Dimensional Relationships in *Crassostrea madrasensis* (Preston) and *C. gryphoides* (Schlotheim) in Mangrove Ecosystem

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Mangrove influenced estuarine habits in the tropics are favor the settlement of oysters and their larval stages, which protect them from strong waves and speedy currents. Shell structure in Bivalves forms an important protective system. Description of the relationship between shell and soft body characteristics are essential in understanding ecological variations and productivity of oyster population. A total number of 627 oyster specimens were collected from different locations in Goa as case study for the tropical estuaries and studied for their allometric relationships. Data described in the present document could be of importance in monitoring the health of natural oyster beds. It also serves a baseline for planning sustainable management and understanding the aquaculture potential of *Crassostrea* spp. in mangrove influenced estuarine habitats.

**Keywords:** Allometry; *Crassostrea* spp.; Mangrove; Estuary; Tropics

**Introduction**

Mangroves and associated environmental features favour oyster and their larval settlement. Such ecosystem supports a protection to oyster beds against strong wave action and speedy currents. Enrichment of organic carbon in the water column in mangrove regions possess adequate amount of nutrients for the production of plankton, which can support the growth and fattening of oysters. Oysters form edible, cheap and feasible source of commercial importance. They contribute sediments to the marine environment by fragmentation of their shells and thus are of geological significance. Oyster species like *Crassostrea madrasensis* (Preston) and *C. gryphoides* (Schlotheim) from the mangroves and in the vicinity regions influenced by them have been studied for their biometric relationships and their production.

The length-weight relationship in oysters helps in establishing the yield and converting one variable into the other. Of the two, length, width and height are easier to measure and can be converted into weight. Description of the relationship between shell and soft body characteristics are essential in understanding ecological variations and productivity of oyster population. As case attempts have been made to study *Crassostrea* spp. from mangrove and in the vicinity regions of Mandovi estuary of Goa. The data described and discussed in the present paper would be applicable to the tropical oyster fisheries in monitoring the health, and sustainable management of particular resource.

**Materials and Methods**

In order to determine the allometric measurements and relationships, individual specimen was measured for its length, height, width, whole weight, flesh wet weight and dry weight. Shell length, height and width were measured to the nearest 0.02 mm using Vernier calipers. The dimensional terms (length, height and width) applied to oysters followed. The total weight, shell weight and meat weight of individual specimen was determined by using a mono pan electric balance to an accuracy of 0.01 g. The specimens collected from two mangrove dominated areas in the Mandovi Estuary. First site (St-1) is located in Chorao Island (Dr. Salim Ali Bird Sanctuary), whereas the second site (St-2) is located in Nerul Creek (Fig. 1).

![Fig. 1— Location of sampling site along the Mandovi river](image-url)
A total of 219 specimens of *C. madrasensis* and 82 specimens of *C. gryphoides* were collected from St-1, during the study period, and a total number of 203 *C. madrasensis* and 115 specimens of *C. gryphoides* were collected from St-2. These data were used to determine the relationships between each of the body dimensions in the two populations of each station and compared the populations with each other. Each oyster species allometric data were pooled together and taken as one class. Regressions were calculated by least square method (the straight line is fitted to scattered diagram). This relationship was expressed by the following equation\(^3\), and is given below:

\[
Y = a X^b \text{ or } (\log Y = a + b \log X)
\]

where, \(X\) and \(Y\) are the independent and dependent variables of allometric parameters, respectively, whereas \(a\) and \(b\) are constants estimated by regression. Statistical analyses of relationships including ANOVA were performed using statistical packages.

**Results**

During the period of investigations, the average density of oysters at St-1 was estimated to be about 969.6 specimens/m\(^2\), of which 36% of the population was live. At St-2, oyster bed harbored average of 948 specimens/m\(^2\) of oysters; however, the live (16.17%) were relatively much less compared to the same from St-1. A total number of 305 oyster specimens were collected from St-1 over the period of study from August 2005 to July 2006. The number of *C. madrasensis* found to be 221 specimens (72.46%), while only 84 specimens (27.54%) found to be *C. gryphoides* of the total number collected. The total number of oyster specimens collected from St-2 was 322, of which 205 (63.66%) was found to be *C. madrasensis*, while *C. gryphoides* amounted to 117 (36.34%).

The length of *C. madrasensis* collected from St-1 ranged between 25-65 mm, while width and height were found in the ranges of 17-41 mm and 12-35 mm, respectively. The total weight of the animal ranged between 3.37-37.18 g, and the fresh weight of meat ranged between 1.81-0.32 g (Fig. 2). While the length of the same species from St-2 ranged between 27-60 mm, width 17-49 mm and height 10-34 mm. The total weight of the animal ranged between 4.34-36.23 g, and the wet weight of meat ranged between 0.21-2.85 g (Fig. 3).

In the other hand, the length of the *C. gryphoides* collected from St-1 ranged between 25-51 mm, width 19-43 mm and height 9-32 mm. The total weight of the animal ranged between 4.39-27.12 g, and the meat wet weight ranged between 0.29-2.34 g (Fig. 4). Whereas, the length, width and height of the specimens collected from St-2 ranged between 24-55 mm, 18-40 mm and 11-32 mm, respectively. The total weight of the animal ranged between 3.27-28.87 g, and the wet meat weight ranged between 0.20-1.72 g (Fig. 5).

The statistical analysis of allometric parameters of the two species from St-1 and St-2 are summarized in Table 1 and Table 2, respectively.

**Discussion**

The oyster colonies from the study area were generally overcrowded and covered with sediments, with irregular shape of individual with different sizes. However, shell cavities in both the species found to be deep, except in some organisms, it was narrow. Evaluation of the biometric characteristics and relationships in oyster provides better understanding of their relative growth of various body parts\(^4\). Shell height is considered to be effective in predicting biomass parameters\(^5,6\). Oysters are irregular in shape, even within the same species and they live in an overcrowded colonial pattern attached on to the hard substratum. They are subjected to a process called xenomorphism in which their shape is determined by contour of the substrate where they grow\(^7\). Overcrowding results in the infestation by other specimens on the oyster shell along the colony compels in alteration of its shell growing pattern to accommodate itself within the colony. Therefore, dimensional relationships modifies by the environmental conditions under which the oyster grows\(^3,7,8\). Overcrowding results in the assumption of a variety of crooked forms\(^9\). The relationship in *Perna viridis* L. could indirectly be influenced by the local ambient environmental conditions, including food availability, feeding efficiency and population density\(^10\).

Generally, positive allometric relationships have been reported in bivalves\(^11\). The relationships between the three dimensions of the oyster shells (length, width, and height) from St-1 and St-2, found to be significantly correlated with the total body weight than that of the flesh wet weight\(^12\). However, the important of larger bivalves could easily be over estimated, if calculated from the total weight\(^12\). Overall, the relationships between length, width and
Fig. 2 — Allometric relationship in Crassostrea madrasis at St-1
Fig. 3—Allometric relationships in *Crassostrea madrasensis* at St-2
Fig. 4—Allometric relationships in *Crassostrea gryphoides* at St-1
Fig. 5 — Allometric relationships in *Crassostrea gryphoides* at st-2
those occurring in natural habitats remains higher in the cultured mussels compare to weight in significant. Correlation coefficient between shell size contribution of soft tissue to the total weight was with the increase in the flesh weight, indicating that however, the increase in the total weight coincided with the increase in the flesh weight, indicating that of soft tissue to the total weight was significant. Correlation coefficient between shell size and fresh meat weight was found to be 0.7615. The total weight found to increase faster than length to the tune of 2.07 and 1.72 times in C. madrasensis collected from St-1 and St-2, respectively. While in C. gryphoides, it was to the tune of 1.47 and 2.00 times from St-1 and St-2, respectively. Meat weight increased faster than length, which was 2.07 and 1.71 times in C. madrasensis collected from St-1 and St-2 respectively, whereas it was 1.24 time faster than length in C. gryphoides. In larger mussels, the increases in size, growth rate decreases.

The rate of conversion of energy to soft tissue remains higher in the cultured mussels compare to those occurring in natural habitats. The present findings revealed that the increase in total weight and meat weight are mostly dependent on the increase of the shell length of C. madrasensis and C. gryphoides. However, the increase in the total weight coincided with the increase in the flesh weight, indicating that contribution of soft tissue to the total weight was significant. Correlation coefficient between shell size and
from St-1. About 64% of the oyster bed has been exploited from St-1, while from St-2; it has been estimated to be about 83.83%. The lesser exploitation of oyster bed from St-1 could be attributed to the protection of mangrove habitats from the Chorao Island as it has been declared as a sanctuary protected area. However, the area remains accessible by locals, and the oyster’s bed still uncontrolled.

The marketable size of oyster is considered to be when the shell height reaches 70 mm, which is referred in the present study as length\(^9\). However, the oyster size from St-1 in case of \textit{C. madrasensis} ranged between 25-60 mm, however, in \textit{C. gryphoides} it was ranged between 51-55 mm. The relatively smaller size compared to the marketable size might be due to the constant overexploitation, which does not allow the oyster to grow to the marketable size.

It could be concluded from these observations that the exploitation of those natural oyster beds is uncontrolled and would lead to total destruction of the oyster population and meat revenue from the area. Destruction of oyster beds has been noticed at several locations from the estuaries of the state. Regulation of oyster collection is necessary for the sustainable development of mangrove dependent oyster fisheries.

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