Indian J. Fish., 62(3) : 146-150, 2015

Note

Biometric relationships of the Indian abalone *Haliotis varia* Linnaeus 1758 from Mandapam waters of Gulf of Mannar, south-east coast of India

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ABSTRACT

Biometric relationships,including length-weight relationship, in different size groups of the Indian abalone *Haliotis varia* collected from the 'paars' off Mandapam coastal waters of the Gulf of Mannar were studied. In *H. varia,* length-weight (L-W) relationship between males and females in the same size group was not significantly different and therefore a combined equation was derived. The L-W relationship had reasonably good fit in medium sized abalones (shell length (SL) 25-35 mm, $r^2 = 0.8368$), while it was poor in small sized abalones (SL 15-25 mm, $r^2 = 0.2609$) and lowest in large sized abalones (SL 35 - 45 mm, $r^2 = 0.1641$). The L-W relationship in different size groups indicates that the growth in length and weight was initially allometric and subsequently became isometric in medium sized abalones and finally reverted back to allometry. In all other biometric relationships such as shell length - shell width (SL-SW), shell length - shell height (SL-SH) and shell width - shell height (SW-SH), allometric growth was observed in all the size groups. The results of the study may form the baseline information on the abalone population in Indian waters to facilitate their commercial exploitation.

Keywords: Allometric growth, Biometry, *Haliotis varia,* Indian abalone, Length-weight relationship

Abalones are one of the most economically important edible gastropods, which support significant commercial fishery in many parts of the world (Fedorenko and Sprout, 1982; Tahil and Juinio-Menez, 1999). Even though the large temperate abalones have been supporting commercial fishery from time immemorial, exploitation of tropical abalones is a relatively recent enterprise owing to small size (Jarayabhand and Paphavasit, 1996). However, culture of the tropical abalones is now intensified due to increasing demand for small live abalones in the international market (Chen, 1989). *Haliotis varia* Linnaeus, 1758 has a limited distribution along the Indian coast and in some other South-east Asian countries. Though *H. varia* does not support any commercial fishery in India, the successful accomplishment of hatchery seed production of this species has opened new avenues in the field of abalone mariculture in the country (Najmudeen and Victor, 2004a). Preliminary studies on the reproduction and juvenile production of *H. varia* have been carried out in recent years to elucidate its mariculture prospects (Najmudeen, 2000; Najmudeen *et al*., 2000; Najmudeen and Victor 2004a, b). In India, *H. varia* is distributed in the Gulf of Mannar and Andaman and Nicobar Islands.

Length-weight relationships and other important biometric relationships are useful in comparing the life history and morphology between the populations of a species from different habitats. Baseline information on the biometry and length-weight relationships are also useful in estimations of weight from length, conversions of growth in length to growth in weight for predictions of weight at different size groups, which will be useful in stock assessment models (Anderson and Gutreuter, 1993; Pauly, 1993). McShane *et al.* (1994) observed that morphometric variation occurred over small spatial scales in abalones, based on the analysis of morphometric relationships in 61 populations of *Haliotis iris* in New Zealand. The biometric relationship undergoes changes with age and this information is vital for the planning and development of any aquaculture enterprise. The objective of the study was to delineate the changes in length weight relationship and other biometric relationships in *H. varia* over time and the co-relationships between their shell dimensions.

A total of 390 specimens of *H. varia* were collected from the intertidal rocks (paars) at Manauli and Putty Islands of Gulf of Mannar off Mandapam coast (09º 16' N 79º 12' E) at a depth of 1-3 m, for a period of 15 months from December 1997 to February 1999. The total body weight (TW) of each animal was taken to the nearest milligram (mg). The shell length (SL), shell width (SW) and shell height (SH) of each abalone were measured using vernier calipers, to the nearest millimeter (Fig. 1). The specimens were then shucked and dissected to examine the gonad. For studying the variation in relationship between different shell dimensions, the data were grouped

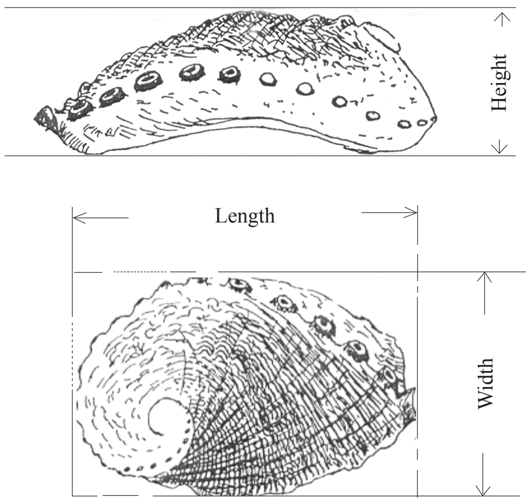

Fig. 1. Linear length measurements from *H. varia* used in the present study

into three length classes with a class interval of 10 mm *viz*., 15-25, 25-35 and 35-45 mm. Length-weight relationship was calculated using the ABee software (Pauly and Gayanilo, 1998), after converting the measurements to cm units. All other biometric relationships were estimated by the least square method using the linear regression equation y = a + bx, where *a* is the intercept, *b* the slope. A 't' test was performed (H_0, $b = b_0$) with a confidence level of +95% to confirm if the values of b obtained by linear regression were significantly different from isometric value, expressed by the equation $ts = (b-3)/S_b$ for length-weight relationship and $ts = (b-1)/S_b$ for all other linear measurements.

The allometry coefficient is expressed by the exponent *b* of the linear regression equations. When the value of *b* is close to 3, it indicates isometric growth, while values significantly different from 3 indicate allometric growth (Amin and Zafar, 2004; Amin *et al*., 2008)

Establishment of these morphometric relationships was made by the adjustment of an exponential curve to the data.

$Y = aX^b$

This equation can also be expressed in its linearised logarithmic form

Log Y = log a + b log X

where Y = length or weight, X = length or weight or width or height, A = intercept, b = slope

The relationship between shell length (SL) and total weight (TW) of *H. varia* is shown in Fig. 2. As the L-W relationship between males and females in the same size group was not found to be significantly different, a combined equation was derived. In all the size groups, there was an increase in weight with respect to length. However, the *a* and *b* values in the relationship did not show any significant trend in increase along with the increase of length measurements. The L-W relationship had reasonably good fit in medium sized abalones (SL 25-35 mm, $r^2 = 0.8368$), while it was poor in small sized abalones (SL 15-25 mm, $r^2 = 0.2609$) and lowest in large sized abalones (SL 35-45 mm, $r^2 = 0.1641$). The L-W relationship in different size groups indicate that the growth in length and weight was initially allometric and subsequently became isometric in medium sized abalones and finally reverted back to allometry. Maliao *et al.* (2004) observed that the linear relationship between the log-transformed length and log-transformed wet weight of *Haliotis asinina* was sufficiently robust with an r^2 value of 0.833 to use with future field research on the species. Observations in the variations of SL - TW in different size groups in the present study may be partly influenced by the variations in soft tissue weight owing to the maturity conditions of the animal and frequency of spawning. In spent abalones, the total weight would be considerably low compared to the mature and fully ripe specimens. Similar size-related variations in growth and length-weight relationship have also been observed in many bivalve species in the country (Alagaraja, 1962; Chellam, 1988; Mohamed *et al*., 2006).

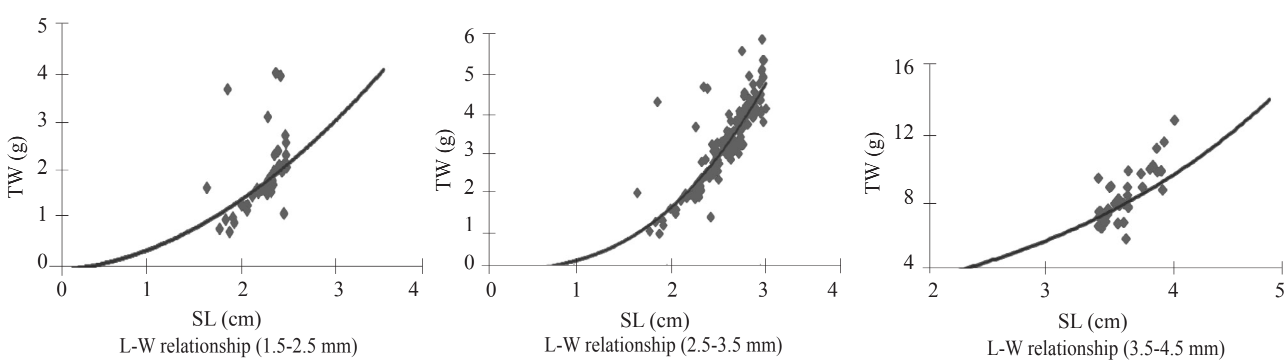

Fig. 2. Curvilinear relationships of SL to TW in various size groups of *H. varia.* SL : Shell length

Relationship between the other linear measurements such as shell length (SL) and shell width (SW) and shell height (SH) in different size groups are shown in Fig. 3. The correlation coefficient, intercept and slope of these relationships and type of relationship for various size groups of *H. varia* are given in Table 1. In all the linear biometric relationships such as shell length-shell width (SL-SW), shell length–shell height (SL-SH) and shell width-shell height (SW-SH), the growth observed was allometric in all the size groups. The exponent b obtained for both the lowest and highest size groups of *H. varia* in this study being less than 3 generally is in agreement with many other gastropods (Jamabo *et al*., 2009) indicating negative allometric growth in *H. varia* during initial phases and final phases of life. The biometric study reveals that there exists a significant difference in the type of growth in relation to size classes. Many studies refer to the existence of a gradient in biometric relationships in molluscs and suggest that the bathymetry is one of the factors in spatial distribution of these animals (Gaspar *et al*., 2002).

Distribution of abalones in India is scarce, and hence they do not support any regular or intensive fishery. At present, the resources are being exploited only for the shell craft industry and research purposes. Most of the abalone resources are overexploited in many parts of the world (Wallace, 1999) and there were attempts to rebuild the abalone fishery with regulations such as imposing minimum legal size for capture and allocating quota systems (Fedorenko and Sprout, 1982; Maliao *et al.,* 2004). Recently Kripa *et al*. (2007) noticed the potential for mabe pearl technology in some of the bivalves as an additional source of livelihood for tsunami affected villagers in Andaman and Nicorbar islands. The species, *H. varia* is also reported from Andaman and Nicorbar islands, and being an abalone species, it has a great

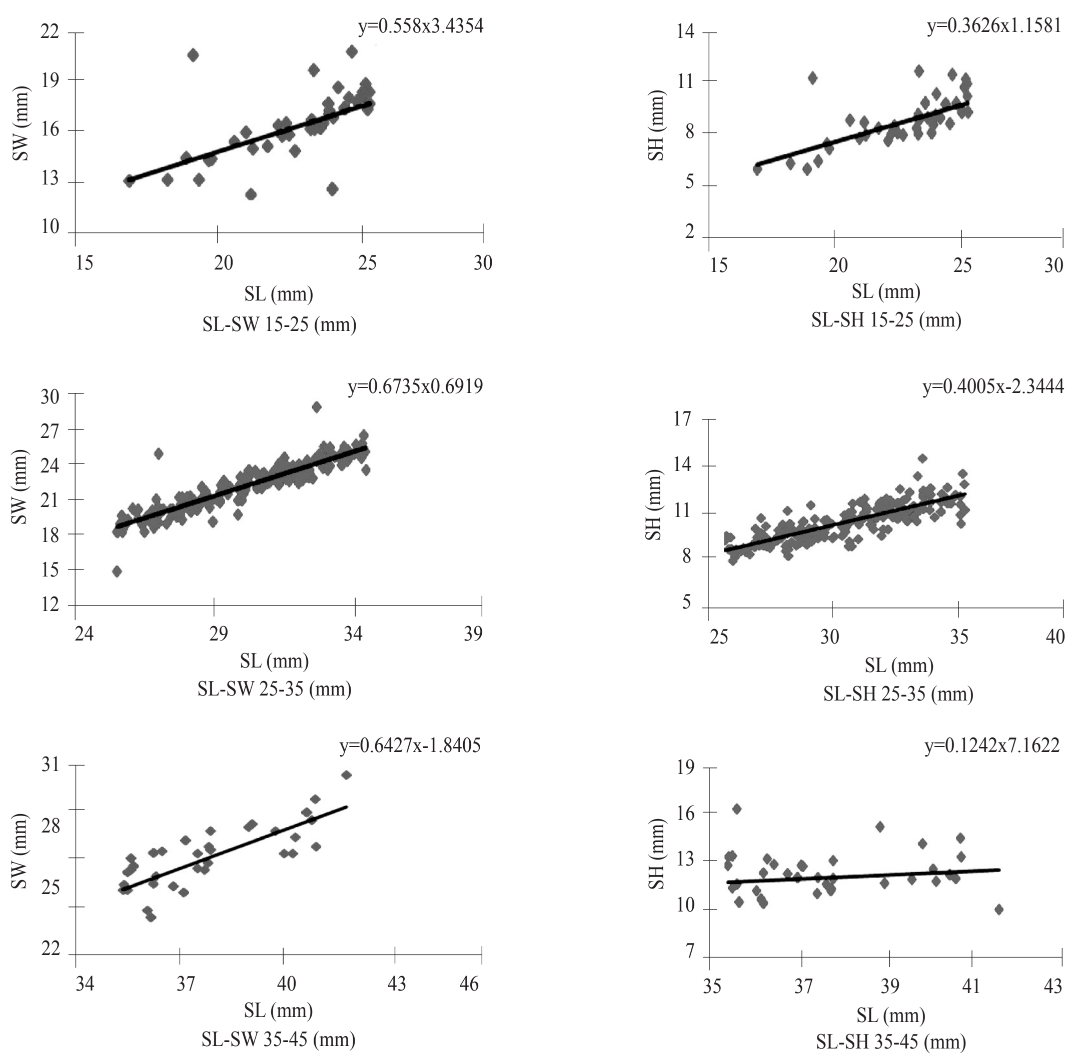

Fig 3. Linear relationships between SL –SW and SL-SH in various size groups of *H. varia.* SL: Shell length, SH: Shell height

Table 1. Biometric relationships in *H. varia* in different size groups

Size group (mm)	N	Variables	'a' value	'b' value	R^2 value	Relationship
15-25	57	SL-TW	0.00454	1.9184	0.2603	Allometric
		SL-SW	3.43542	0.5580	0.3098	Allometric
		SL-SH	-1.15805	0.3626	0.4478	Allometric
25-35	200	SL-TW	0.000106	3.1079	0.8368	Isometric
		SL-SW	0.691935	0.6736	0.8454	Allometric
		SL-SH	-1.65757	0.3800	0.4923	Allometrci
35-45	63	SL-TW	0.011020	1.8026	0.1644	Allometric
		SL-SW	1.840488	0.6427	0.4169	Allometric
		SL-SH	7.162164	0.1242	0.0365	Allometric

potential for producing superior quality mabe pearls (Fankboner, 2002). In molluscs, morphometry of the shell could reflect levels of growth rate (Alunnobruscia *et al*., 2001). Hence the present findings on the biometric relationships of abalone collected from natural beds will be helpful to choose the right sized animals for rearing while attempting mabe pearl culture in the species. Further, the results of the study may form baseline information on the abalone population in Indian waters to facilitate their commercial exploitation.

Acknowledgements

The author expresses his gratitude to Dr. A.C.C Victor, former principal scientist, ICAR-CMFRI for his valuable guidance and suggestions to undertake the study and also to the Director, ICAR-CMFRI for providing necessary facilities.

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Date of Receipt : 14.07.2014
Date of Acceptance : 27.10.2014