John, *Studies on Anadara rhombea (Born) (Mollusca: Bivalvia : Arcidae) from Porto Novo waters*, Ph D thesis, Annamalai University, India, 1980.
15 Thivakaran G A, *Studies on the Littorina quadricentus (Phillipi) and Nodilittorina pyramidalis (Quoy and Gaimard, 1883)(Gastropoda:Prosobranchia:Littorinidae) from the Tranquebar rocky shore (Southeast coast of India)*, Ph D Thesis, Annamalai University, India, 1988.
16. Maruthamuthu S, Thivakaran G A, Sriraman K & Kasi nathan R, *Indian J Mar Sci*, 14 (1985) 160.
17 Kuenzler E J, *Limnol Oceanogr*, 6 (1961) 400.
18 Shafee M S, *Indian J Fish*, 23 (1976).