Fishery Technology
1995, Vol. 32 (1) pp : 6 - 13

Allometric Relationships in the Mussel, *Musculista senhausia* from Cochin Backwaters*

K. Shiny Sreedhar and C.K. Radhakrishnan**
School of Marine Sciences
Cochin University of Science and Technology
Cochin - 682 016, India

The allometry of a population of *Musculista senhausia* (Benson) were studied during the period from February 1987 to June 1988. Monthly samples were taken from Cochin backwaters and the allometric relationships between length and height, depth, total weight, flesh weight and shell weight were determined. The relationships are described by regression analysis of pairs of variables. Covariance analysis of the data revealed significant monthly differences in these relationships except in length-height and the factors causing these fluctuations are discussed.

Key words : ***Musculista senhausia*, allometric relationships, Cochin backwaters.**

Musculista senhausia (Benson) is an inhabitant of Cochin backwater (Sreedhar, 1991) which is mainly used as poultry feed. The relationships between different shell dimensions and soft-body characters are important parameters in the studies of ecological variation and productivity. Several attempts have been reported to study allometric relationships in mussels like *Mytilus viridis* (Rao *et al.*, 1975), *Modiolus metcalfei* (Parulekar *et al.*, 1978), *Perna viridis* (Shafee, 1975; Mohan, 1980; Chatterji *et al.*, 1984). Knowledge of allometry is essential to fully understand the growth of a species. This paper describes variations in the allometric relationships in *M. senhausia* from Cochin waters.

Materials and Methods

M. Senhausia was collected fortnightly from the natural bed of Cochin backwater during the period from February 1987 to June 1988 using a van Veen grab of 0.05 m^2. In the laboratory, mussels were kept in aerated water of habitat salinity for 24 h for depuration. Length (greatest antero-posterior measurement), height (maximum distance between the hinge and the ventral margin of the valve) and depth (greatest distance between the outer surface of the two valves measured in a direction perpendicular to the antero-posterior axis) of 1925 mussels were measured with vernier calipers to the nearest 0.05 mm. Total weight, flesh weight and shell weight were determined to the nearest 0.1 mg in an electric balance.

The relation of height, depth and different weights on length were studied by fitting the regression equation of the type $Y = a + bX$; where Y is the dependent variable, X the independent variable, a the constant and b the regression coefficient estimated by least square regression analysis. Where required logarithmic transformation was applied. Length was taken as an independent variable in all studies. The allometric relationships between length and height, length and depth, length and total weight, length and flesh weight, and length and shell weight in different months were studied and compared.

Results and Discussion

All morphometric relationships and length-weight relationships studied showed

* Formed part of the Ph.D. thesis of the first author approved by Cochin University of Science and Technology.
** Present Address : S.N. Nivas, Kuthiathode, Cherthala - 688 533, India

linear growth pattern. The coefficient of correlation of different allometric relationships were calculated using Pearson's formula (Snedecor & Cochran, 1968) and the a, b and r values obtained are shown in Tables 1-5. Covariance analysis of the various relationships between different dimensions by month is given in Tables 6-10.

Covariance analysis of the linear regression of logarithm of height on logarithm of length during various months resulted in a non-significant F value of 0.34 (Table 6) indicating absence of seasonal variation. But the analysis of covariance between length and depth was significant ($F = 6.44$, $p < 0.01$) (Table 7). The analysis of covariance of the linear regression of logarithm of total weight on logarithm of length also showed significance ($F = 5.17$, $p < 0.01$) (Table 8). Here maximum growth was observed in June. Covariance analysis between length and flesh weight showed a significant difference in the regression coefficients between months ($F = 7.95$, $p < 0.01$) (Table 9). Between length and shell weight also covariance analysis showed a significant F value of 9.95 ($p < 0.01$) (Table 10). Here maximum growth was observed during April. Besides, the correlation coefficients of different dimensions worked out (Tables 1-5) were also significant ($p < 0.01$), indicating that linear regression is a good fit for the data.

Length-height relationship showed no significant difference in different months which indicates that these parameters have a constant relative growth. Jones (1979) observed a homogenous length-height values in *Cerastoderma edule* and reported that these were unaffected by season. Variation in length-depth relationship in different months could be correlated with the development of internal organs in relation to reproductive cycle. The lowest value observed in July may be the result of poor growth because of low saline conditions during monsoon season.

Difference in length-shell weight relationship were found to be due to the difference in shell thickness and height in different months. The decrease in shell weight during June and July may be the result of the stress due to low saline conditions. Variation in length-total weight and length-flesh weight relationships can be explained on the basis of the differences in different phases of life (Sreedhar, 1991). Up to maturity the animal shows rapid growth. The lowest value observed during March, April and May (Tables 8 & 9) seems to be largely due to spawning and subsequent gonad regression. Again in June a high value was observed indicating the normal growth of the new recruits. The increase in growth in the rest of the months may be largely due to somatic tissue growth and accumulation of food reserves before sexual maturity. Hancock & Franklin (1972) correlated seasonal variation in length-tissue weight relationship in *Cardium edule* with reproductive cycle and food availability. Jones *et al.* (1978) have got similar results in *Patella vulgata*. Jones (1979) also reported a variation in length-tissue weight relationship in *Cerastoderma edule* according to the breeding cycle and food availability. Likewise, *Donax incarnatus* inhabiting the Panambur beach near Mangalore also showed high growth rate in connection with sexual maturity (Thippeswamy & Joseph, 1992). In the present study 'b' value observed was between 2.4 and 3.2, an observation that is consistent with reports by Wilber & Owen (1964), Rao *et al.* (1975), and Shafee (1976). According to them the values of 'b' lie between 2.4 and 4.5. Thippeswamy & Joseph (1992) opined that the high equilibrium constant (b) values indicate gonadal growth and high condition index. It is

Table 1. Allometric relationship between length and height in *Musculista senhausia*

Month	N	Length, mm	Height, mm	a	b	r
February 1987	255	8.6-22.6	4.1-11.6	-0.2180	0.9030	0.9710
March	108	5.6-21.9	3.1-9.6	-0.2691	0.9510	0.9711
April	45	16.6-26.9	7.2-12.1	-0.2020	0.8960	0.9510
May	51	11.3-29.3	5.6-13.5	-0.2690	0.9399	0.9377
June	50	16.6-25.6	7.6-12.2	-0.2236	0.9108	0.9840
July	50	8.6-19.7	3.9-8.6	-0.0970	0.7956	0.9206
December	59	8.1-19.1	3.8-9.6	-0.2022	0.9037	0.9727
January 1988	192	6.4-29.6	3.1-11.1	-0.2541	0.9293	0.9851
February	145	12.7-21.1	5.5-9.6	-0.2508	0.9295	0.9069
March	116	14.6-23.1	6.7-10.6	-0.2781	0.9460	0.7298
April	175	11.3-24.2	5.1-11.3	-0.2901	0.9545	0.9540
May	268	6.9-18.4	3.2-8.6	-0.2689	0.9410	0.9690
June	411	5.6-15.9	2.7-7.7	-0.2013	0.8913	0.9191

Table 2. Allometric relationship between length and depth

Month	N	Length, mm	Depth, mm	a	b	r
February 1987	255	8.6-22.6	2.7-7.7	-0.4050	0.9630	0.9560
March	108	5.6-21.9	2.1-7.5	-0.4934	1.0124	0.9315
April	45	16.6-26.9	5.4-9.2	-0.3960	0.9510	0.9380
May	51	11.3-29.3	4.1-9.4	-0.3092	0.8788	0.8078
June	50	16.6-25.6	5.3-9.8	-0.5731	1.0995	0.9827
July	50	8.6-19.7	2.8-7.1	-0.2952	0.8595	0.8928
December	59	8.1-19.1	2.3-6.6	-0.5867	1.1037	0.9484
January 1988	192	6.4-29.6	1.8-8.6	-0.6809	1.1555	0.9705
February	145	12.7-21.1	4.2-7.3	-0.3884	0.9334	0.8567
March	116	14.6-23.1	4.7-7.8	-0.3920	0.9266	0.8901
April	175	11.3-24.2	3.4-8.3	-0.5052	1.0168	0.9000
May	268	6.9-18.4	2.1-7.6	-0.5194	1.0296	0.9390
June	411	5.6-15.9	1.8-5.7	-0.4796	1.0146	0.8857

Table 3. Allometric relationship between length and total weight

Month	N	Length, mm	Total wt., mg	a	b	r
February 1987	255	8.6-22.6	27.5-439.9	-0.1650	2.8860	0.9830
March	108	5.6-21.9	9.2-489.9	-0.1928	2.8401	0.9791
April	45	16.6-26.9	194.9-805.8	-0.8720	2.6500	0.9640
May	51	11.3-29.3	71.1-784.8	-0.7901	2.5858	0.9315
June	50	16.6-25.6	178.9-590.1	-1.3805	3.0362	0.9878
July	50	8.6-19.7	33.8-390.1	-0.7633	2.5422	0.9651
December	59	8.1-19.1	27.2-368.2	-0.9376	2.7403	0.9804
January 1988	192	6.4-29.6	13.2-693.8	-1.1634	2.8819	0.9921
February	145	12.7-21.1	94.3-473.0	-1.0426	2.8214	0.9304
March	116	14.6-23.1	184.1-572.2	-0.5641	2.4213	0.9406
April	175	11.3-24.2	55.6-800.1	-1.0768	2.7780	0.9430
May	268	6.9-18.4	20.4-380.9	-0.9908	2.7332	0.9690
June	411	5.6-15.9	10.1-199.1	-0.9920	2.7776	0.9606

Table 4. Allometric relationship between length and flesh weight

Month	N	Length, mm	Flesh wt., mg	a	b	r
February 1987	255	8.6-22.6	15.4-291.4	-1.5860	3.0640	0.9710
March	108	5.6-21.9	4.3-318.1	-1.5001	2.9197	0.9614
April	45	16.6-26.9	136.1-571.2	-0.8870	2.5385	0.9400
May	53	11.3-29.3	54.2-558.7	-0.9015	2.5492	0.8982
June	50	16.6-25.6	106.8-354.8	-1.7729	3.1941	0.9833
July	50	8.6-19.7	20.8-275.8	-1.1544	2.7180	0.9539
December	59	8.1-19.1	17.1-262.1	-1.2154	2.8397	0.9741
January 1988	192	6.4-29.6	6.1-455.6	-1.6362	3.1213	0.9878
February	145	12.7-21.1	50.0-304.1	1.6233	3.1327	0.8965
March	116	14.6-23.1	114.9-376.3	-0.7450	2.4058	0.8994
April	175	11.3-24.2	28.7-385.1	-1.1936	2.7183	0.9170
May	268	6.9-18.4	14.3-239.8	-1.2638	2.7972	0.9551
June	411	5.6-15.9	5.7-139.3	-1.4326	3.0341	0.9522

Table 5. Allometric relationship between length and shell weight

Month	N	Length, mm	Shell wt., mg.	a	b	r
February 1987	255	8.6-22.6	12.1-159.9	-0.2600	2.6130	0.9820
March	108	5.6-21.9	4.9-171.8	-1.4148	2.6790	0.9722
April	45	16.6-26.9	58.8-239.8	-1.7120	2.8980	0.9730
May	51	11.3-29.3	16.9-325.8	-1.3824	2.6457	0.9482
June	50	16.6-25.6	72.1-276.2	-1.5228	2.7901	0.9842
July	50	8.6-19.7	10.1-115.9	-0.8747	2.2411	0.9246
December	59	8.1-19.1	10.1-114.9	-1.2060	2.5333	0.9771
January 1988	192	6.4-29.6	7.1-238.2	-1.1774	2.5088	0.9900
February	145	12.7-21.1	44.3-173.9	-0.8848	2.3352	0.9017
March	116	14.6-23.1	67.8-214.2	-0.9757	2.4049	0.9333
April	175	11.3-24.2	24.4-415.0	-1.6238	2.8569	0.9661
May	268	6.9-18.4	6.1-140.1	1.3944	2.7095	0.9661
June	411	5.6-15.9	4.1-59.8	-1.0209	2.3398	0.9401

Table 6. Analysis of covariance of linear regression of logarithm of shell height on logarithm of shell length

Month	N	df	Regression coefficient	Deviation from regression		
				df	ss	ms
February 1987	255	254	0.9034	253	0.0985	0.0004
March	108	107	0.9510	106	0.0341	0.0003
April	45	44	0.8959	43	0.0240	0.0006
May	51	50	0.9394	49	0.0143	0.0003
June	50	49	0.9107	48	0.0389	0.0008
July	50	49	0.7955	48	0.0175	0.0004
December	59	58	0.9037	57	0.0198	0.0004
January 1988	192	191	0.9293	190	0.0757	0.0005
February	145	144	0.9294	143	0.0481	0.0003
March	116	115	0.9461	114	0.1865	0.0016
April	175	174	0.9545	173	0.0565	0.0003
May	268	267	0.9410	266	0.1052	0.0004
June	411	410	0.8913	409	0.1708	0.0004
Pooled	1925	1912	0.9187	1911	0.8918	0.0005
				1899	0.8899	0.0005
	Difference between slopes			12	0.0019	0.0002

$F(12, 1899) = 0.3377$

Table 7. Analysis of covariance of linear regression of logarithm of shell depth on logarithm of shell length

Month	N	df	Regression coefficient	Deviation from regression		
				df	ss	ms
February 1987	255	254	0.9630	253	0.1660	0.0007
March	108	107	1.0123	106	0.0974	0.0009
April	45	44	0.9506	43	0.0346	0.0008
May	51	50	0.8787	49	0.0482	0.0010
June	50	49	1.0994	48	0.0615	0.0013
July	50	49	0.8599	48	0.0289	0.0006
December	59	58	1.1036	57	0.0582	0.0010
January 1988	192	191	1.1555	190	0.2375	0.0013
February	145	144	0.9332	143	0.0815	0.0006
March	116	115	0.9268	114	0.0534	0.0005
April	175	174	1.0167	173	0.1529	0.0009
May	268	267	1.0296	266	0.2603	0.0010
June	411	410	1.0141	409	0.5523	0.0014
Pooled	1925	1912	1.0456	1911	1.9072	0.0010
				1899	1.8327	0.0010
	Difference between slopes			12	0.0746	0.0062

F (12, 1899) = 6.4408

Table 8. Analysis of covariance of linear regression of logarithm of total weight on logarithm of shell length

Month	N	df	Regression coefficient	Deviation from regression		
				df	ss	ms
February 1987	255	254	2.8865	253	0.5605	0.0022
March	108	107	2.8400	106	0.2173	0.0021
April	45	44	2.6494	43	0.1507	0.0035
May	51	50	2.5850	49	0.1197	0.0024
June	50	49	3.0361	48	0.3267	0.0068
July	50	49	2.5422	48	0.0735	0.0015
December	59	58	2.7403	57	0.1293	0.0023
January 1988	192	191	2.8819	190	0.3819	0.0020
February	145	144	2.8214	143	0.3181	0.0022
March	116	115	2.4213	114	0.1814	0.0016
April	175	174	2.7780	173	0.6051	0.0035
May	268	267	2.7331	266	0.8889	0.0033
June	411	410	2.7770	409	1.2627	0.0031
Pooled	1925	1912	2.8288	1911	5.3865	0.0028
				1899	5.2160	0.0027
	Difference between slopes			12	0.1705	0.0142

F (12, 1899) = 5.1740

Table 9. Analysis of covariance of linear regression of logarithm of flesh weight on logarithm of shell length

Month	N	df	Regression coefficient	Deviation from regression		
				df	ss	ms
February 1987	255	254	3.0644	253	1.1056	0.0044
March	108	107	2.9197	106	0.4363	0.0041
April	45	44	2.5385	43	0.2392	0.0056
May	51	50	2.5483	49	0.1827	0.0037
June	50	49	3.1939	48	0.5007	0.0104
July	50	49	2.7183	48	0.1128	0.0023
December	59	58	2.8397	57	0.1856	0.0033
January 1988	192	191	3.1213	190	0.6996	0.0037
February	145	144	3.1328	143	0.6176	0.0043
March	116	115	2.4057	114	0.3250	0.0029
April	175	174	2.7183	173	0.8811	0.0051
May	268	267	2.7972	266	1.3793	0.0052
June	411	410	3.0342	409	1.8494	0.0045
Pooled	1925	1912	2.9857	1911	8.9426	0.0047
				1899	8.5148	0.0045
	Difference between slopes			12	0.4278	0.0356

F (12, 1899) = 7.9499

Table 10. Analysis of covariance of linear regression of logarithm of shell weight on logarithm of shell length

Month	N	df	Regression coefficient	Deviation from regression		
				df	ss	ms
February 1987	255	254	2.6130	253	0.4699	0.0019
March	108	107	2.6788	106	0.2599	0.0025
April	45	44	2.8977	43	0.1330	0.0031
May	51	50	2.6448	49	0.0922	0.0019
June	50	49	2.7900	48	0.3608	0.0075
July	50	49	2.2406	48	0.1317	0.0027
December	59	58	2.5333	57	0.1300	0.0023
January 1988	192	191	2.5088	190	0.3691	0.0019
February	145	144	2.3354	143	0.3227	0.0023
March	116	115	2.4049	114	0.2035	0.0018
April	175	174	2.8569	173	0.6795	0.0039
May	268	267	2.7094	266	0.9620	0.0036
June	411	410	2.3399	409	1.4062	0.0034
Pooled	1925	1912	2.5864	1911	5.8675	0.0031
				1899	5.5205	0.0029
	Difference between slopes			12	0.3470	0.0289

F (12, 1899) = 9.9456

apparent from these accounts that while shell length-shell height relationships tended to be stable in *Musculista senhausia* population, some differences occurred in other allometric relationships which could be attributed to physiological and ecological variations.

The authors are thankful to the Director, School of Marine Sciences, Cochin University of Science and Technology, Cochin for providing facilities to undertake the work.

References

Chatterji, A., Ansari, Z.A., Ingole, B.S. & Parulekar, A.H. (1984) *Aquaculture*, **40**, 47

Hancock, D.A. & Franklin, A. (1972) *J. Appl. Ecol.* **9**, 567

Jones, A.M. (1979) *J. Mar. Biol. Ass. U.K.* **59**, 277

Jones, A.M., Jones, Y.M. & Baxter, J.M. (1978) in *Cyclic Phenomena in Marine Plants and Animals* (Naylor, E. & Hartnoll, R.G., Eds.), p. 199, Pergamon press, Oxford, UK

Mohan, M.V. (1980) *Indian J. Mar. Sci.* **9**, 224

Parulekar, A.H., Ansari, Z.A., Harkantra, S.N. & Nair, A. (1978) *Indian J. Mar. Sci.* **7**, 51

Rao, K.V., Krishnamurthy, L. & Dwivedi, S.N. (1975) *Indian J. Mar. Sci.* **4**, 189

Shafee, M.S. (1976) *Indian J. Fish.* **23**, 1

Snedecor, G.W. & Cochran, W.G. (1968) *Statistical Methods*, 6th edn., p. 593, The Iowa State University Press, Iowa, USA

Sreedhar, K.S. (1991) *Studies on the biology of the bivalve Musculista senhausia (Benson) from Cochin waters*, Ph.D. thesis, Cochin University of Science and Technology, Cochin, India

Thippeswamy, S. & Joseph, M.M. (1992) *Indian J. Mar. Sci.* **21**, 161

Wilber, K.M. & Owen, G. (1964) in *Physiology of Mollusca* (Wilber, K.M. & Young, C.M., Eds.), p. 211, Academic Press, New York, USA