Height-Depth (Breadth) Relationship of Shells in the Backwater Oyster *Crassostrea madrasensis* (Preston) of the Cochin Harbour*

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A study of the height-depth relation in the Indian backwater oyster *Crassostrea madrasensis* (Preston) was carried out. The plot of height against depth showed an exponential trend and a relationship of the form $H = AD^B$. Plot of height against depth also showed larger deviations in height for oysters with greater depth. Analysis showed that variations in height does not result in corresponding variations in depth, particularly in oysters with increased height.

Shell dimensions and their inter-relations in bivalve mulluscs have been reported by several workers (Weymouth, 1923; NewCombe, 1935, 1936, 1950; Orton, 1926; Quayle, 1952; Rao, 1951; Abraham, 1953; Galtsoff, 1931; Hamai, 1934, 1935). Shell growth is correlated with the growth of soft tissues in bivalves and studies on shell dimensions help to determine the optimum marketable size of oysters.

Studies pertaining to the morphometry of oyster shells are reported from several parts of the world and variations in shell dimension are ascribed to differences in habitats, (Kristensen, 1957; Pohlo, 1964; Durve & Dharmaraja, 1965; Kuenzler, 1961; Shafee, 1976; Lee & Yoo, 1975), depth (Holme, 1961); over-crowding (Tanita & Kikuchi, 1957).

Animals exhibit isometric and allometric growth. In the case of isometric growth the functional regression value, b would be 3 and this would characterise an unchanging body form and unchanging specific gravity, even though many species show changes in weight consequent to spawning, stomach content etc. However, in the case of certain species, the b values appear to be greater or less than 3, a condition described as allometric growth (Ricker, 1975). The growth particularly in molluscs is usually reflected in shell characteristics. The allometric growth recognised by Huxley & Teissier (1936) has been demonstrated by several workers in many animals (Needham, 1942; Teissier, 1960). In some bivalve molluscs allometry characterised by variations in the ratio of shell dimensions have been demonstrated more particularly during definite stages in cases such as *Mya arenaria* (Swan, 1952), *Tapes japonica* (Ohba, 1959), *Meretrix meretrix* (Hamai, 1936) *Meretrix casta* (Durve & Dharmaraj, 1965) and *Cardium edule* (Kristensen, 1957).

Very little work on the dimensional relationship of shells in oysters has been carried out from Indian waters. The studies pertaining to this important aspect of bivalve morphometry from India are those of Paul (1942), Rao & Nayar (1956), Durve & Shrikande (1976), Durve & Dharmaraja (1965). No published data on the morphometry of *Crassostrea madrasensis* inhabiting Cochin backwaters are

*Formed part of the Ph.D. Thesis of the first author approved by the University of Cochin.

avaliable and it is thought worthwhile to have a detailed study on this aspect and the attempt of the authors in this line are reported in this communication.

Materials and Methods

For determining the height-depth relationship, morphometric data of oysters ranging from 0.2 to 16.9 cm in height were employed. 'Height' is the maximum distance recorded from hinge to the opposite side of the shell, 'length' the greatest dimension of the anterio-posterior axis and depth is the maximum distance between the outersides of the two shells at a point where the axes of the other two dimensions crossed (Galtsoff, 1964). Random samples of wild oysters numbering about 1195 of different size group were collected from the shipping channel, near bar mouth of Cochin backwaters and measurements were made with the help of a vernier calippers.

Results

Height and depth were plotted on a graph with depth on abscissa and height on ordinate in the form of a scatter graph (Fig. 1). The plot of height against depth showed an exponential trend and a relationship of the form $H = AD^B$ was found to be appropriate. A curve ($H = AD^B$) to the mean values in Table 2 was also fitted (Fig. 1). On taking logarithm, this gave a linear relationship of the form $Y = a + bZ$, where $Y = \log H$, $Z = \log D$, $a = \log A$ and $b = B$. The plot (Fig. 1) also showed larger deviations in height for oysters with greater depth. The relationship of height and depth was worked out for the groups with height above 8 cm and below 8 cm. The corrected sum of squares, sums of cross products and deviation from regression for the two groups are given in Table 1.

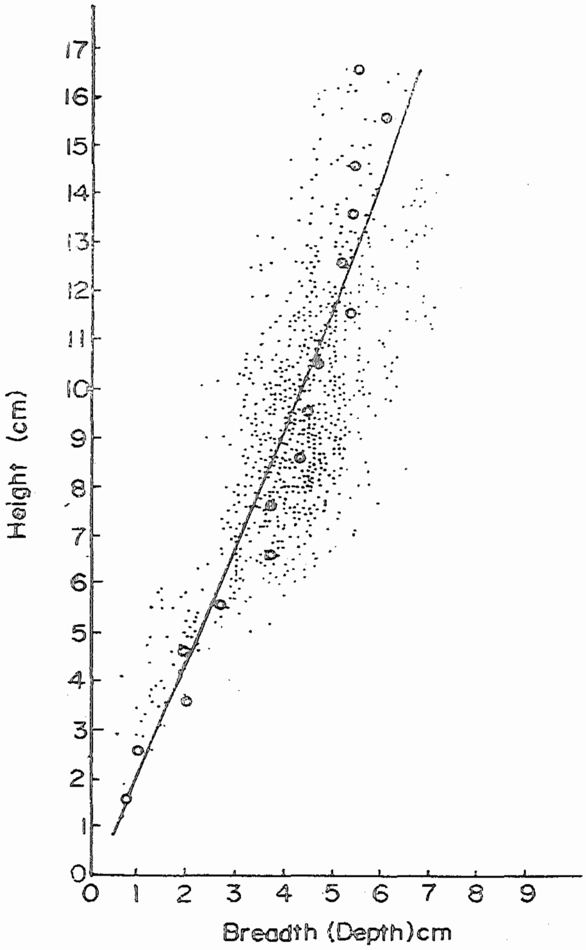

Fig. 1. Height-depth (breadth) relationship in *C. madrasensis*. Circles indicate the mean values of depth for the different size groups in height.

Residual variances were observed to be heterogeneous. The F-test for equality of variances showed that the variances were significantly different ($F = 2.30$, $df = 766,291$).

Discussion

The equation in terms of log values worked out to $Y = 0.3059 + 1.0936Z$. The regression co-efficient was found to be highly

Table 1. *Analysis of covariance of log height on log depth*

	df	Σz^2	Σzy	Σy^2	Regression coefficient	Deviation from regression df	ss	ms
Group 1 (Height 8 cm and below)	291	9.8646	5.3064	3.8009	0.5379	290	0.9464	0.003263
Group ii (Height 8 cm and above)	766	3.6912	1.4529	6.3153	0.3936	765	5.7435	0.007508

significant, with a correlation coefficient of 0.9775. The standard error of the regression coefficient (b) was 0.0631 and 95% confidence interval of b was 0.9583 to 1.2289. The equation in the original scale worked out to $H = 2.0225\ D^{1.0936}$. As the B values of 1.0936 for the grouped data is not very much different from unity, a linear

Table 2. *Mean values of depth for the various size (height) group of oysters*

Class interval cm	Mid point	Number	Average depth cm
1.1– 2	1.5	1	0.80
2.1– 3	2.5	6	0.95
3.1– 4	3.5	24	1.97
4.1– 5	4.5	20	1.95
5.1– 6	5.5	44	2.63
6.1– 7	6.5	88	3.67
7.1– 8	7.5	151	3.70
8.1– 9	8.5	194	4.26
9.1–10	9.5	172	4.42
10.1–11	10.5	123	4.59
11.1–12	11.5	101	4.83
12.1–13	12.5	64	5.06
13.1–14	13.5	32	5.30
14.1–15	14.5	28	5.38
15.1–16	15.5	7	6.11
16.1–17	16.5	10	5.36

relationship between height and depth also holds good ($H = -1.4618 + 2.7450\ D$). The above analysis of height-depth relationship shows that variations in height does not result in corresponding variation in depth, particularly in oysters with increased height.

Variation in shell depth consequent to increase in shell height was noticed in *Tapes japonica* by Ohba (1959). The relation of height to depth was not the same for the entire growth range as observed in the present study. Wilber & Owen (1964) also pointed out the same phenomena and opined that a single allometric relation is inappropriate for the entire growth range. Allometric relation of height-depth was observed in *Mya arenaria by* Newcombe & Kessler (1936), *Donax cuneatus* by Nayar (1955), *Pecten maximus* (Mason, 1957) and *Donax faba* (Alagarswami, 1966). Thomson (1969) observed a height-depth ratio of $Y = 0.10 + 0.25 \times$ in *Crassostrea gigas*, $Y = 0.44 + 0.11 \times$ in *Crassostrea commercialis* and $Y = 0.45 + 0.18 \times$ in *Ostrea gigas,* where Y = depth and X = height. As observed by Rao & Nayar (1956), oysters vary a great deal in shape even among the members of the same species. Oysters are sedentary throughout their life and the substratum on which they settle after the free swimming larval life is of great importance (Galtsoff, 1964). Corresponding with the contour of the substrata, oysters assume flat or uneven shape. Over-crowding results in a variety of shapes. As pointed out by Korringa (1952), salinity, velocity of water currents, wave action, depth and exposure all have an abiding influence in determining the shape of oyster shells.

As pointed by Lison (quoted by Galtsoff, 1964) oyster shell cannot be expressed in precise geometrical terms because of its variability. The index of shape determined as a ratio of the sum of height and width to its length $\frac{(\text{height} + \text{width})}{\text{length}}$ by Crozier (as quoted by Galtsoff, 1964) was also employed in this study. The frequency distribution of the index of shape is presented in Fig. 2. The index vaiied from 1,05 to 5.23 indicating that increase in

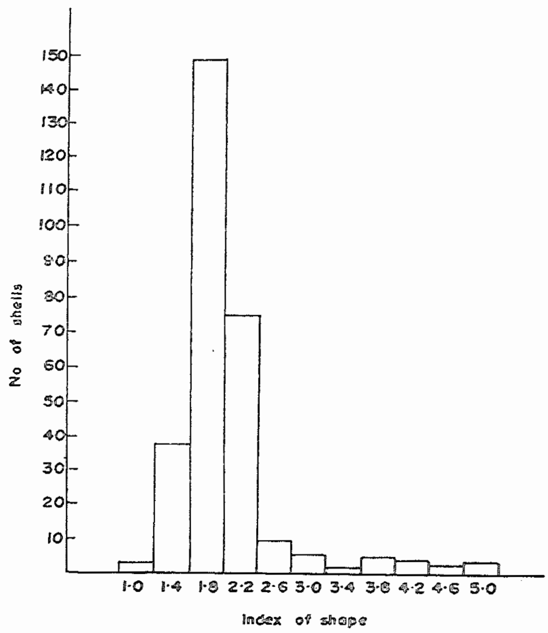

Fig. 2. Frequency distribution of the index of shape in shells of *C. madrasensis.*

height and width are not directly proportional to the increase in length in *Crassostrea madrasensis* collected from wild population in the Cochin Harbour. Galtsoff (1964) also noticed that the index of shape in American oyster *Crassostrea virginica* as highly variable. For the entire range of distribution of *Crassostrea virginica from* Atlantic and Gulf States, the index of shape varied between 0.5 to 1.3 (Galtsoff, 1964). The difference in index of shape was not very significant between the northern and southern oyster population in the United States according to him.

We are thankful to the Director, Central Institute of Fisheries Technology, Cochin for the facilitities provided for this work. The help rendered by Mr. A. K. Kesavan Nair in the statistical treatment of the data is gratefully acknowledged.

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