J. Mar. biol. Ass. India, 1962, 4 (2): 198-205

OBSERVATIONS ON THE LENGTH-WEIGHT RELATIONSHIP OF PEARL OYSTERS

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INTRODUCTION

THE data taken up for analysis are from ' Results obtained at the Pearl oyster Farm, Krusadai Island, Gulf of Mannar, and their application to problems relating to pearl fisheries in the Gulf of Mannar—Part I,' by Devanesan and Chidambaram (1956), which shall hereafter be referred to simply as the ' Report '. ' Several appendices of measurements and body weights are appended to this report not only for reference but also with the object of stimulating other interested workers to try and isolate more precious metal from the inadequately assayed ore.' It is found from the Report that the analysis done was only on age and length, age and body weight and age, length and body weight and that too limited to oysters up to the one and half year age group only. Direct analysis on length-weight relationship alone had not been attempted. Since not much of work has so far been done on the length-weight relationship of Indian oysters, some of the raw data given in the Report were taken up for detailed analysis in an attempt to see whether any relationship exists between length and weight and if so, whether the relationship was the same for different groups and, if different, the probable reasons for the same and also to provide a better yardstick for predicting the time for pearl fishing.

METHOD

Length-weight measurements for the first three year groups only were taken up for analysis in view of the irregular growth pattern concerning length in the subsequent years. Let ' A ' denote the data relating to the spats collected in 1933 (Appendix I of the Report) and ' B ' that of 1934 (Appendix II) and ' C ' that of 1939 (Appendix III). The subscripts for A, B, and C, denote their respective age groups, as for instance, A_3 means the measurements of third year age group of oysters belonging to group ' A '. Since weight measurements have not been given in the Report, for A_1, A_2, and B_1, for this study, the data of A_3, B_2, B_3 and C_1, C_2 and C_3 only were taken up. At the outset it might be pertinent to point out some of the drawbacks of these data. There appeared to be some discrepancies, perhaps due to printing errors in the body of the data, as for instance some of the figures given in Appendix VI do not tally with the corresponding figures in Appendices I, II and III. Apart from this the measurements were taken by five different persons on different occasions during the period 1933-42. These factors would certainly contribute to various ' error components '.

OBSERVATIONS

Length-weight relationship was estimated separately for different age groups of different broods. This analysis indicates that the relationship between length

and weight in oysters (figs. 1 and 2) is linear ($W=a+bL$) unlike in the case of fishes where the relation is of the form $W=aL^n$. Length-weight regressions of identical year classes belonging to different broods (viz. A_3, B_3 and C_3) were found

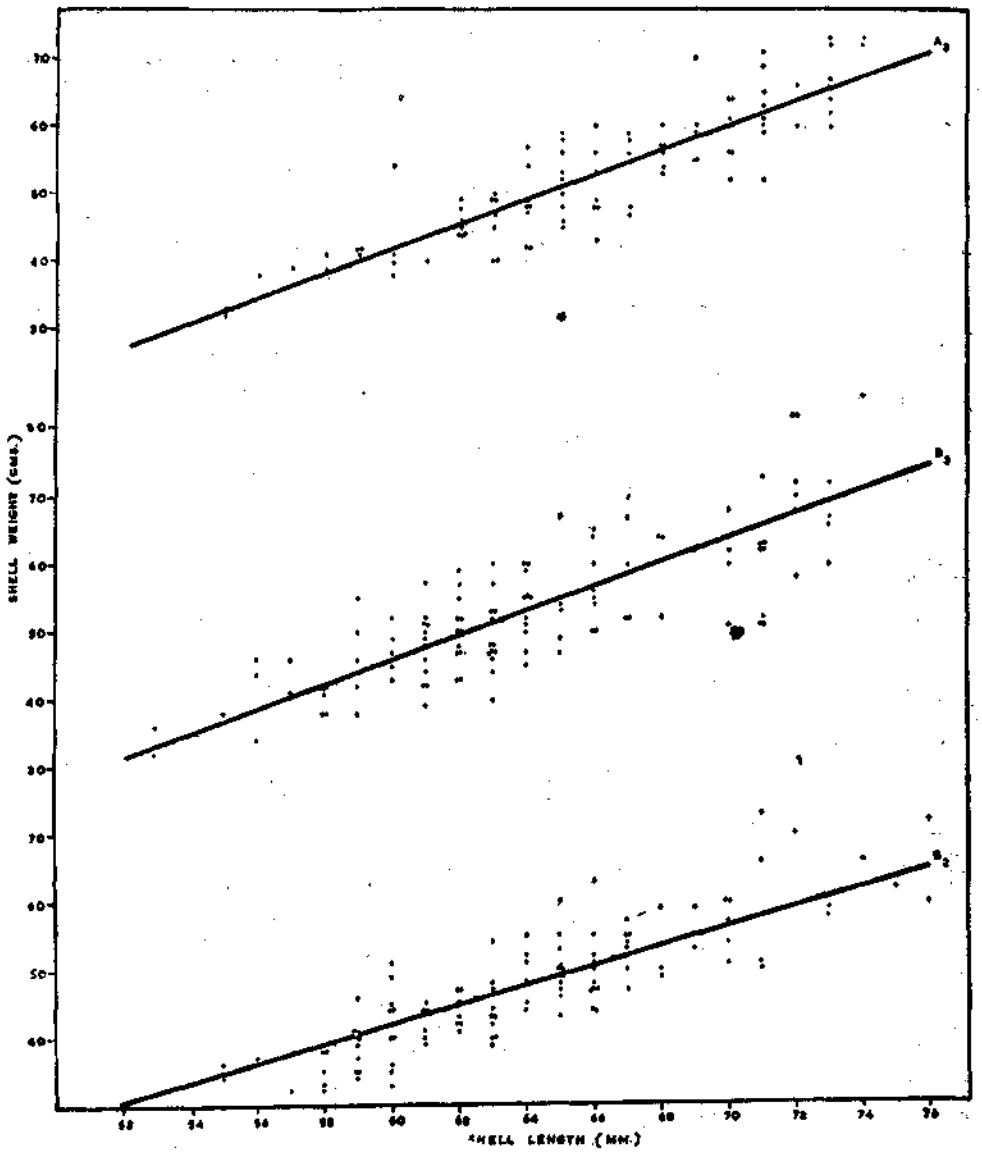

FIG. 1. Regression lines for Pearl Oysters belonging to the groups A_3, B_2 & B_3.

to be significantly different at 1% level. Further, equality of slopes when tested was found to be significantly different at 5% level, but not so at 1% level. When the same tests were performed on A_3 and B_3 alone it was found that the lines were not identical but the slopes were not significantly different at 5% level (Table III).

Similar tests were made on B_2 and C_2 (Table III) and it was found that the lines were significantly different at 1% level and their slopes were also significantly

TABLE I

Equations of the regression lines

Source	*Equation*	*Correlation coefficient*
A_3	$W = -68.03 + 1.8318\ L$	0.8829
B_2	$W = -57.19 + 1.6355\ L$	0.8523
B_3	$W = -60.82 + 1.7818\ L$	0.8242
C_1	$W = -40.41 + 1.2906\ L$	0.8201
C_2	$W = -33.29 + 1.3147\ L$	0.7776
C_3	$W = -32.94 + 1.3646\ L$	0.7566

Where W denotes weight and L denotes length.

different at 5% level but not so at 1% level. The tests on B_2 and B_3 (Table III) showed that the lines were significantly different at 1% level but their slopes were not significantly different even at 5% level. The tests on C_1, C_2 and C_3 (Table III) gave similar results. But when combined test was made on A_3, B_2, B_3, C_1, C_2 and C_3 (Table III) the lines were found to be significantly different, as well as their slopes at 1% level. Coefficients of correlation were also derived (Table I) for these groups and the apparent linearity, when tested, could be found to be highly significant (Table II).

DISCUSSION

The significance of the parameters ' a ' and ' b ' ($W = a + bL$) was not known, unlike in the case of fishes. Further studies in the laboratory might give some information about these parameters. In the absence of above studies it is difficult to draw any conclusions based on the values of these parameters. However, the linear relationship $W = a + bL$ being the solution of the differential equation $\frac{dW}{dL} = b$, changes in factors that affect simultaneously the growth in weight as well as in length, might not affect the value of ' b ' much. Cole & Waugh (1959) observed that ' for fattening an abundance of available and rich food material is presumably indispensable but for rapid shell growth sustained high water temperatures seem to be of major importance '. Hence if there was not much of fluctuation in factors like temperature and availability of food from year to year then no significant difference in ' b ' values of different age groups could be expected. Non-significant difference in ' b ' values of A_3 and B_3 might then be due to similar conditions in temperature as well as in the availability of food in both the periods. But data on neither of these factors were appended in the Report for these years to confirm the above statement.

It is interesting to note that the mortality rates in group A were higher than in group B (Table IV taken from Table I of the Report). The reasons given for this were

' (1) the partial transport by rail ; in a lot of 102 spats 42 died three days after arriving into the Farm ; this means of transport was not resorted to therefore subsequently.

TABLE II

Calculated sums of squares etc. for analysis (corrected sums of squares)

Source	*Sample size*	*Sll*	*Slw*	*Sww*	*S*lw/Sll*	*residuals*	*d.f.*
A_3	95	2028.0000	3715.0000	8730.4842	6805.3378	1925.1464	93
B_2	114	2309.6842	3777.4210	8503.9386	6177.8616	2326.0770	112
B_3	117	2637.2992	4699.0171	12323.6581	8372.4902	3951.1679	115
C_1	123	1802.6016	2326.4065	4463.6260	3002.4201	1461.2059	121
C_2	84	1419.0000	1865.5000	4056.7024	2452.4949	1604.2075	82
C_3	69	1223.0725	1669.0290	3978.8116	2277.5901	1701.2215	67
Total	602	11419.6575	18052.3736	42057.2209	29088.1947	12969.0262	590

TABLE III

Tests on regression lines

Tests on hypothesis that	*'F' value obtained*	*degrees of freedom*	Differences *at 5% level* *at 1% level*
Lines of $A_3 \equiv B_3 - \equiv C_3$	12.26	4 \$ 275	highly significant
Slopes of $A_3 = B_3 = C_3$	3.44	2 \$ 275	significant not significant
Lines of $A_3 \equiv B_3$	12.55	2 \$ 208	highly significant
Slopes of $A_3 = B_3$	*0.10	1 \$ 208	Not significant
Lines of $B_2 \equiv C_2$	19.78	2 \$ 194	highly significant
Slopes of $B_2 = C_2$	4.47	1 \$ 194	significant not significant
Lines of $B_2 \equiv B_3$	35.03	2 \$ 227	highly significant
Slopes of $B_2 = B_3$	*0.95	1 \$ 227	Not significant
Lines of $C_1 \equiv C_2 \equiv C_3$	75.52	4 \$ 270	highly significant
Slopes of $C_1 = C_2 = C_3$	*0.11	2 \$ 270	Not significant
Lines of $A_3 \equiv B_2 \equiv C_1 \equiv C_2 \equiv C_3$	33.88	10 \$ 590	highly significant
Slopes of $A_3 = B_2 = B_3 = C_1 = C_2 = C_3$	5.01	5 \$ 590	significant

Note.—Whenever 'F' value is less than unity the reciprocal is taken and tested.

(2) the attempt made to rear spat in the Galaxea Reef whose environment was found to be uncongenial ; and

(3) the lack of experience in the new type of work. Such disabilities are incidental to all kinds of pioneering-efforts.'

But the above stated factors might affect growth in general thereby affecting growth in length and weight simultaneously and as such there might not be any significant changes in the ' b ' values, as was seen above in the case of A_3 and B_3. It would be quite interesting to correlate the increase in ' a ' value of B_3 to the better conditions prevailing then. It might be worth attempting to see whether under controlled experiments the values of ' a ' could throw any light on the environmental conditions.

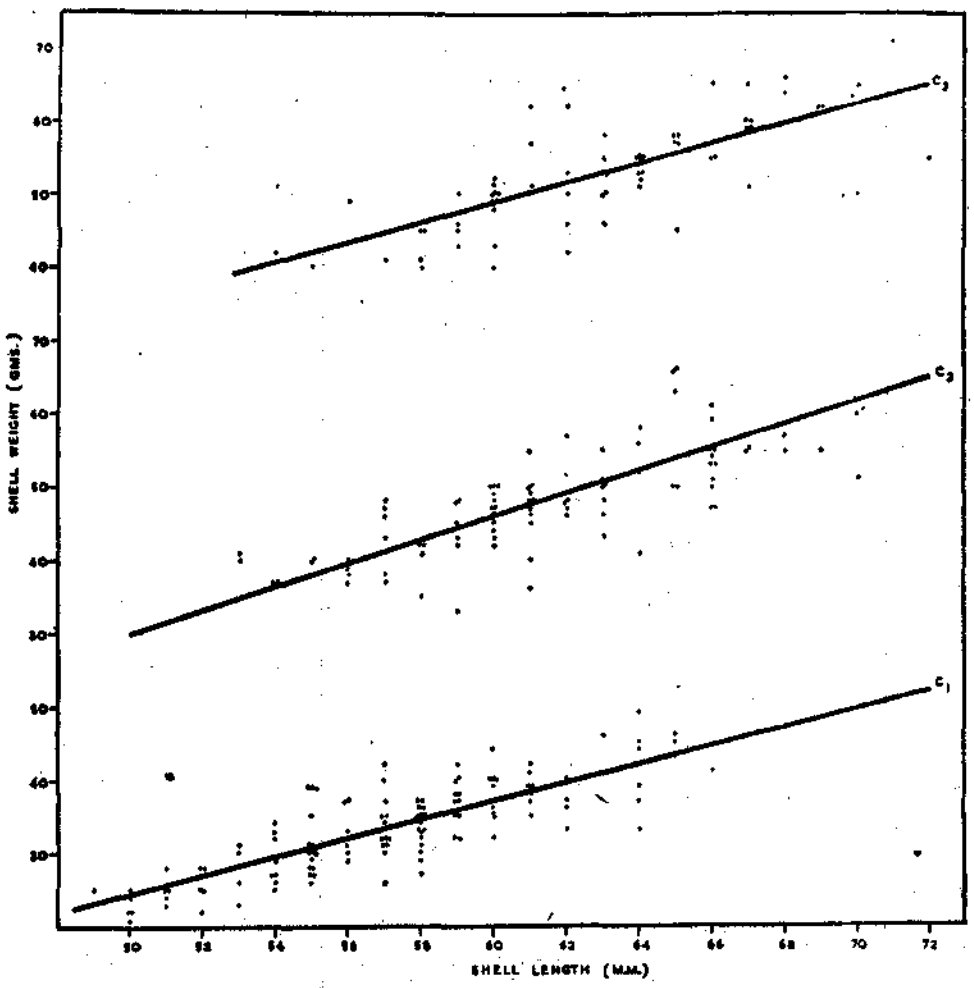

FIG. 2. Regression lines for Pearl Oysters belonging to the groups C_1, C_2 & C_3.

The tests made on groups A, B & C indicated that group C might be a little different from groups A & B. The reasons for this difference are not known. Moreover the furnished data in the Report consisted only of temperature and that too only for the year 1940. In the absence of data pertaining to temperature and ecological conditions for the period of observation it is not possible to draw any further conclusions.

TABLE IV

The percentage rate of mortality

Growth year	*Annual %*	
	A	*B*
First year	68%	25%
Second year	10%	10%
Third year	9.8%	13%

Further, there is as yet no effective method of finding out the various age groups of oysters taken from their natural beds to predict the time for pearl fishing. If the conception of different lines for different age groups is confirmed by further studies then it might be of great help for pearl fishing. Since as pointed out above there are different regression lines for different age groups a standard line for the second year age group can be determined. Then a sample of oysters from the beds may be taken and measured and the measurements plotted on a graph. Provided the environmental conditions are similar to those that existed when the second year line was determined, if the frequency of the points lying above the standard line is more, then it may be concluded that the majority of the oysters belong to the second year group and above and as such pearl fishing can safely be resorted to in the next year, when the majority of oysters will be of third year group and above. Hence the conclusions based on the second year line are of great importance and therefore the determination of this line needs careful attention.

Attempts had earlier been made to determine age groups of other oysters by probability paper method using length frequencies (Cassie, 1954). But the data given in the Report show too much of overlapping in length measurements for different age groups. However, in the case of weights there was difference between age groups with lesser amount of overlapping. Hence it should be possible to use the frequency of weight measurements for age determination, if as studied by the authors of the Report ' the body-weight of pearl oyster grows steadily and continuously throughout its life.' Since probability paper method is more subjective, there should be another way of checking the results obtained by this method. Therefore a combined study for regression line for the second year group and the results from the analysis of data from the probability paper method might be more reliable.

SUMMARY

The relation between the length and the weight of pearl oysters of Gulf of Mannar based on data published by Devanesan and Chidambaram (1956) was found to be linear for each year group separately. The linear relationship was statistically tested and found to be significantly different for each year age group. The

equality of slopes was tested for the same oysters of particular year spats at different ages and found to be not different. An attempt has been made to interpret the significance of the parameters occurring in the linear regression. The use of length-weight relationship in predicting pearl fishery has been pointed out.

ACKNOWLEDGEMENTS

The author is grateful to Dr. B. S. Bhimachar for the interest he evinced in this study and to Shri V. R. Pantulu for critically going through the manuscript and for helpful suggestions. The author is thankful to Sarvashri K. K. Ghosh and H. P. C. Shetty for going through the manuscript.

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