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Biometric relationships of the black-lip pearl oyster *Pinctada margaritifera* (Linnaeus, 1758) from the Andaman and Nicobar waters

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ABSTRACT

The black-lip pearl oyster, *Pinctada margaritifera* is widely distributed in Indo-Pacific region and has prime importance in the production of black pearls. In India, its natural occurrence is confined to the Andaman and Nicobar Islands. The biometric relationships between (dorso-ventral measurement [DVM] and Hinge Length [HL]; Thickness [THK] and Total Weight [TWT]) were studied from 458 oysters collected from these islands which were grouped in to 5 length classes. In all size groups, there was increase in weight with increase in length. The highest coefficient (r^2=0.7828) was obtained for the animals with DVM ranging from 76 to 95 mm. The correlation coefficient 'r' was low for DVM-HL and slightly higher for DVM-THK. Comparisons of biometric relationships of the natural populations of the Indian pearl oysters with that of farmed oysters in other regions indicated xenomorphism in pearl oysters in Andaman and Nicobar Islands due to restricted space in natural habitats.

Introduction

Pinctada margaritifera, the black-lip pearl oyster is endemic to the Andaman and Nicobar Islands in the Bay of Bengal (Alagarswami, 1983). This oyster produces the black pearls and supports a million dollar industry in the Pacific (Fassler, 1995). Considering the economic importance of this oyster, its biology (Sims, 1990), spatfall (Coeroli *et al*., 1984; Cabral *et al*., 1985) and seed production (Tanaka *et al*., 1970; Kakazu *et al*., 1971; Alagarswami *et al*., 1989) in the Indo-Pacific region have been studied extensively. Linear growth of *P. margaritifera* has been studied in the French Polynesia (Sims, 1984; Leduc, 1997), Cook Islands (Coeroli *et al*., 1984; Pouvreau *et al*., 2000) and the Red Sea (Elnaein, 1984). However, the remoteness of the Andaman and Nicobar Islands from mainland and lack of infrastructure has led to ineffective utilization of this resource in India. This species is found attached to the coralline and subtidal regions in these Islands (Alagarswami, 1983). The seed production of *P. margaritifera* collected from these islands has been successfully attempted at the shellfish hatchery of CMFRI at Tuticorin (Alagarswami *et al*., 1989). The mariculture potential of this species in Andaman and Nicobar Islands has been indicated by Alagarswami (1983) after conducting a detailed survey in the islands during 1978.

During the year 2003, the Central Marine Fisheries Research Institute, Cochin initiated a research programme funded by the Department of Ocean Development for the development of pearl production in *P. margaritifera* in Andaman and Nicobar Islands. As a part of this project, pearl oysters were collected from different islands of the Andaman and Nicobar Islands. The biometric relationships of *P. margaritifera* based on these collections are presented here. Baseline information on the biometry of this oyster will be helpful to decide one of the critical factors in pearl industry such as the optimum size of nuclei that can be implanted in the oysters which is directly dependent on the thickness and cavity size of the oyster.

Materials and methods

458 specimens of *P. margaritifera* ranging in size from 40.18 to 132.72 mm DVM (dorso-ventral measurement) collected from different islands were used for this study. Foulers attached were scraped off and the oysters were cleaned to remove silt. Linear measurements (Gervis and Sims, 1991), such as DVM excluding the growth process, hinge length (HL), thickness (THK) in millimeter were taken using digital Vernier calipers (Mitutoyo™) to a precision of 0.01mm. Total weight (TWT) to the nearest 0.01gram was taken using a digital balance.

For studying the variation in relationship between different shell dimensions during various growth stages, the data were grouped into five length classes with a class interval of 20 mm viz., 36-55, 56-75, 76-95, 96-115 and 116-135 mm. The length-weight relationship was calculated using the ABee software after converting the measurements to centimeter-gram units. For other biometric relations such as DVM-HL and DVM-THK, millimeter was used as the unit and calculations were done by the least square method using the linear regression equation ‘y = a + bx’ where, ‘a’ is the intercept and ‘b’ the slope.

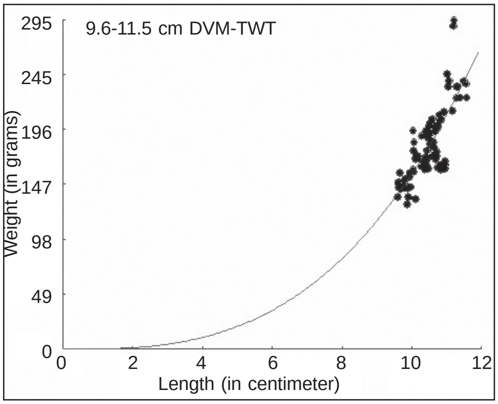
Results and Discussion

Length–Weight Relationship

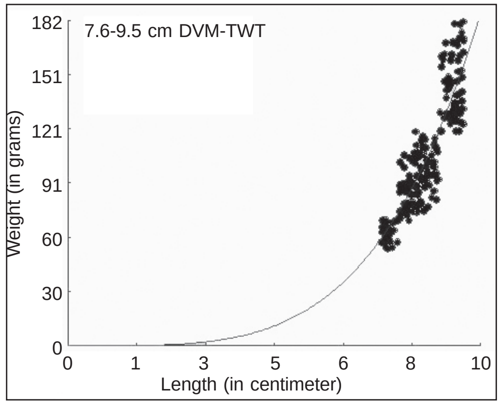
The relationship between DVM-TWT is shown in Fig. 1 and the corresponding values for intercept, slope and correlation coefficients are presented in Table 1. In all size groups, there was an increase in weight with respect to length. However, the intercept and slope did not show any trend in increase along with increase of DVM measurements. The highest coefficient (r^2=0.7828) was obtained for the animals with DVM ranging from 76 to 95 mm. Alagarswami (1983) who studied the biometric relations of pearl oysters of the same region using 106 oysters in the length range 34 to 109.5 mm obtained a slightly higher ‘r’ value (Table 2) indicating a better relationship. The variation can be attributed to the fact that in the present study, the length range of the sample was wider and more specimens were analyzed which increased the chances of variation. However, the length-weight relationship is almost similar to that obtained by Friedman and Southgate (1999) who studied the growth of farmed *P. margaritifera* in the Solomon Islands. The correlation coefficient in the present study was comparatively higher in the medium size groups such as 56-75 and 76-95 mm than that of the smaller and larger group of specimens. Pouvreau *et al.* (2000) observed that the dry shell weight increments were higher in older oysters (from 109 mg to 175 mg.d^{-1} for third year oysters). Contrary to the shell weight observations, Pourveau *et al.* (2000) stated that there was seasonal variation in tissue weight and these are more affected by temporal short-scale variations especially those related to

TABLE 1: *Intercept (a), slope (b) parameters and correlation coefficient (R^2) for the relationships between DVM and TWT in different size groups of* P. margaritifera

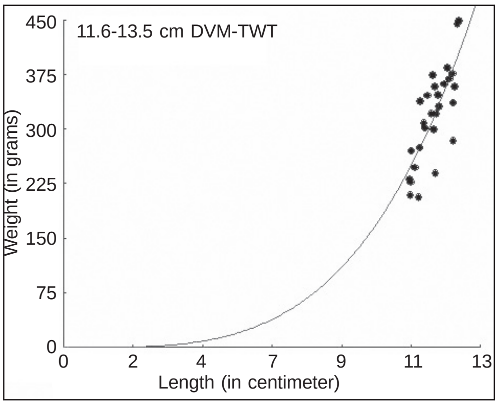
Size group	N	‘a’ value	‘b’ value	R^2 value
36-55	22	0.1381	2.9872	0.6514
56-75	126	0.0670	3.3894	0.7142
76-95	198	0.0157	4.0728	0.7828
95-115	84	0.1679	2.9723	0.6216
116-135	28	0.0295	3.6832	0.6035



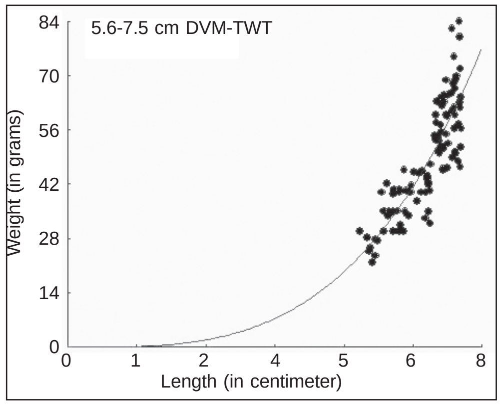
9.6 -11.5cm DVM-TWT



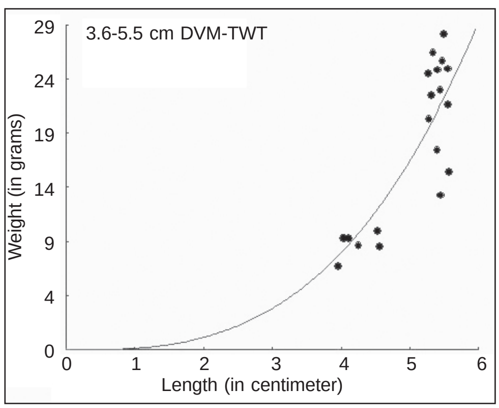
11.6 -13.5cm DVM-TW



7.6 -9.5cm DVM-TWT



5.6 -7.5cm DVM-TWT



3.6 -5.5cm DVM-TWT

Fig. 1. Curvi-linear relationships of DVM to weight in various size groups of *P. margaritifera*

gonad. The observations in the variations of DVM–TWT in different size groups in the present study may be partly influenced by the variations in soft tissue weight. The length and weight of *P. fucata* in the mainland waters of the country have also shown size related variations in growth (Alagaraja, 1962; Chellam, 1988; Mohamed *et al*., 2006).

TABLE 2: *Estimates of biometric relationships of* P. margaritifera *in other regions*

S. No.	Region	Source of stock and sample number	Variables tested	Relationship	Correlation coefficient	Author
1	Andaman and Nicobar Island	Natural bed, intertidal and subtidal regions (n=106)	DVM vs TWT	$0.0006\ X^{2.6753}$	0.9610	Alagarswami (1983)
			DVM vs HL	14.8 + 0.4041 X	0.7921	
			DVM vs THK	$41.3 – (50.8)(0.98)^{X}$	0.86	
2	Solomon Islands	Farmed oysters (n=2272)	DVM vs TWT		0.862	Friedman and Southgate (1999)
			DVM vs THK		0.573	
3	Takapoto lagoon, French Polynesia	Farmed oysters (n= 500 ~840)	DVM vs Total Shell weight	6.81×10^{-6} (± 2.78 10 - 6 SE) $H^{3.07}$	0.97	Pouvreau *et al.* (2000)

Dimensional relationships

The dimensional relationships of DVM-HL and DVM-THK in different size groups are shown in Fig. 2. The correlation coefficient, intercept and slope of these relationships for various size groups are given in Table 3. The relationships of DVM with HL did not show good correlation coefficients in all the size groups and they have shown a decrease with increase in DVM of higher size groups. However, between DVM–THK, the relationship showed slightly higher correlation in all the size ranges. Alagarswmai (1983) also obtained lower 'r' values for shell dimensions like HL and THK than for length-weight relationships and further observed that there is a wider spread of weights over a certain value of thickness which is due to the asymptotic nature of growth in thickness. The very low 'r' value in the present study may be due to the fact that the oyster's hinge is often wedged between coral boulders making it difficult for increase in HL with corresponding increase in length. The power exponent of each equation of the biometric relationships of *P. margaritifera* in the Takapoto Island in French Polynesia (Table 2) was very close to 1 indicating that the growth in length and thickness were fairly isometric (Pouvreau *et al.*, 2000). In Solomon Islands also, the coefficient of determination were lower than that for length-weight relationship (Friedman and Southgate, 1999). The studies of Chellam (1988) indicated an increase in thickness in *P. fucata* with age of the oyster. The rate of increase in thickness was higher in smaller oysters and it also showed a decreasing trend with further growth of oysters. Moreover, Mohamed *et al*. (2006) have found that the growth pattern and biometric relationships in *P. fucata* were strongly influenced by the growing environment.

The poor 'r' values in Indian *P. margaritifera* from natural beds can also be attributed to the environmental variations. Most of the oysters were collected from the intertidal-subtidal regions where they were strongly embedded in the coralline crevices which restrict growth in the HL and slightly curtailed growth in THK. Such xenomorphism or variations in shell dimensions and shape is well established in several bivalves with relatively

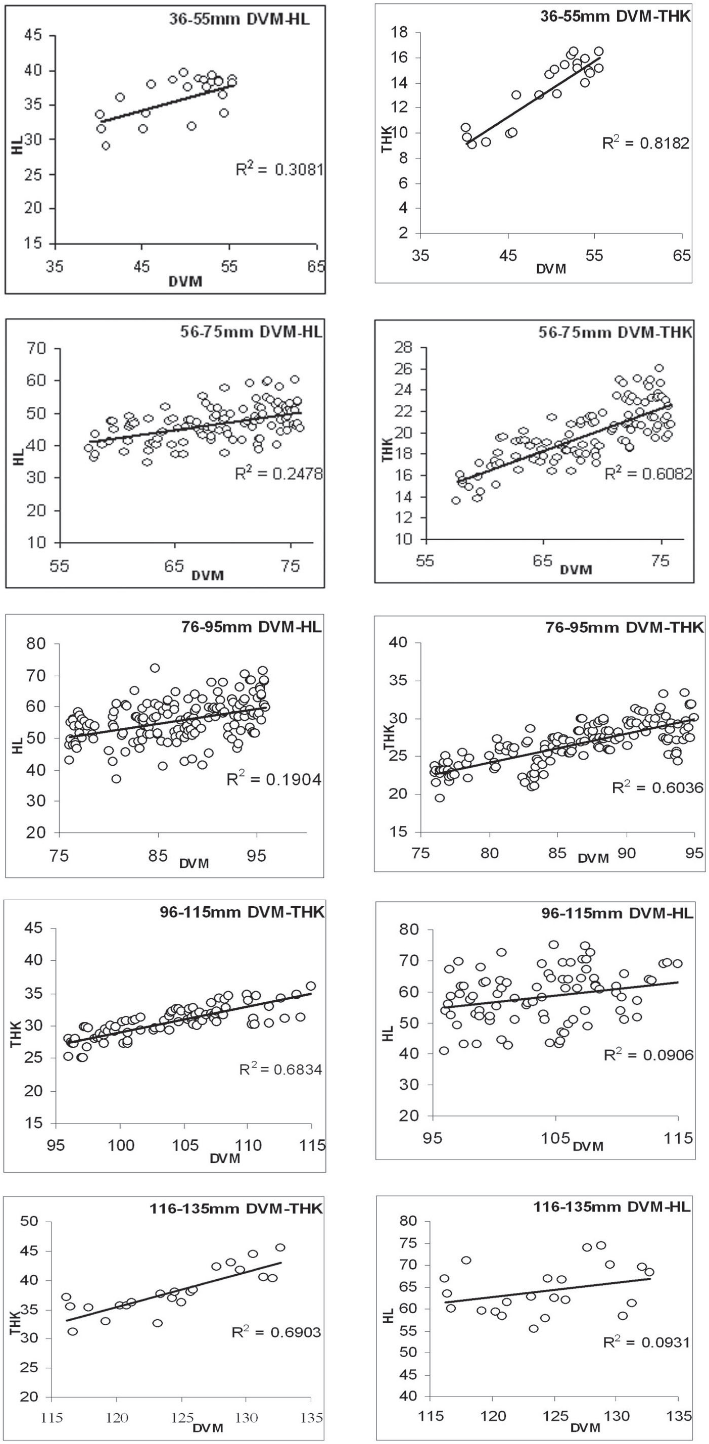


Fig. 2. Linear relationships between DVM-HL and DVM-THK in various size groups of *P. margaritifera*

TABLE 3: *Intercept (a), slobe (b) parameters and correlation coefficient (R^2) for the linear relationships in different size groups of* P. margaritifera

Size group	N	Variables	'a' value	'b' value	R^2 value
36-55	25	DVM vs HL	18.711	0.343	0.308
		DVM vs THK	8.753	0.446	0.818
56-75	116	DVM vs HL	11.249	0.516	0.248
		DVM vs THK	7.710	0.4004	0.608
76-95	161	DVM vs HL	14.639	0.472	0.190
		DVM vs THK	5.776	0.375	0.604
95-115	89	DVM vs HL	11.623	0.449	0.091
		DVM vs THK	9.584	0.386	0.683
116-135	22	DVM vs HL	24.643	0.317	0.093
		DVM vs THK	37.001	0.603	0.690

higher magnitude in the edible oyster or species of the genus *Crassostrea* (Quaylae and Newkrick, 1989). In pearl oysters of the genus *Pinctada* also both environmental and genetic factors are known to influence shell characters (Hynd, 1960; Wada, 1984).

Critical factors that determine the size of the cultured pearl are the shell dimensions of the pearl oyster. Thickness of the oyster is a prime factor which determines the size of the nucleus which can be used for implantation. Bigger nuclei can be implanted in pearl oysters with larger thickness. However, Knaur and Taylor (2002) reported that wet weight was the best predictor of nuclei size in *P. maxima*. In *P. fucata,* Mohamed *et al*. (2006) opined that, oysters having larger thickness, weight and DVM are suitable for insertion of 6 to 8 mm diameter nucleus in contrast to the commonly used small sized 3 to 4 mm nuclei.

The results of the present comparison of biometric relationships based on oysters collected from natural beds and its comparison with that of farmed stocks in other geo-locations indicate that culturing oysters in chaplets or in containers from suspended farm structures would help to have better correlation coefficients in DVM-THK relationship since the shell thickness of oysters is a critical factor in the production of larger pearls.

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