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Length-weight relationship study of mangrove clam *Geloina proxima* (Prime-1864) of Dapoli Coast of Ratnagiri District

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ABSTRACT

Mangrove clam *Geloina proxima* is one of the dominant indigenous bivalves of Ratnagiri Coast. The study of Length-weight relationship of clam *G. proxima* was carried out during July 2017 to June 2018 to understand growth rate and its pattern. Average total length for males and females recorded was 65.40 mm and 65.25 mm, respectively, which is also supported by the calculation of the weight studies. It is interesting to note that in *G. proxima*, irrespective of the sex, there is a coordination between the length and weight relationship. In the present study significant difference was observed between the length-weight relationship to weight relationship of male and females of *G. proxima*. Analysis of results for length-weight relationship in *G. proxima* indicates negative allometric growth pattern. It is observed that weight of *G. proxima* bears a curvilinear relationship with the length that becomes linear on logarithmic transformation. The value of correlation coefficient in males was r = 0.97 while the same in females were r =0.98, which were found to be statistically highly significant. The coefficient of determination r^2 is an indication of goodness of fit of regression to the observed data. The closer it is to 1, the better is the fit.

Keywords : Mangrove, Geloina, Proxima, Length, Weight, Relationship, Dapoli

I. INTRODUCTION

Animals may be unicellular or multicellular of different phyla exhibit structural organization. Growth of an organism is the usually explained in terms of the changes that occur in its length, width, height and weight. However, many factors contribute to the changes in the individual parameters. This Growth process changing over time. Allometry is the study of the relationship between two measurable variables, or allometry is the study of size and its consequences [1]. The allometric principles of animal morphology have long been recognized, since the concept of allometry was first postulated[2]. Often growth is estimated by measuring shell dimensions or the volume of the animal [3] The length-weight relationship not only provides data to convert one factor to another, but also give indications of taxonomic differences, events in the

life history such as metamorphosis and the onset of maturity [4].

In bivalves, the size is directly related to its age, and the cumulative increase in biomass with respect to time is termed "absolute growth" while the percentage increase in biomass per unit time is "relative growth"[5]. The growth of certain bivalve species is not uniform throughout the year but there are certain periods of the growth such as poor growth, moderate growth and rapid growth.[6]

The shell size and thickness of the bivalves are related to the temperature. [7] The biology and functional morphology of the Southeast Asian mangrove bivalve, *Polymesoda (Geloina) erosa* (Solander 1786) (Bivalvia: Corbiculidae) and claimed that it is a sturdy animal and has excellent attributes for mariculture [8] *Polymesoda (Geloina) erosa* is a large and fleshy bivalve it can attains a shell length of up to 11 cm. [9] The bivalve growth and establishing allometric relationships are essential for generating useful information for managing resources and understanding changing environmental conditions and pollution. [10]

The relationships of shell length, shell height, and volume to ash-free dry weight in the zebra mussel- *Dreissena polymorpha* and the quagga mussel - *Dreissena bugensis* showed that before using shell measurement to estimate soft tissue growth in a bivalve population, the robustness of the relationship between the shell morphology and total tissue component should be established. [11] In ocean quahog, *Artica islandica* , physical and biological variables of habitat are known to affect the growth and can change the allometry between the shell and the flesh. [12] The growth of the *G. proxima* by length frequency method and related the same with gonado somatic index shows variations in gonado somatic values as per the spawning period. [13] The allometric relationship between shell length, width or volume to live weight can be used for monitoring the growth of this species in the natural population. [14] Though many researchers have made an attempt to study various parameters in different bivalves, very few researchers have made an attempt to study *G. proxima*.

II. MATERIAL AND METHODS

Sufficiently large number of the clams were collected monthly from selected localities of Dapoli coasts. All collected clams were washed thoroughly and labelled as per their collection locality. However, due to a wider range of clam size, regular samples do not represent the quantitative data for all size groups within the population. The clams were blotted and then left for a 10-15 minutes in air to allow the shell surface to dry before being measured and weighed. The morphometric variables recorded were total length, total weight of the whole specimen.

The measurements were done as total length (TL) (maximum distance on the anterior-posterior axis). Variables were measured to the nearest 0.01 mm with a Vernier caliper. Total weights (TW) to the nearest 0.01 g. (mg.) were determined after drying the shell with blotting paper on Contech electronic balance. The data obtained by making the use of sufficiently large number of clams. All these clams then grouped as per their size groups. Combined data of male and female were processed for the observations of the length- weight relationship. The details of the Length and weight measurement of male clam are given in the Tables.**1, 2, 3** and in **Fig.**1 while of the female clam given in the tables. **4,5,6** and in Fig. **2**

III. RESULTS AND DISCUSSION

Table: 1 : Monthly number and Percentage frequency of Male in Different Size groups

Table: 1: Monthly number and Percentage frequency of Male in Different Size groups.

Year and Month/ Size Group in mm.	July 2017		Aug.2017		Sept. 2017		Oct. 2017		Nov. 2017		Dec. 2017		Jan. 2018		Feb. 2018		Mar. 2018		April 2018		May 2018		June 2018		Animal used
	No.	%	No.	%	No	%	No.	%	No.	%	N0.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
00-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15-20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20-25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25-30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30-35	03	14.28	04	19.04	04	18.18	02	8.69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
35-40	02	9.52	03	14.28	02	9.09	02	8.69	01	5.55	04	16.66	01	4.34	01	5.26	01	4.16	-	-	-		01	3.84	18
40-45	01	4.76	-	-	01	4.54	02	8.69	02	11.11	02	8.33	04	17.39	01	5.26	05	20.83	-	-			-		18
45-50	02	9.52	02	9.52	01	4.54	05	21.73	03	16.66	01	4.16	03	13.04	03	15.78	02	8.33	01	4.34	-		02	7.69	25
50-55	03	14.28	03	14.28	03	13.63	01	4.34	01	5.55	04	16.66	03	13.04	02	10.52	01	4.16	02	8.69	02	9.09	01	3.84	26
55-60	01	4.76	03	4.76	01	4.54	02	8.69	02	11.11	-	-	04	17.39	04	21.05	-	-	03	13.04	03	13.63	05	19.23	28
60-65	03	14.28	-	-	02	9.09	03	13.04	01	5.55	03	12.5	02	8.69	02	10.52	01	4.16	03	13.04	03	13.63	04	15.38	27
65-70	-	-	02	9.52	04	18.18	02	8.69	03	16.66	03	12.5	02	8.69	03	15.78	02	8.33	01	4.34	01	4.54	02	7.69	24
70-75	02	9.52	-	-	02	9.09	01	4.34	02	11.11	02	8.33	01	4.34	02	10.52	04	16.66	04	17.39	02	9.09	02	7.69	24
75-80	01	4.76	01	4.76	01	4.54	02	8.69	02	11.11	03	12.3	03	13.04	-	-	04	16.66	02	8.69	02	9.09	03	11.53	25
80-85	02	9.52	-	-	01	4.54	01	4.34	-	-	01	4.16	-	-	01	-	02	8.33	03	13.04	03	13.63	03	11.53	17
85-90	01	4.76	01	4.76	-	-	-	-	01	5.55	01	4.16	-	-	-	-	02	8.33	02	8.69	03	13.63	01	3.84	12
90-95	-	-	02	9.52	-	-	-	-	-		-		-	-	-	-	-		02	8.69	02	9.09	01	3.84	07
95-100	-	-		-	-	-															01	4.54	01	3.84	02
Total	**21**	**100**	**21**	**100**	**22**	**100**	**23**	**100**	**18**	**100**	**24**	**100**	**23**	**100**	**19**	**100**	**24**	**100**	**23**	**100**	**22**	**100**	**26**	**100**	**266**

Table: 2. Length group wise morphometric measurements (range) of **Male** *G. proxima collected during* study.

Length Group (mm)	Number of Specimen	Length Range (mm)	Avg. Total Length (mm)	Total Weight Range (gms.)	Avg. Total Weight (gms)
30-35	13	31.45 - 34.2	33.52	7.2 – 9.3	8.7
35-40	18	35.4 - 39.2	37.21	10.8 - 13.7	12.5
40-45	18	40.4 - 44.6	43.08	13.7 - 24.6	17.9
45-50	25	45.3 - 49.5	48.11	24.6- 29.7	26.3
50-55	26	51.3 – 54.9	54.7	29.7- 43.8	38.5
55-60	28	56.1 - 59.1	58.2	44.1- 52.4	50.3
60-65	27	61.5 - 64.7	63.5	52.9 - 60.4	54.8
65-70	24	65.4 - 68.2	67.04	61.3 - 68.8	65.2
70-75	24	70.6 -74.6	72.6	69.2 - 78.1	74.8
75-80	25	76.2 - 79.1	78.9	79.6 - 86.3	84.3
80-85	17	81.7- 84.3	83.1	87.1- 89.7	88.2
85-90	12	85.5 - 88.3	87.6	90.4- 95.8	93.6
90-95	07	91.3 - 93.7	92.2	97.1- 104.3	102.6
95-100	02	95.4 - 96.3	95.85	104.8- 109.2	107.0
	266				

Table: 3: Total Length and Weight relationship (LWR) in Male – *G. Proxima*

Length Group (mm)	Number of Specimen	Avg. Total Length (mm) X	Avg. Weight (gms) Y	log X	log Y	X^2	Y^2	XY	Y = bx + a	Antilog of Y value = Calculated Weight
30-35	13	33.52	8.7	1.525304	0.939519	2.326552	0.882696	1.433052	1.025484	10.6
35-40	18	37.21	12.5	1.57066	1.09691	2.466972	1.203212	1.722872	1.13354	13.59
40-45	18	43.08	17.9	1.634276	1.252853	2.670857	1.569641	2.047507	1.285098	19.28
45-50	25	48.11	26.3	1.682235	1.419956	2.829916	2.016274	2.3887	1.399358	25.08
50-55	26	54.7	38.5	1.737987	1.585461	3.0206	2.513686	2.755511	1.532181	34.05
55-60	28	58.2	50.3	1.764923	1.701568	3.114953	2.895334	3.003136	1.596353	39.48
60-65	27	63.5	54.8	1.802774	1.738781	3.249993	3.023358	3.134628	1.686528	48.59
65-70	24	67.04	65.2	1.826334	1.814248	3.335496	3.291494	3.313422	1.742658	55.29
70-75	24	72.6	74.8	1.860937	1.873902	3.463085	3.511507	3.487212	1.825095	66.85
75-80	25	78.9	84.3	1.897077	1.925828	3.598901	3.708812	3.653443	1.911196	81.51
80-85	17	83.1	88.2	1.919601	1.945469	3.684868	3.784848	3.734523	1.964857	92.23
85-90	12	87.6	93.6	1.942504	1.971276	3.773322	3.885928	3.829211	2.019422	104.57
90-95	07	92.2	102.6	1.964731	2.011147	3.860168	4.044714	3.951363	2.072375	118.13
95-100	02	95.85	107.0	1.981592	2.029384	3.926707	4.118399	4.021411	2.112545	129.58
	266			$\sum X$= 25.11093	$\sum Y$= 23.3063	$\sum X^2$= 45.32239	$\sum Y^2$= 40.4499	$\sum XY$= 42.47599		

Number of group/Class (N) = 14

$\bar{X} = 1.793638$ $\bar{Y} = 1.664736$

Regression coefficient (b) = 2.3824

Correlation coefficient (r) = 0.97

Constant (a) = − 2. 6084

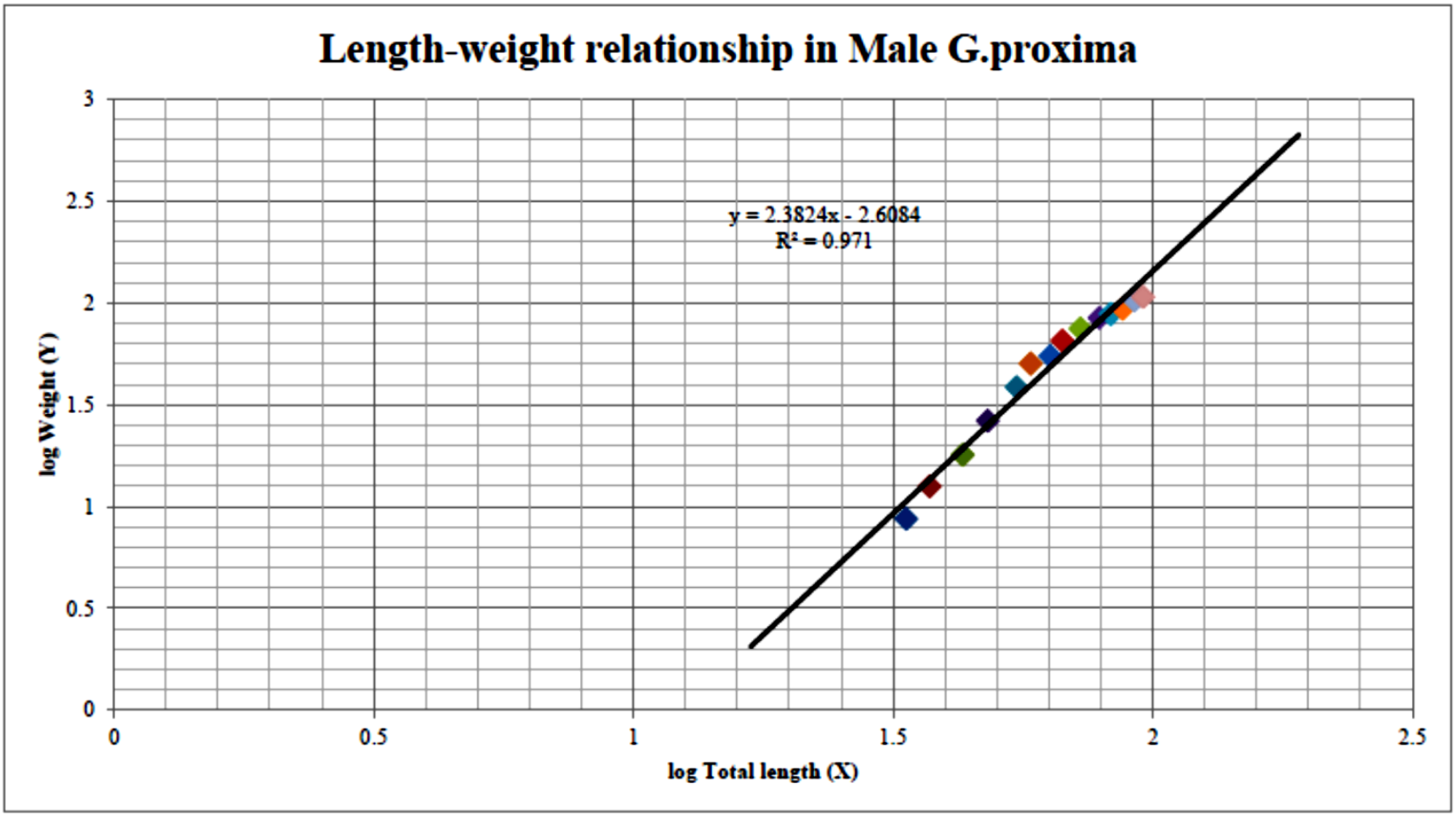

Fig. 1. Length- Weight relationship of Male *G. proxima.*

Table: 4. Monthly number and Percentage frequency of Female in Different Size groups.

Year and Month/ Size Group in mm.	July 2017		Aug.2017		Sept. 2017		Oct. 2017		Nov. 2017		Dec. 2017		Jan. 2018		Feb. 2018		Mar. 2018		April 2018		May 2018		June 2018		Animals used
	No.	%	No.	%	No.	%	No.	%	No.	%	N0.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
00-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15-20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20-25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25-30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
30-35	02	9.09	01	5	02	8.33	02	9.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	07
35-40	03	13.63	02	10	03	12.5	02	9.09	01	4.34	03	12.5	01	4.54	01	4.16	01	4.76	01	4.34	01	5.26	-		19
40-45	03	13.63	03	15	01	4.16	02	9.09	02	8.69	02	8.33	01	4.54	01	-	-	-	-	-	01	5.26	-		16
45-50	02	9.09	02	10	03	12.5	03	13.63	02	8.69	01	4.16	01	4.54	01	4.16	01	4.76	01	4.34	02	10.52	03	13.63	22
50-55	04	18.18	03	15	03	12.5	01	4.54	01	4.34	02	8.33	02	9.09	-	-	01	4.76	02	8.69	01	5.26	01	4.54	21
55-60	02	9.09	02	10	03	12.5	02	9.09	02	8.69	03	12.5	03	13.63	03	12.5	02	9.52	03	13.04	01	5.26	02	9.09	28
60-65	03	13.63	01	5	03	12.5	03	13.63	04	17.39	04	16.66	04	18.18	02	8.33	02	9.52	-	-	01	5.26	01	4.54	28
65-70	01	4.54	02	10	03	12.5	02	9.09	03	13.04	03	12.5	04	18.18	04	16.66	03	14.28	03	13.04	-	-	-	-	28
70-75	01	4.54	02	10	01	4.16	02	9.09	03	13.04	02	8.33	02	9.09	05	20.83	04	19.04	04	17.39	01	5.26	01	4.54	28
75-80	-	-	01	10	01	4.16	02	9.09	02	8.69	02	8.33	03	13.63	03	12.5	03	14.04	02	8.69	02	10.52	04	18.18	25
80-85	01	4.54	-		01	4.16	01	4.54	02	8.69	01	4.16	-	-	02	8.33	02	9.52	01	4.34	03	15.78	03	13.63	17
85-90	-		01		-	-	-	-	01	4.34	01	4.16	-	-	01	4.16	02	9.52	02	8.69	03	15.78	03	13.63	14
90-95	-		-		-	-		-				-	01	-	-	-		-	02	8.69	02	10.52	03	13.63	08
95-100	-				-	-		-							01	4.16		-	02	8.69	01	5.26	01	4.54	05
Total	**22**	100	**20**	**100**	**24**	**100**	**22**	**100**	**23**	**100**	**24**	**100**	**22**	**100**	**24**	**100**	**21**	**100**	**23**	**100**	**19**	**100**	**22**	**100**	**266**

Table: 5. Length group wise morphometric measurements (range) of **female** *G. proxima* collected during study

Length Group (mm)	Number of Specimen	Length Range (mm)	Avg. Total length (mm)	Total Weight Range (gms)	Avg. Total Weight (gms)
30-35	07	31.2- 34.6	33.7	09.1 - 14.8	13.1
35-40	19	35.3 - 38.7	36.22	14.8 - 19.2	16.3
40-45	16	41.2 - 43.6	42.51	20.1 - 27.3	24.8
45-50	22	45.7 - 48.2	47.21	29.8- 32.7	31.7
50-55	21	51.5 – 54.2	53.4	33.5- 44.8	42.6
55-60	28	56.6 - 59.4	58.7	45.8- 53.7	52.8
60-65	28	60.8 - 63.8	62.8	54.9 - 63.1	60.2
65-70	28	65.2 - 69.1	68.1	64.4 - 71.2	69.4
70-75	28	71.6 - 73.9	72.7	72.1 - 80.2	78.6
75-80	25	75.3 - 78.8	77.5	81.6 - 89.7	88.2
80-85	17	80.6- 84.1	82.8	89.8- 97.2	96.5
85-90	14	86.2 - 89.3	88.4	97.4- 105.4	102.4
90-95	08	91.4 - 94.6	93.2	106.1- 109.8	106.6
95-100	05	95.2 - 97.2	96.3	109.8 - 115.3	112.7
	266				

Table: 6: Total Length and Weight relationship (LWR) in **female** – *G. proxima*

Length Group (in mm)	Number of specimen	Avg. Total length (mm) X	Avg. Weight (gms) Y	log X	log Y	X^2	Y^2	XY	Y = bx +a	Antilog of Y value = Calculated Weight
30-35	07	33.7	13.1	1.52763	1.117271	2.333653	1.248295	1.706777	1.183879	15.27
35-40	19	36.22	16.3	1.558948	1.212188	2.43032	1.469399	1.889738	1.247728	17.68
40-45	16	42.51	24.8	1.628491	1.394452	2.651983	1.944495	2.270852	1.389505	24.51
45-50	22	47.21	31.7	1.674034	1.501059	2.80239	2.253179	2.512824	1.482353	30.36
50-55	21	53.4	42.6	1.727541	1.62941	2.984399	2.654976	2.814872	1.591438	39.03
55-60	28	58.7	52.8	1.768638	1.722634	3.128081	2.967468	3.046716	1.675222	47.34
60-65	28	62.8	60.2	1.79796	1.779596	3.232659	3.166964	3.199643	1.735	54.33
65-70	28	68.1	69.4	1.833147	1.841359	3.360428	3.390605	3.375483	1.806737	64.08
70-75	28	72.7	78.6	1.861534	1.895423	3.46531	3.592627	3.528394	1.86461	73.21
75-80	25	77.5	88.2	1.889302	1.945469	3.569461	3.784848	3.675577	1.921219	83.41
80-85	17	82.8	96.5	1.91803	1.984527	3.67884	3.938349	3.806384	1.979788	95.45
85-90	14	88.4	102.4	1.946452	2.0103	3.788676	4.041306	3.912953	2.037732	109.08
90-95	08	93.2	106.6	1.969416	2.027757	3.878599	4.111799	3.993497	2.084548	121.49
95-100	05	96.3	112.7	1.983626	2.051924	3.934773	4.210392	4.07025	2.113519	129.87
	266			$\sum X$= 25.08475	$\sum Y$= 24.11337	$\sum X^2$= 45.23957	$\sum Y^2$= 42.7747	$\sum XY$= 43.80396		

Number of group/Class (N) =14

$\bar{X}$ = 1.791768

$\bar{Y}$ = 1.722383

Regression coefficient (b) = 2.0387

Correlation coefficient (r) = 0.98

Constant (a) = − 1.9305

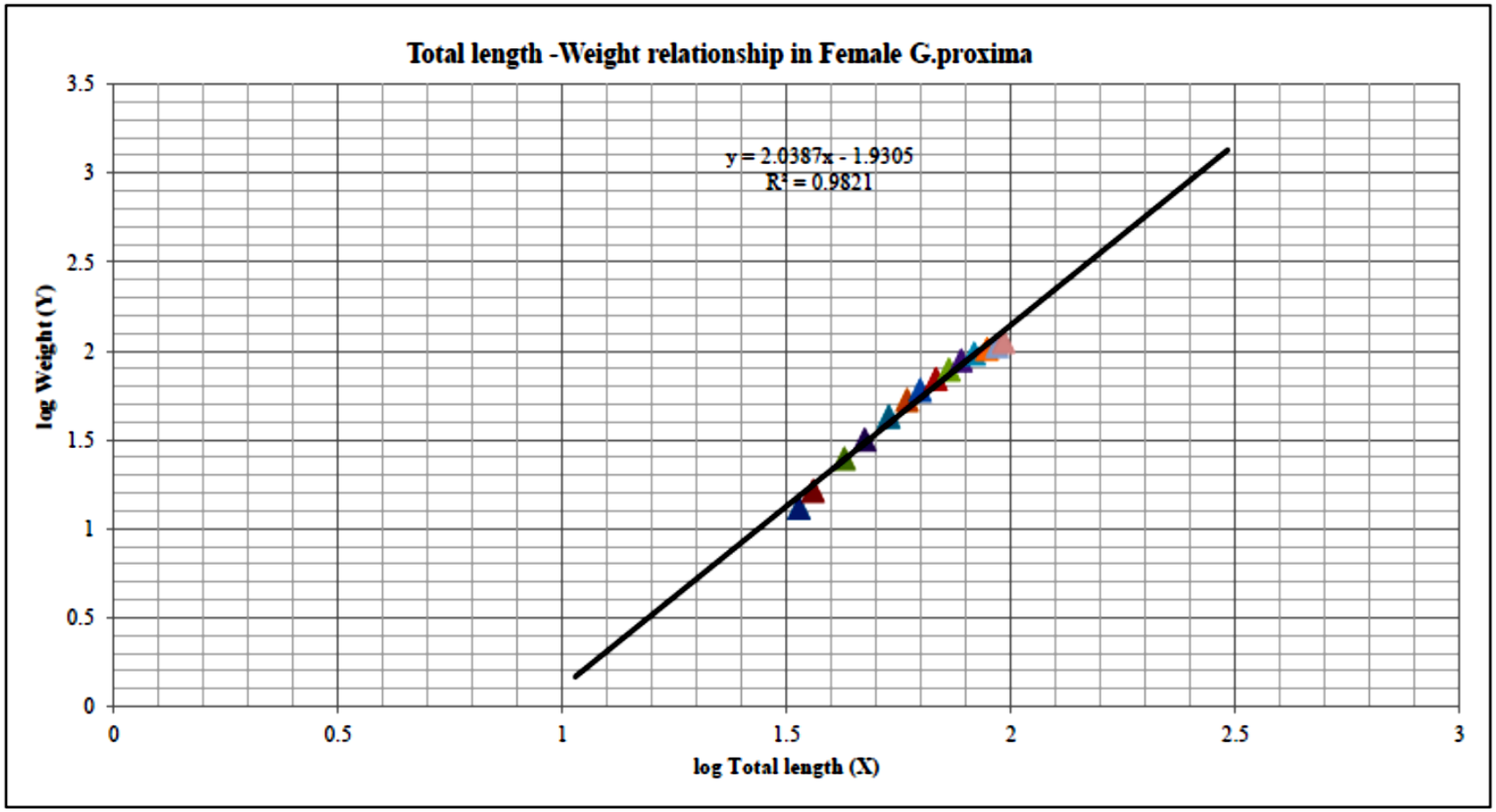

Fig. 2: Length- Weight relationship of female *G. proxima.*

Discussion

G. proxima was found dispersed randomly in the intertidal mud flat and around the mangrove roots throughout the year. *G. proxima* as per its continuous occurrence along the vicinity of the mangrove vegetation of the Dapoli coast indicates that certain bivalve species like oysters and *G. proxima* have firm and inseparable relationship with this mangrove habitats.

To understand growth rate and its pattern, the length and weight parameters were studied. In *G. proxima*, it was observed that smallest animal (length wise) was in male 31.45 mm. and in female 31.2 mm. and both found in the month of July. The male animal of smallest length group (30 - 35mm) were also recorded in the month of June, July, August, September and October. While the female animals of smallest length group (30-35mm) were also observed in the month of July, August, September and October. However, the largest male clam was observed in the month of May with 96.3mm. in length while largest female clam was observed in the month of May with 97.2 mm. length.

Average total length for males and females recorded was 65.40 mm and 65.25 mm, respectively, which is also supported by the calculation of the weight studies. The weight of the male and female animal was also small during the same month. This hold good even for the maximum length and weight of the male and female animal respectively in the month of May.

It is interesting to note that in *G. proxima*, irrespective of the sex, there is a coordination between the length and weight relationship. It means that as the length of the animal increases, the weight is also gained by the animal. It is placed on the record that, the average length of the male clam is 65.40 mm. and average weight of the male clam is 58.90 gm. While the average length of the female clam is 65.25 mm. and average weight of the female clam is 63.99 gm. In the present study significant difference was observed between the length-weight relationship to weight relationship of male and females of *G. proxima*. Park and Oh (2002) [15] when, studying the length-weight relationship of 12 species of bivalves observed that of this, eight species showed isometric growth at 95% confidence limit of b. Gaspar et al. (2001) [16] studied six species of clams of Veneridae family and found that two species showed isometric growth. In Isometric growth, the growth in length is accompanied by weight increase. In Positive allometric growth, the weight increase is even superior to the growth in length. In negative allometric growth, the growth in length is superior to the weight increase. In the relationships between different types of variables (linear and Length-weight relationships reflects an isometric growth when b=3, i.e. relative growth of both variables is identical [17]. When b<3, it can be said to have a negative allometric growth and is defined as hypo allometry; instead when b>3, it showed a positive allometric growth and is defined hyper allometry[18] .

- The length-weight relationship of male and female *G. proxima* was are as follows:
- MALE : Log W = −2.6084 + 2.3824 Log L
- FEMALE : Log W = −1.9305 + 2.0387 Log L

The value of exponent 'b' for males was 2.3824 and that for females was 2.0387. Analysis of results for length-weight relationship in *G. proxima* indicates negative allometric growth pattern. It is observed that weight of *G. proxima* bears a curvilinear relationship with the length that becomes linear on logarithmic transformation. The value of correlation coefficient in males was r = 0.97 while the same in females were r =0.98, which were found to be statistically highly significant. The coefficient of determination r^2 is an indication of goodness of fit of regression to the observed data. The closer it is to 1, the better is the fit. The significant difference in growth of the bivalve shell valves and the inner soft body tissue may be created due to environmental factors or variations in the reproductive cycle of the bivalve. Soft body of the bivalve are mainly involved in the carrying out the living processes of the animal, not the shell. With these different morphometric measurements, it is concluded that *G. proxima* shows extended period of breeding, spawning and consequently the reproduction.

Conclusion

It is interesting to note that in *G. proxima*, irrespective of the sex, there is a coordination between the length and weight relationship. It means that as the length of the animal increases, the weight is also gained by the animal.

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