J. Mar. biol. Ass. India 1965, 7 (1): 69-79

A STUDY ON THE DIMENSIONAL RELATIONSHIP IN THE CLAM *MERETRIX CASTA* (CHEMNITZ) COLLECTED FROM TWO LOCALITIES*

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Introduction

It is known that variations in factors like temperature, light, salinity, nature of substratum and food supply, influence the structure of animals. This holds good especially in the case of molluscs (Wilton & Wilton, 1929 ; Newcombe, 1935 ; Newcombe, Thompson and Kessler, 1938 and Swan, 1953). The study on the dimensional relationship in lamellibranchs carried out by Galtsoff (1931), Newcombe (1950) and Hamai (1934a) indicates that animals of different origin show differences in ratio in their dimensions. Such variations in the dimensional relationships in shells in the case of *Meretrix meretrix* have been attributed to temperature, (Hamai, 1934b) and also to factors like physical nature of sand, salinity and other chemical conditions of sea water (Hamai, 1935 a & b).

The present work on the dimensional relationship in the case of *Meretrix casta* is aimed at finding out whether populations of the species collected from two localities *viz.*, marine fish farm and the natural clam beds of Athankarai estuary, which differ widely in their environmental conditions, show variations in the relationship.

Material and Methods

Clams for this study were collected in random samples of 100 each from ponds 1 and 3 of the marine fish farm of the Central Marine Fisheries Research Institute, Mandapam Camp and also from the natural clam beds of the Athankarai estuary situated at about 15 km. from Mandapam Camp. Marine fish farm consisting of total seven ponds is situated in the salt water lagoon near Mandapam Camp and is so constructed that the water in the ponds gets renewed to some extent by the high tides in the Palk Bay. There is no influence of fresh water in the ponds. The soil in the ponds is highly silt-laden and contains high percentage of fine grade *mud*. The percentage of organic content and total phosphate in the soil is also appreciable (Durve, unpublished). More details of the fish farm are given by Tampi (1960).

Athankarai estuary is formed by the confluence of the river Vaigai with the Palk Bay, near the village Athankarai. The estuary naturally has the influence of fresh water from the river all the year round except during summer months and also the influence of sea water of incoming tides. The soil contains less of organic matter but is very rich in phosphates and medium grade mud (Durve, unpublished). Topography of the Athankarai estuary is given by Durve and Algarswami (1964).

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The clams collected from the above localities were brought to the laboratory and kept in fresh sea water so as to clear them of their faeces. They were then measured for their dimensions with vernier calipers. All the measurements were made correct upto 0.1 mm. The dimensions measured were width, depth and height. Width denotes the distance between the syphon end and the opposite extremity of the clam, depth refers to the maximum distance between two valves and the height, the maximum distance between umbo and the gaping end. Weight of each clam correct up to 0.1 g. was also determined on a three-beam balance.

The relation of depth, height and weight on width was expressed by the simple allometric equation. The log/log plot of the data was represented by the linear regression of the form $y=a+bx$. Comparisons were made by the analysis of covariance with the significance of all tests judged at the 5 per cent level of probability.

Results and Discussions

The relation of depth (D), height (H) and weight (W) on width (L) of the molluscan shells have been studied by Nomura (1926) and later confirmed by Hamai (1934). The relations are given below.

$$D=a_1\ L^{b^1} \quad .. \quad .. \quad .. \quad .. \quad (1)$$
$$H=a_2\ L^{b^2} \quad .. \quad .. \quad .. \quad (2)$$
$$W=a_3\ L^{b^3} \quad .. \quad .. \quad .. \quad (3)$$

From these equations Nomura (1934) further developed the following relations.

$$\alpha=\beta=\gamma \quad .. \quad .. \quad .. \quad .. \quad (4) \text{ where}$$
$$\alpha=(b_3-b_2-1)/b_1 \quad .. \quad .. \quad .. \quad (5)$$
$$\beta=(b_3-b_1-1)/b_2 \quad .. \quad .. \quad .. \quad (6)$$
$$\gamma=(b_3-b_2-b_1) \quad .. \quad .. \quad .. \quad (7)$$

The above equations (1) to (7) were applied in the present study and the results are given below.

Pond 1	Pond 3	Athankarai estuary
$D=0.4787\ L^{1.0586}$	$D=0.6977\ L^{0.9453}$	$D=0.1986\ L^{0.6667}$
$H=0.1239\ L^{0.8975}$	$H=0.1104\ L^{0.9231}$	$H=0.1774\ L^{0.8070}$
$W=0.0004183\ L^{2.9895}$	$W=0.0007185\ L^{2.8177}$	$W=0.006789\ L^{2.2206}$

The corresponding logarithmic regression relations of the dimensions are :

Pond 1 $\log D = -0.3199+1.0586 \log L$
$\log H = 0.0929+0.8975 \log L$
$\log W = -3.3785+2.9895 \log L$

Pond 3 $\log D = -0.1563+0.9453 \log L$
$\log H = 0.0431+0.9231 \log L$
$\log W = -3.1436+2.8177 \log L$

Athankarai estuary $\log D = 0.2978+0.6667 \log L$
$\log H = 0.2490+0.8070 \log L$
$\log W = -2.1682+2.2206 \log L$

TABLE I

The calculated values of α, β and γ for the clams of Pond 1, Pond 3 of fish farm and Athankarai estuary.

Locality	α	β	γ	Average
Pond 1 ..	1.0316	1.0372	1.0334	1.0341
Pond 3 ..	0.9464	0.9451	0.9493	0.9469
Athankarai estuary ..	0.6204	0.6864	0.7469	0.6846

Table I shows that the relation (4) holds good in the case of Pond I and Pond 3 of fish farm but it is not the case in respect of Athankarai estuary. Further, the averages of α, β and γ are more or less same for the Ponds 1 and 3 ; but they differ widely with the average of α, β and γ for Athankarai estuary. This suggests that there may not be much difference in the dimensional relations of the clams from Ponds 1 and 3, but there may be difference in these relations among the clams of fish farm (Ponds 1 and 3) and Athankarai estuary. In order to confirm this, the test of significance was employed for the logarithmic regression relation of the dimensions of the clams from the two localities.

The comparison by covariance analysis of the linear regression of the logarithm of the depth, height and weight on the logarithm of width among clams of Pond 1 and Pond 3 resulted in non-significant ' F ' values of 1.18, 15.78 and 2.00 respectively at 196 and 1 degrees of freedom (Appendix, 2). These results support the earlier statement that differences do not exist in the dimensional relations of the clams from Pond 1 and Pond 3 of the fish farm.

In view of the absence of a marked difference in dimensional relations of the clams among Ponds 1 and 3, the data on these were pooled and presented as that of fish farm and then compared with those of clams of Athankarai estuary. The logarithmic relations of dimensions of clams from the fish farm (Ponds 1 and 3) are :

Fish Farm (Ponds 1 & 3) $\log D = -0.2153+0.9869 \log L$
$\log H = 0.0343+0.9327 \log L$
$\log W = -3.2557+2.9002 \log L$

The equation (1), (2) and (3) and the values α, β and γ calculated for the dimensional relations of the clams of fish farm (Ponds 1 and 3) and Athankarai estuary are given below for comparison.

Fish farm (Ponds 1 and 3)	*Athankarai estuary*
$D = 0.6091\ L^{0.9869}$	$D = 0.1986\ L^{0.6667}$
$H = 0.1082\ L^{0.9327}$	$H = 0.1774\ L^{0.8070}$
$W = 0.0005550\ L^{2.9002}$	$W = 0.006789\ L^{2.2206}$

TABLE II

The calculated values of α, β and γ for the clams of Fish farm (Ponds 1 and 3 pooled) and Athankarai estuary.

Locality	α	β	γ	*Average*
Fish farm (Ponds 1 and 3)	0.9803	0.9792	0.9806	0.9800
Athankarai estuary ..	0.6204	0.6864	0.7469	0.6846

Table II shows that the relation (4) holds good in respect of clams of fish farm (Ponds 1 and 3). However, as stated in Table 1, this relation (4) does not hold good in respect of clams of Athankarai estuary. The average of α, β and γ for the clams of fish farm and Athankarai estuary respectively is also not same. The test of significance was employed for the logarithmic regression relation of the dimensions of the clams of these two localities in order to confirm the above statement.

The covariance analysis of the linear regression of the logarithm of the depth, height and weight on the logarithm of width of clams of fish farm (Ponds 1 and 3) and Athankarai estuary in Appendix, Table 2, shows a significant 'F' value of 6.97 in the case of depth on width, a non-significant 'F' value 1.69 in the case of height on width and again a significant 'F' value 7.88 in the case of weight on width at 1 and 296 degrees of freedom respectively. These values suggest a lack of homogeneity in respect of dimensional relations of depth and weight on width, and a probable homogeneity in respect of height on width of the clams of these two localities.

The differences in dimensional relations in the clams of these two localities under consideration, may perhaps be due to the structural differences in their shells. This could probably be attributed to the widely differing environmental conditions prevailing there.

Relation between height and shell volume

From the foregoing account it is observed that width-depth and width-weight relations differ significantly among the clams of fish farm (Ponds 1 and 3) and Athankarai estuary. This suggests that clams of fish farm may have thicker and heavier shells than those of Athankarai estuary. To ascertain this, separate samples of clams, 80 from Pond 1, 100 from Pond 3 and 97 from Athankarai estuary were examined for their shell volume in relation to height. Shell volumes were measured by displacement method.

The height in this case was taken as a standard of measure as it was found that there was no significant difference in the relation of height on width of the clams of the two localities under study.

The logarithmic relation of volume on height in the case of clams of Ponds 1, 3 and Athankarai estuary are :

Pond 1 $\log V = -3.7398 + 2.9846 \log H$
Pond 3 $\log V = -3.7264 + 2.9492 \log H$
Athankarai estuary $\log V = -3.9722 + 3.0743 \log H$

The analysis of covariance of the linear regression of the logarithm of the volume on the logarithm of height among Pond 1 and Pond 3, resulted in a non-significant ' F ' value 45.13 at 176 and 1 degrees of freedom (Appendix, 4). This result shows that there is no significant difference in the relation of volume on height among Pond 1 and Pond 3 of the fish farm. Having established this, the data of volume and height on clams of Ponds 1 and 3 were pooled for comparison with those of Athankarai estuary.

The logarithmic relation of volume against height for the pooled data is :

$$\log V = -3.9912 + 3.1367 \log H$$

The Appendix 4 giving the comparison of the linear regression of the logarithm of the volume on the logarithm of height among the clams of fish farm (Ponds 1 and 3) and Athankarai estuary by the method of analysis of covariance, resulted in a non-significant ' F ' value 6.73 at 273 and 1 degrees of freedom. This result

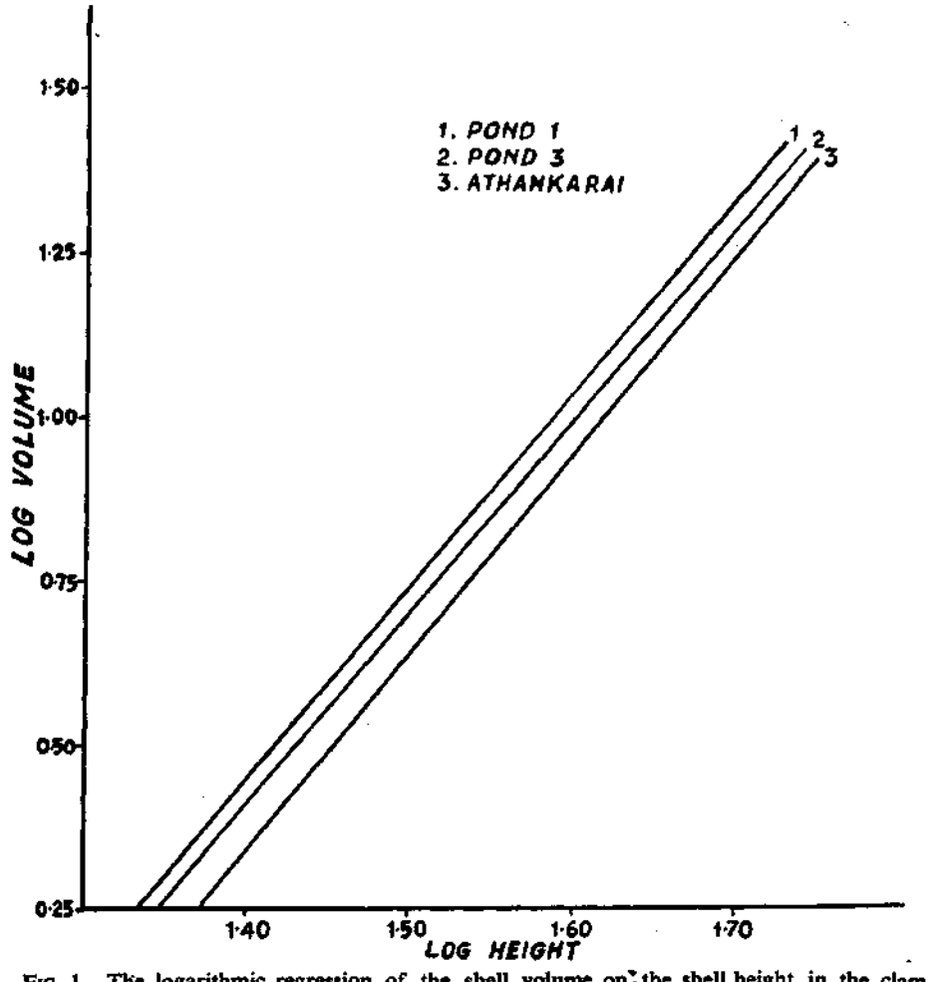

FIG. 1. The logarithmic regression of the shell volume on the shell height in the clam *Meretrix casta* from Pond 1, Pond 3 and Athankarai estuary.

shows that there is no significant difference in the relation of volume on height among clams of fish farm and Athankarai estuary. The logarithmic regression lines of the relation of volume against height for the clams of Pond 1, Pond 3 and Athankarai estuary and those for the pooled data of Ponds 1 and 3 (fish farm) are given in Figs. 1 and 2.

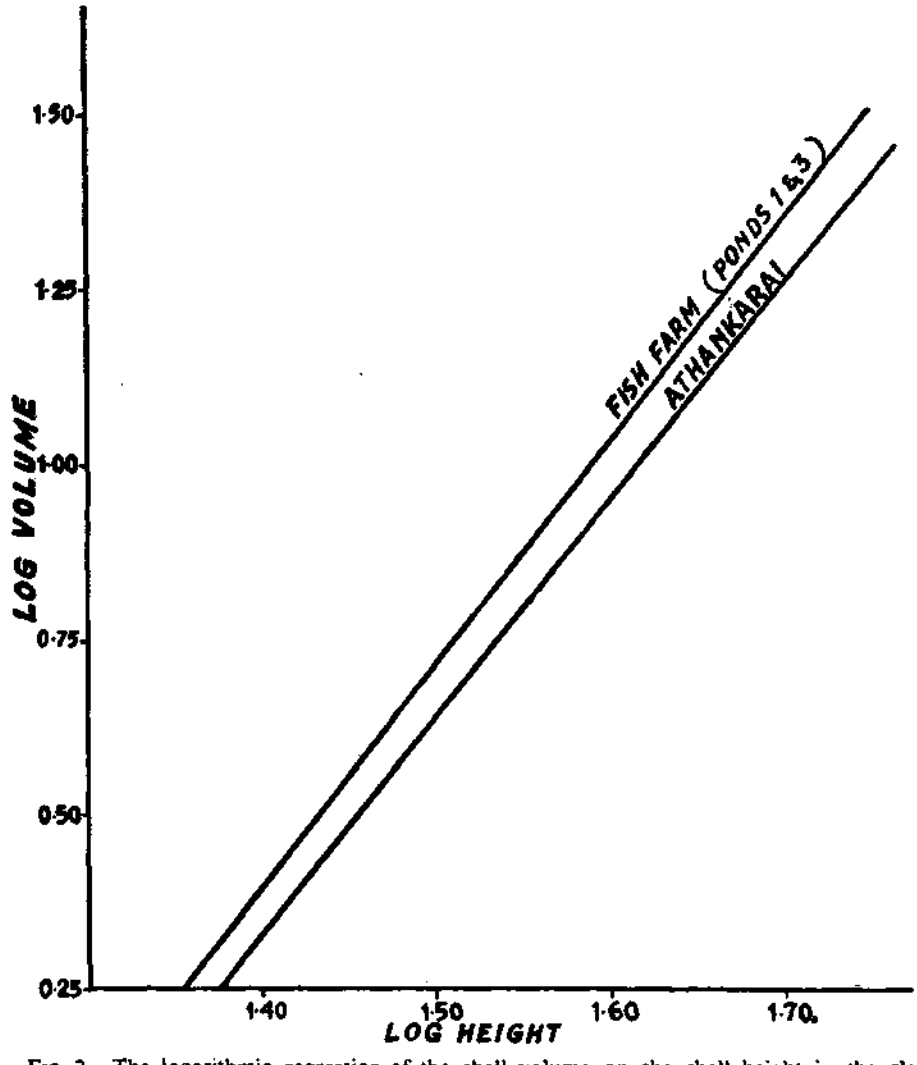

FIG. 2. The logarithmic regression of the shell volume on the shell height in the clam *Meretrix casta* from fish farm (ponds 1 and 3) and Athankarai estuary.

From Fig. 1, it will be seen that for a given height, the volume is always low for clams of Athankarai estuary, while it is higher for the clams of Pond 3 and highest for those of Pond 1. The same phenomenon is evident when the regression line for the combined data of Pond 1 and Pond 3 (Fish farm) is compared with that of the clams of Athankarai estuary (Fig. 2). This indicates that the clams from the fish farm have heavier shells. However, the difference in shell volume

in relation to height is not very distinct when the data was subjected to covariance analysis as stated in the foregoing paragraph.

Reasons for the occurrence of such heavy shells in the clam *M. casta* from the marine fish farm, cannot be said with any certainty. It is *likely* that *probable* higher calcium content in the over saline waters of the fish farm (salinity range= 30.0-45.0‰) may be responsible for the heavier shells in the clams inhabiting there. The ponds in the fish farm have coral stone pitchings and it is likely that calcium from these stones slowly gets dissolved in the water, and thus contributes towards the heavier shells of clams. However, all these aspects need a special study.

SUMMARY

Dimensional relationship in the clam *Meretrix casta* from two widely different localities of marine fish farm and natural clam beds of Athankarai estuary was studied.

The study indicates a clear difference in the dimensional relationship among the clams of these two localities. This difference may be due to the different environmental conditions prevailing there.

A study on the relationship between height and shell volume indicates that clams from the fish farm have heavier shells than those of Athankarai estuary.

ACKNOWLEDGMENT

The authors wish to express their thanks to Dr. S. Jones, Director of this Institute and Dr. R. V. Nair for their encouragement. They are also grateful to Dr. R. Raghu Prasad and Shri S. K. Banerji for going through the manuscript critically and suggesting improvements.

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APPENDIX 2

Analysis of covariance of linear regression of logarithms of depth, height and weight on the logarithm of width in order to test the significance of differences among samples of clam Meretrix casta *collected from Pond 1, Pond 3 of the fish farm and Athankarai estuary*

Characters	Deviations from average total regressions		Deviations from individual regressions within ponds			Difference among ponds			Observed F	5%
	Degrees of freedom	Sum of squares	Degrees of freedom	Sum of squares	Mean square	Degrees of freedom	Sum of squares	Mean square		
(a) *Pond* 1 and *Pond* 3										
Depth	197	0.102903	196	0.102459	0.000523	1	0.000444	0.000444	1.177928	254
Height	197	0.071075	196	0.071052	0.000363	1	0.000023	0.000023	15.782609	254
Weight	197	0.402326	196	0.401303	0.002047	1	0.001023	0.001023	2.000978	254
(b) *Fish farm* (Ponds 1 to 3) and *Athankarai estuary*										
Depth	297	0.144769	296	0.141437	0.000478	1	0.003332	0.003332	6.970711	3.89
Height	297	0.090333	296	0.089820	0.000303	1	0.000513	0.000513	1.693069	3.89
Weight	297	0.578924	296	0.563912	0.001905	1	0.015012	0.015012	7.880315	3.89

APPENDIX 3

Statistics describing logarithmic regression of shell volume (y) on the logarithm of height (x) of the clam Meretrix casta *collected from Pond* 1, *Pond* 3 *of the fish farm and Athankarai estuary*

Character (Shell volume)	N	$\bar{x}$	$\bar{y}$	Sx*	Sy*	Sxy	b
1. Pond 1	80	1.5330	0.8355	0.0583	0.6220	0.1740	2.9846
2. Pond 3	100	1.4898	0.6673	0.2876	2.8754	0.8482	2.9492
3. Fish Farm (Ponds 1 & 3 pooled)	180	1.5090	0.7421	0.4287	4.7537	1.3447	3.1367
4. Athankarai estuary	97	1.5047	0.6536	0.1238	1.3216	0.3806	3.0743

APPENDIX 4

Analysis of covariance of linear regression of logarithm of shell volume on the logarithm of height in order to test the significance of differences among samples of clam Meretrix casta *collected from Pond* 1, *Pond* 3 *of the fish farm and Athankarai estuary.*

Character (Shell volume)	Deviations from average total regressions		Deviations from individual regressions within ponds			Difference among ponds			Observed F	5%
	Degrees of freedom	Sum of squares	Degrees of freedom	Sum of squares	Mean square	Degrees of freedom	Sum of squares	Mean square		
(a) *Pond* 1 *and Pond* 3 *samples*	177	0.476605	176	0.476545	0.002708	1	0.000060	0.000060	45.133333	254
(b) *Fish farm* (ponds 1 & 3) and *Athankarai estuary*	274	0.687680	273	0.687306	0.002518	1	0.000374	0.000374	6.732620	254