

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 settlement¹. 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 followed². 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).

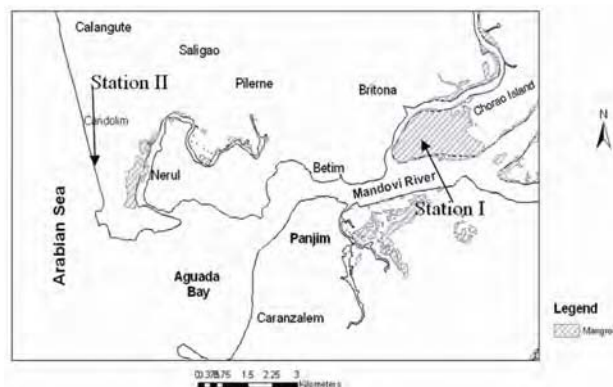


Fig. 1— Location of sampling site along the Mandovi river

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 equation³, 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/m², of which 36% of the population was live. At St-2, oyster bed harbored average of 948 specimens/m² 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 parts⁴. 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 grow². 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 forms⁹. The relationship in *Perna viridis* L. could indirectly be influenced by the local ambient environmental conditions, including food availability, feeding efficiency and population density¹⁰.

Generally, positive allometric relationships have been reported in bivalves¹¹. 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 weight¹². However, the important of larger bivalves could easily be over estimated, if calculated from the total weight¹². Overall, the relationships between length, width and

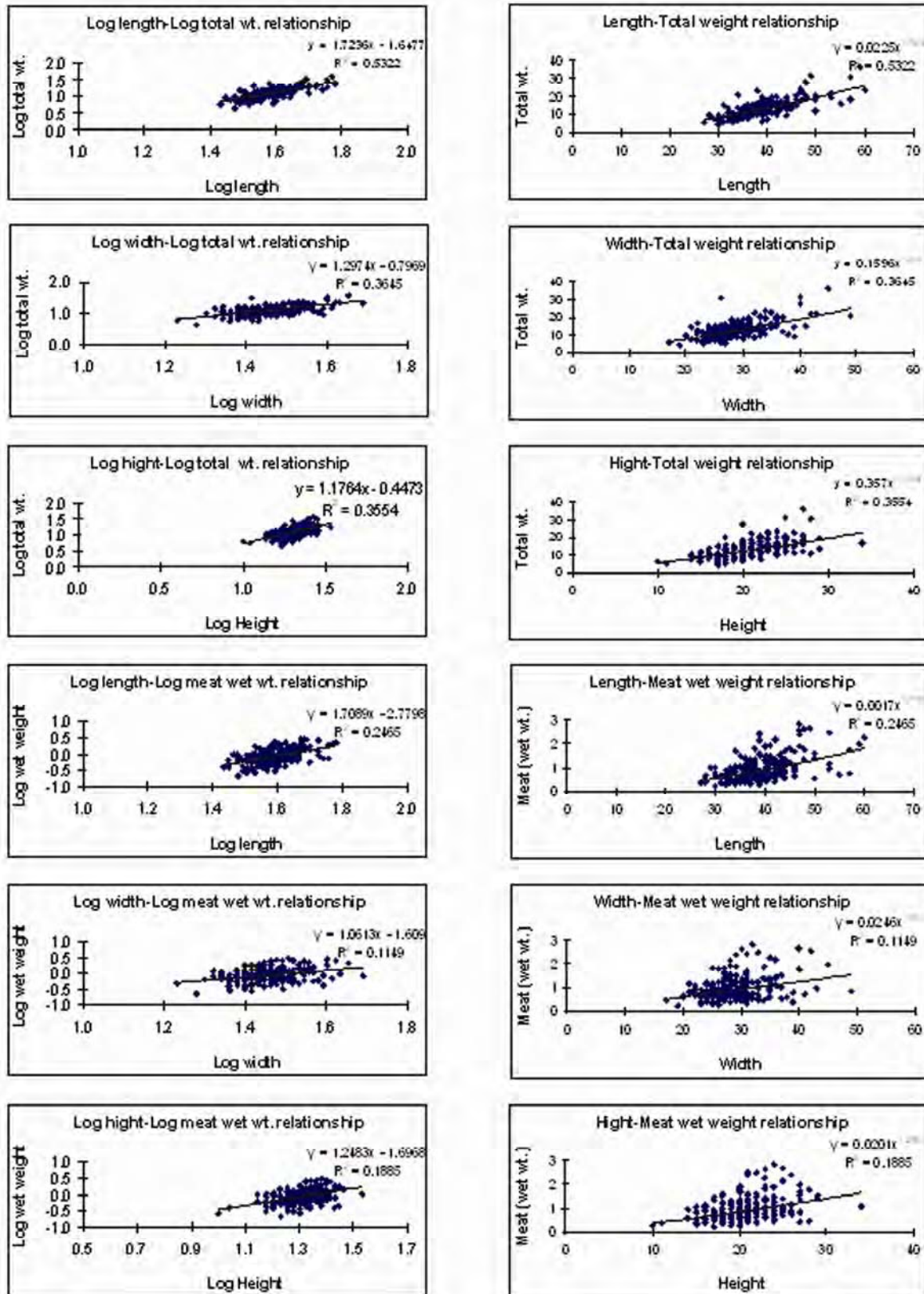


Fig. 2— Allometric relationship in *Crassostrea madrasensis* at St-1

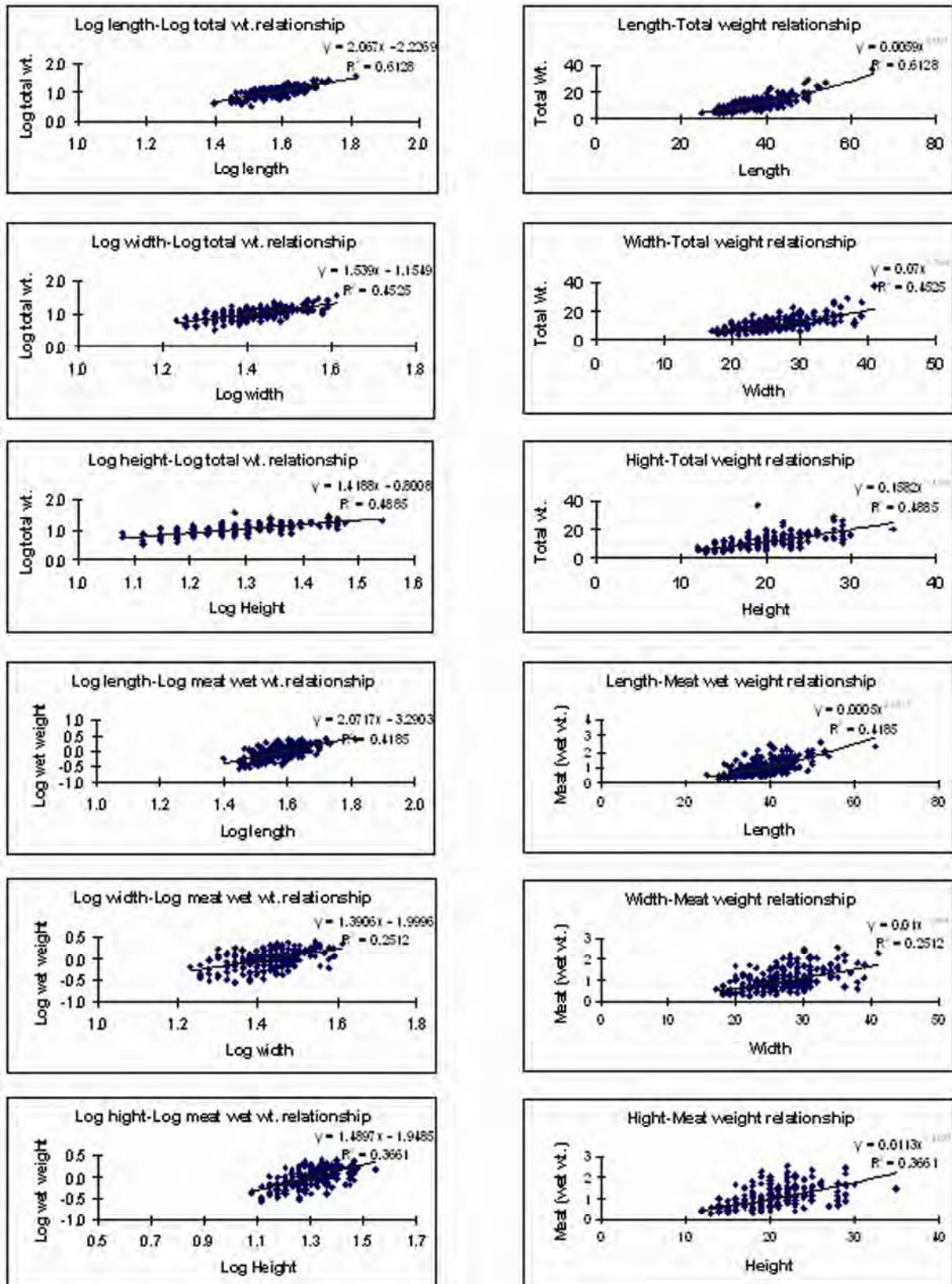


Fig. 3— Allometric relationships in *Crassostrea madrasensis* at St-2

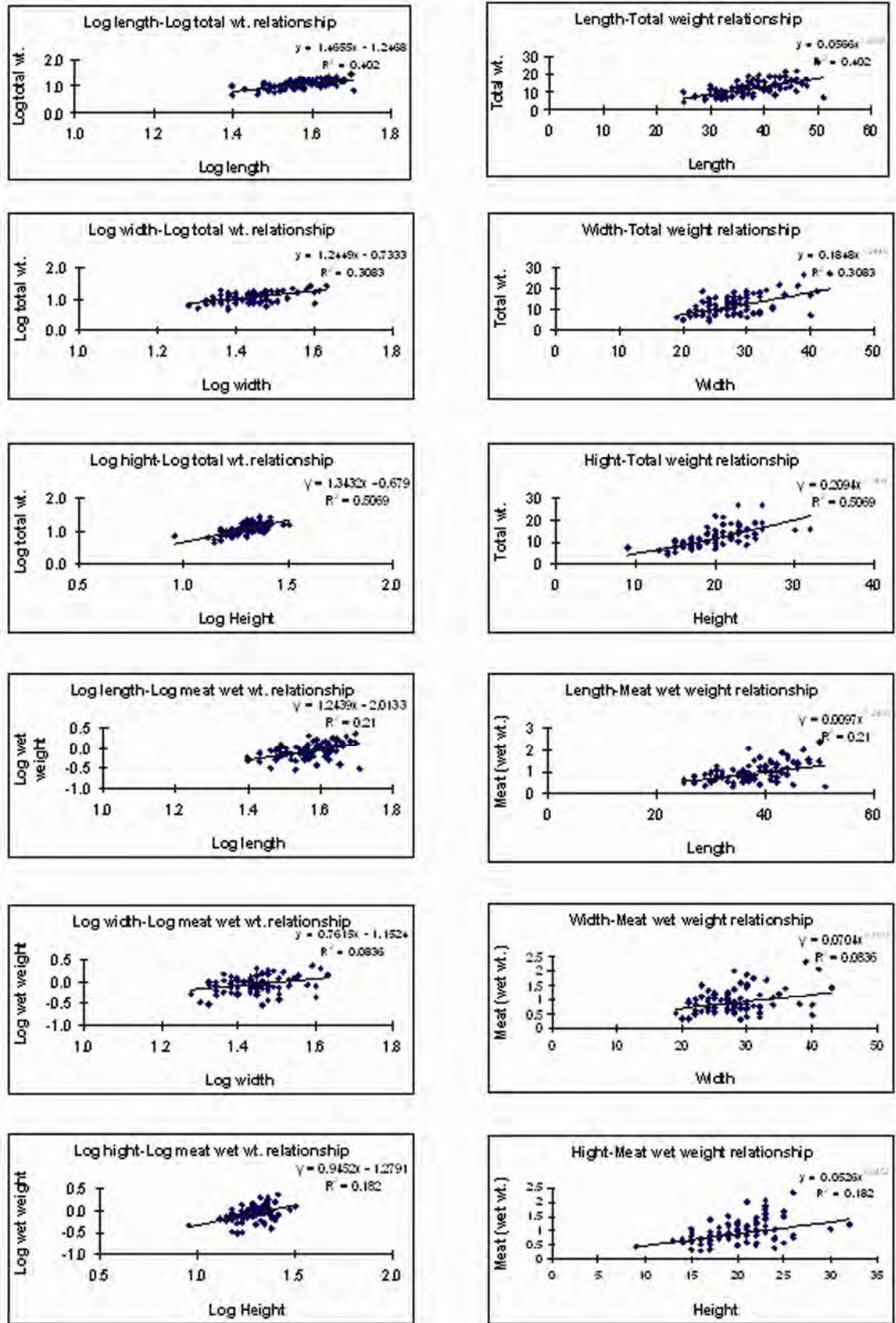


Fig. 4— Allometric relationships in *Crassostrea gryphoides* at St-1

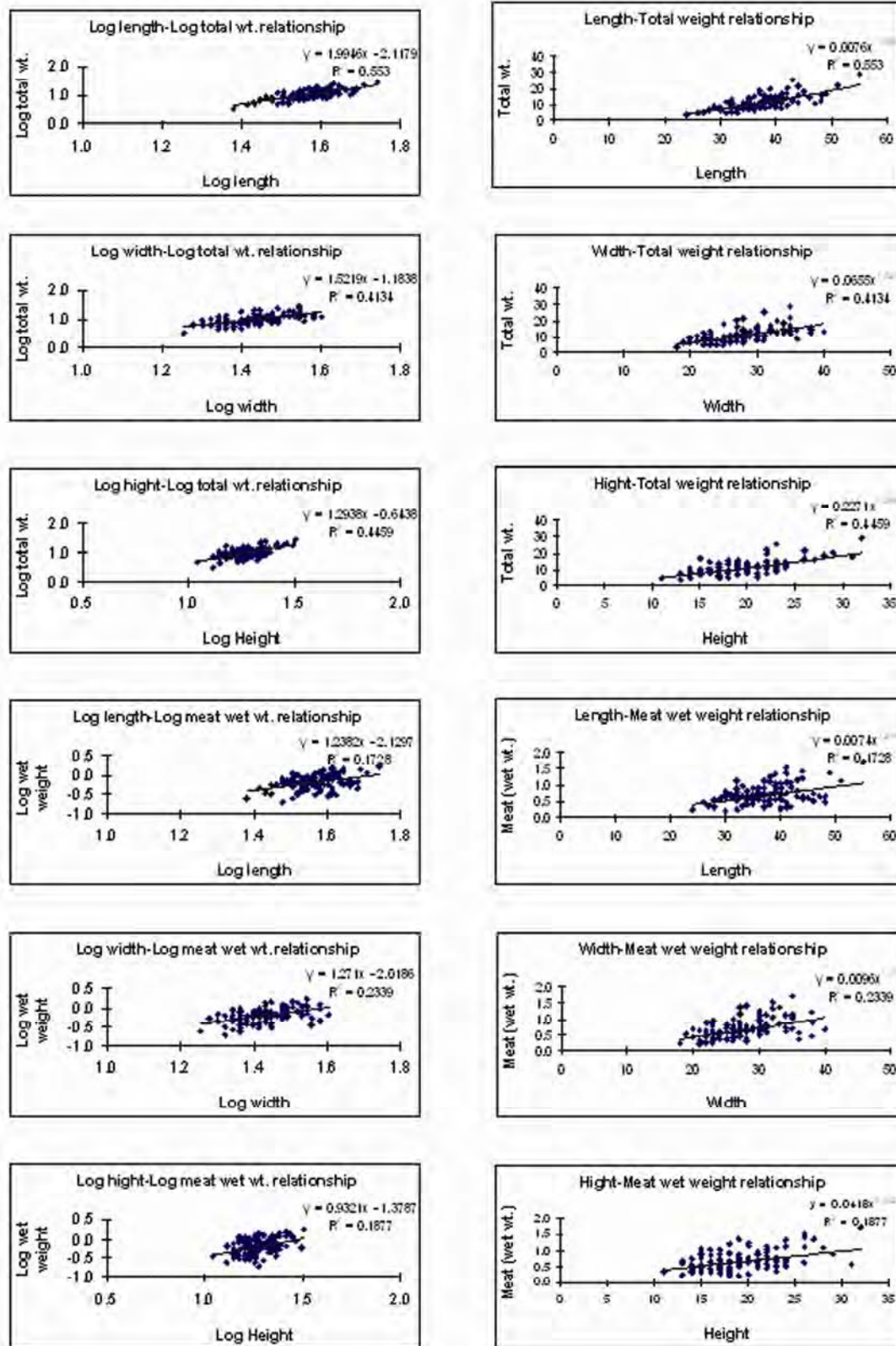


Fig. 5— Allometric relationships in *Crassostrea gryphoides* at st-2

Table 1 — Summary of statistical analysis of allometric data on *Crassostrea madrasensis* collected from St-1 and St-2

Sl. No.	x	y	a	b	SE of b	Regression equation	Parabolic equation	r	Significance
<i>St-1, D.F. = 219</i>									
1	length	Total weight	-2.2269	2.0670	0.1110	Log y = -2.2269 + 2.0670 log x	Y = 0.0059 x ^{2.0670}	0.7828	***
2	Width	Total weight	-1.1549	1.5390	0.1144	Log y = -1.1549 + 1.5390 log x	Y = 0.0700 x ^{1.5390}	0.6727	***
3	Height	Total weight	-0.8008	1.4188	0.0981	Log y = -0.8008 + 1.4188 log x	Y = 0.1582 x ^{1.4188}	0.6989	***
4	length	Wet weight	-3.2903	2.0717	0.1650	Log y = -3.2903 + 2.0717 log x	Y = 0.0005 x ^{2.0717}	0.6469	***
5	Width	Wet weight	-1.9997	1.3906	0.1623	Log y = -1.9997 + 1.3906 log x	Y = 0.0100 x ^{1.3906}	0.5012	***
6	Height	Wet weight	-1.9485	1.4897	0.1325	Log y = -1.9485 + 1.4897 log x	Y = 0.0113 x ^{1.4897}	0.6051	***
<i>St-2, D.F. = 203</i>									
1	length	Total weight	-1.6477	1.7236	0.1134	Log y = -1.6477 + 1.7236 log x	Y = 0.0225 x ^{1.7236}	0.7295	***
2	Width	Total weight	-0.7969	1.2974	0.1202	Log y = -0.7969 + 1.2974 log x	Y = 0.1596 x ^{1.2974}	0.6038	***
3	Height	Total weight	-0.4473	1.1764	0.1112	Log y = -0.4473 + 1.1764 log x	Y = 0.3570 x ^{1.1764}	0.5961	***
4	length	Wet weight	-2.7798	1.7089	0.2097	Log y = -2.7798 + 1.7089 log x	Y = 0.0017 x ^{1.7089}	0.4965	***
5	Width	Wet weight	-1.6090	1.0613	0.2067	Log y = -1.6090 + 1.0613 log x	Y = 0.0246 x ^{1.0613}	0.3390	***
6	Height	Wet weight	-1.6968	1.2483	0.1818	Log y = -1.6968 + 1.2483 log x	Y = 0.0201 x ^{1.2483}	0.4342	***

Table 2— Summary of statistical analysis allometric data on *Crassostrea gryphoides* collected from St-1 and St-2

Sl. No.	x	y	a	b	SE of b	Regression equation	Parabolic equation	r	Significance
<i>St-1, D.F. = 82</i>									
1	length	Total weight	-1.2468	1.4655	0.1974	Log y = -1.2468 + 1.4655 log x	Y = 0.0567 x ^{1.4655}	0.6340	***
2	Width	Total weight	-0.7333	1.2449	0.2059	Log y = -0.7333 + 1.2449 log x	Y = 0.1848 x ^{1.2449}	0.5552	***
3	Height	Total weight	-0.6790	1.3432	0.1463	Log y = -0.6790 + 1.3432 log x	Y = 0.2094 x ^{1.3432}	0.7120	***
4	length	Wet weight	-2.0133	1.2439	0.2664	Log y = -2.0133 + 1.2439 log x	Y = 0.0070 x ^{1.2439}	0.4583	***
5	Width	Wet weight	-1.1524	0.7615	0.2783	Log y = -1.1524 + 0.7615 log x	Y = 0.0704 x ^{0.7615}	0.2892	**
6	Height	Wet weight	-1.2791	0.9452	0.2213	Log y = -1.2791 + 0.9452 log x	Y = 0.0526 x ^{0.9452}	0.4267	***
<i>St-2, D.F. = 115</i>									
1	length	Total weight	-2.1179	1.9946	0.1672	Log y = -2.1179 + 1.9946 log x	Y = 0.0076 x ^{1.9946}	0.7436	***
2	Width	Total weight	-1.1838	1.5219	0.1690	Log y = -1.1838 + 1.5219 log x	Y = 0.0655 x ^{1.5219}	0.6430	***
3	Height	Total weight	-0.6438	1.2938	0.1345	Log y = -0.6438 + 1.2938 log x	Y = 0.2270 x ^{1.2938}	0.6678	***
4	length	Wet weight	-2.1297	1.2382	0.2526	Log y = -2.1297 + 1.2382 log x	Y = 0.0074 x ^{1.2382}	0.4157	***
5	Width	Wet weight	-2.0186	1.2710	0.2145	Log y = -2.0186 + 1.2710 log x	Y = 0.0096 x ^{1.2710}	0.4836	***
6	Height	Wet weight	-1.3787	0.9321	0.1808	Log y = -1.3787 + 0.9321 log x	Y = 0.0418 x ^{0.9321}	0.4333	***

height were found to be highly significant ($p < 0.001$), when correlated with total weight and meat wet weight in *C. madrasensis* and *C. gryphoides* from Goa. The width did not exhibit correlation with most of the allometric parameters of oyster, except with flesh wet weight of *C. gryphoides* at St-1, which was found to be significant at $p < 0.01$.

The rate of conversion of energy to soft tissue remains higher in the cultured mussels compare to those occurring in natural habitats^{6,13}. 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 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^{3,14}. Oyster beds in the mangrove habitats of Goa have been continuously subjected to heavy exploitation, with indiscriminate collection for daily consumptions, which has resulted in declining oyster population. The oyster beds from Nerul creek (St-2) was observed to be relatively more stressed compared to the same

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 length⁹. However, the oyster size from St-1 in case of *C. madrasensis* ranged between 25-60 mm, however, in *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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