THE LENGTH-WEIGHT AND VOLUME RELATIONSHIPS OF THE INDIAN OIL SARDINE *SARDINELLA LONGICEPS* VAL.

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The study of length-weight relationship of fishes forms an important aspect of fishery biological investigations. Its practical applications while estimating the weight from the know length and *vice versa* and also in determining the condition factor or the ponderal index, the spawning seasons and the taxonomic differences of fishes (Le Cren, 1951) hardly need any emphasis. The length-volume study gives an idea on the seasonal changes in their specific gravity (Tester, 1940). There has so far been no published account on the length-weight and volume relationships of the Indian oil sardine, *Sardinella longiceps* Val. The present communication is a preliminary account of studies on these aspects taken up at Mangalore between October 1959 and November 1960.

Specimens chosen for this study were random and they ranged from 90 mm. to 210 mm. in total length. Each fish was weighed nearest to 0·5 gm. accuracy after removing the surface moisture with blotting paper. Further, the fishes were separated into three groups *viz.*, indeterminate, female and male; the number of specimens examined in the three groups were 49, 250 and 194 respectively.

For the length-volume study, the volume of entire fish was determined by the displacement method (accuracy of 0·5 cc).

The length-weight and volume relationships were calculated by the following formula:—

$$W \text{ or } V = AL^b$$

where W = weight,
V = volume,
L = length,
A = a constant
and b = the exponent normally lying between 2·5 and 4·0 (Le Cren, *op. cit*) for an ideal fish.

When the above formula is expressed in logarithms, then this gives a straight line relationship.

$$\log. W \text{ or } \log. V = a + b \log. L$$

where $a = \log. A$

The regression equations for the length and weight and length and volume were calculated on the basis of the individual observations by the least square method. The equations derived for the three groups are given in Table I.

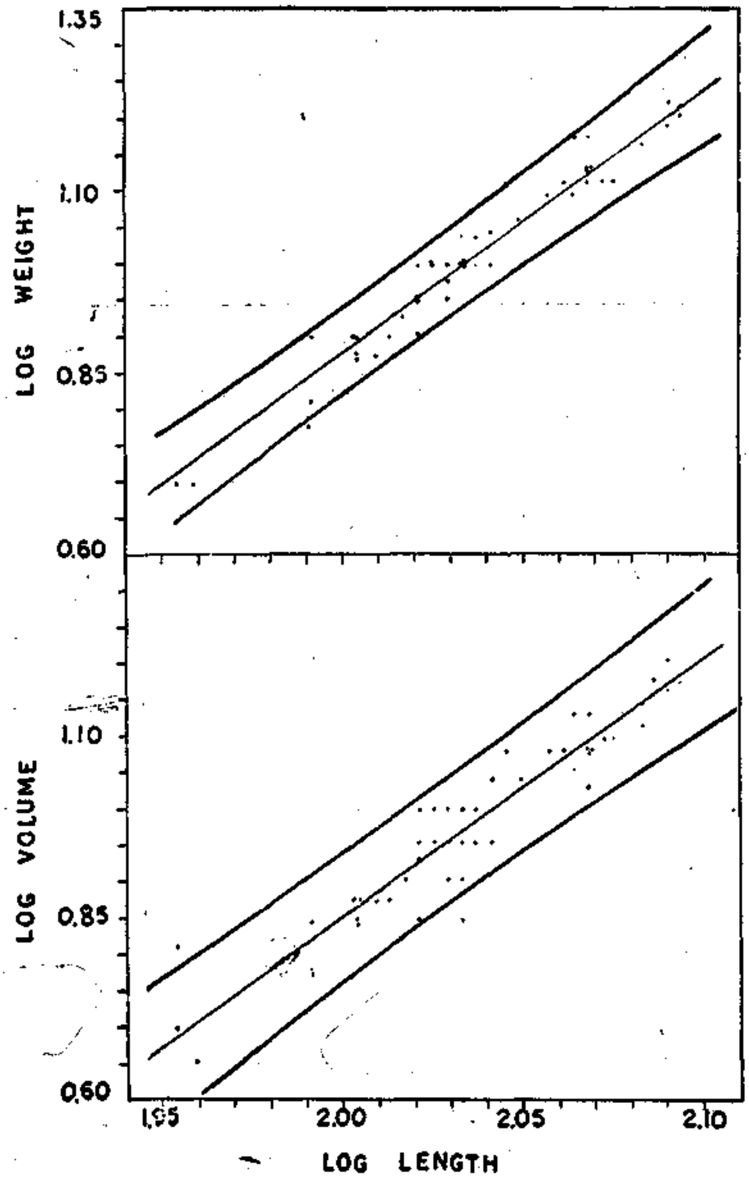

Fig. 1. Showing regressions of long volume and log. weight on log. length of indeterminate oil sardine. Thick lines indicate 95% confidence limits,

TABLE I

Equations for indeterminate, female, male and combined.

Group	Length-weight	Length-volume
Indeterminate .	$\bar{7}$·6451+3·6169 log. L	$\bar{7}$·6599+3·5940 log. L
Female . . .	$\bar{6}$·3420+3·2665 log. L	$\bar{6}$·4108+3·2320 log. L
Male . . .	$\bar{6}$·7010+3·1086 log. L	$\bar{6}$·6944+3·1091 log. L
Combined . .	$\bar{6}$·4662+3·2123 log. L	$\bar{6}$·3489+3·2623 log. L

It is seen from the above table that the regression coefficient is highest for the indeterminate and lowest for the male both for length-weight and length-volume relationships.

In Figs. 1-5 which refer to indeterminate, female, male and combined (all fish taken together), the plotted points show the observed individual values and the straight lines indicate the calculated relation.

Standard deviations for *a* and *b* for different groups are given in Table II and III.

TABLE II

Analysis of standard deviations of a and b of indeterminate, female, male and combined for length-weight relationship.

	Indeterminate	Female	Male	Combined
No. of observations.	49	250	194	493
$\bar{x}$	2·0363	2·1922	2·1945	2·1776
$\bar{y}$	1·0102	1·5029	1·5218	1·4613
Sxy	0·218536	3·488538	1·884660	9·068116
Sx^2	0·060420	1·067956	0·606281	2·822895
b	3·6169	3·2665	3·1086	3·2123
$\Sigma(y-\bar{y})^2$	0·83624231	11·89440655	6·45056071	30·29489439
$\Sigma(y-\hat{Y})^2$	0·04581945	0·59909717	0·59190663	1·16538527
σ^2	0·00097488	0·00241571	0·00308285	0.00237349
S.d. *a*	0·127004	0·047560	0·071309	0·028996
S.d. *b*	0·004460	0·003043	0·004086	0·002213

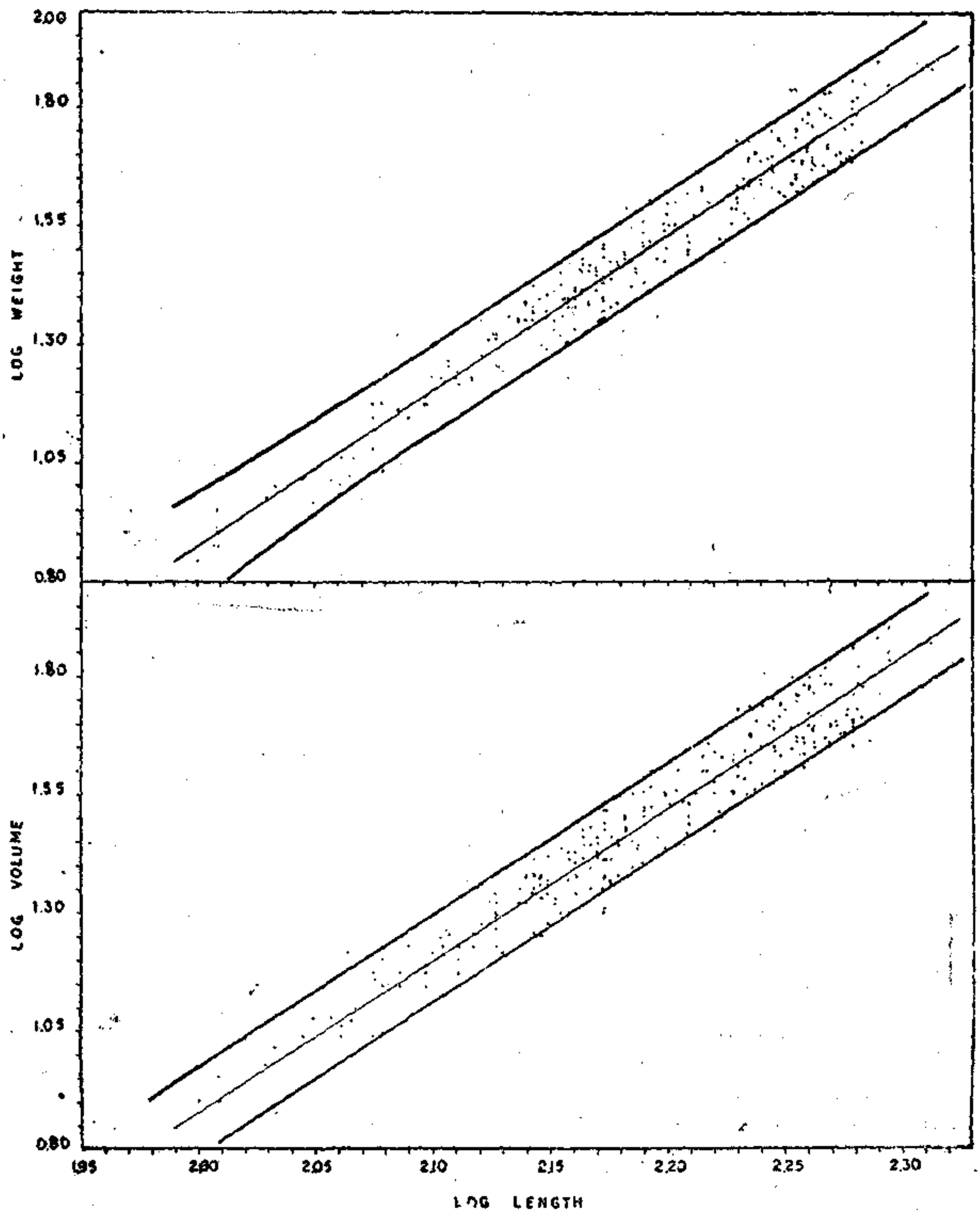

FIG. 2. Showing regressions of log. volume and log. weight on log. length of female oil sardine. Thick lines indicate 95% confidence limits.

TABLE III

Analysis of standard deviations of a and b of indeterminate, female, male and combined for length-volume relationship.

	Indeterminate	Female	Male	Combined
No. of observations	49	250	194	493
$\bar{x}$	2·0363	2·1922	2·1945	2·1776
$\bar{y}$	0·9784	1·4960	1·5173	1·4529
Sxy	0·217153	3·451657	1·884967	9·209212
Sx^2	0·060420	1·067956	0·606281	2·822895
b	3·5940	3·2320	3·1091	3·2623
$\Sigma(y-\bar{y})^2$	0·87397810	11·69964289	6·33795317	31·21023673
$\Sigma(y-\hat{Y})^2$	0·09353022	0·54388747	0·46740227	1·16700059
σ^2	0·00199000	0·00219309	0·00243429	0·00237678
S.d. *a*	0·057393	0·045310	0·063364	0·029017
S.d. *b*	0·006472	0·002962	0·003642	0·002195

The differences between regression coefficients were tested for significance by the *t* test (Fisher 1958). Details are given below :

TABLE IV

Test for regressions of indeterminate, female and male.

Groups	Length-weight			Length-volume		
	D.F.	*t*	*P*	*D.F.*	*t*	*P*
Between indeterminate and female	297	1·8488	$<0·01$	297	1·8688	$<0·01$
Between indeterminate and male	241	2·3167	$<0·01$	241	2·3511	$<0·01$
Between female and male	442	1·7569	$<0·01$	442	1·5960	$<0·01$

It is seen from the table given above that the test for significance for regressions for different groups is not significant.

The 95% confidence limits for a given x (length) and the predicted $\hat{Y}$ (weight) for the same x were calculated by the following formula :

$$\hat{Y} = a + b(x - \bar{x})$$

where y is considered as a dependent variable on x and $\hat{Y}$ the predicted value for a given x

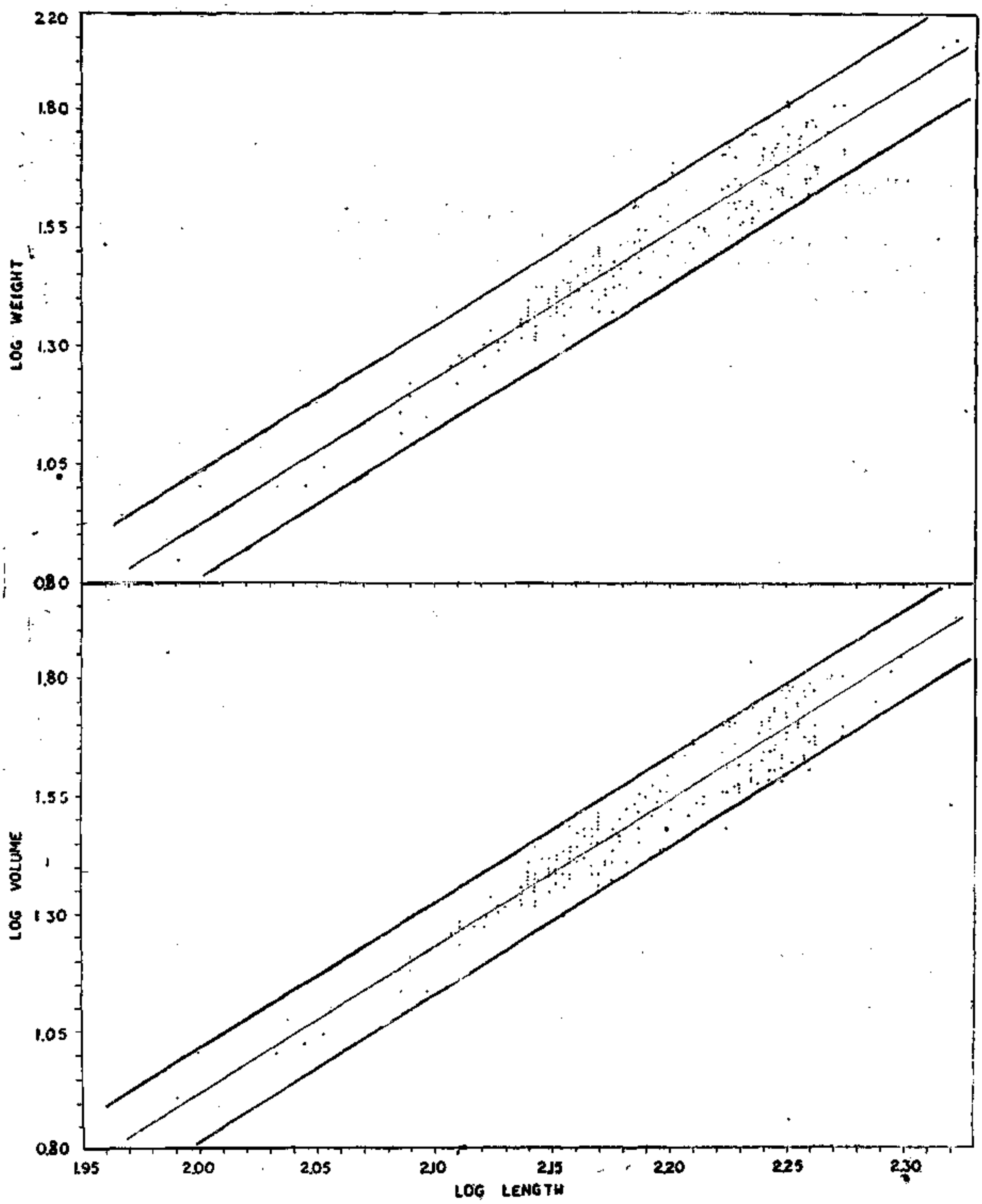

FIG. 3. Showing regressions log. volume and log. weight on log. length of male oil sardine. Thick lines indicate 95% confidence limits.

Variance ($S\hat{Y}^2$) for the 95% confidence intervals was calculated as follows :

$$S_{\hat{Y}}^2 = \sigma^2 \left[1 + \frac{1}{n} + \frac{(x-\bar{x})}{\Sigma(x-\bar{x})^2} \right]$$

The confidence intervals for indeterminate, female male and combined were estimated as follows:

$$\hat{Y} - t_{.05}\, S_{\hat{Y}} \leq \mu \leq \hat{Y} + t_{.05}\, S_{\hat{Y}}$$

where μ is the point of estimate for any y. The value of $t_{.05}$ was obtained by entering the t at b. In Figs. 1-5, the thicker lines show the confidence limits for indeterminate, female, male and combined :

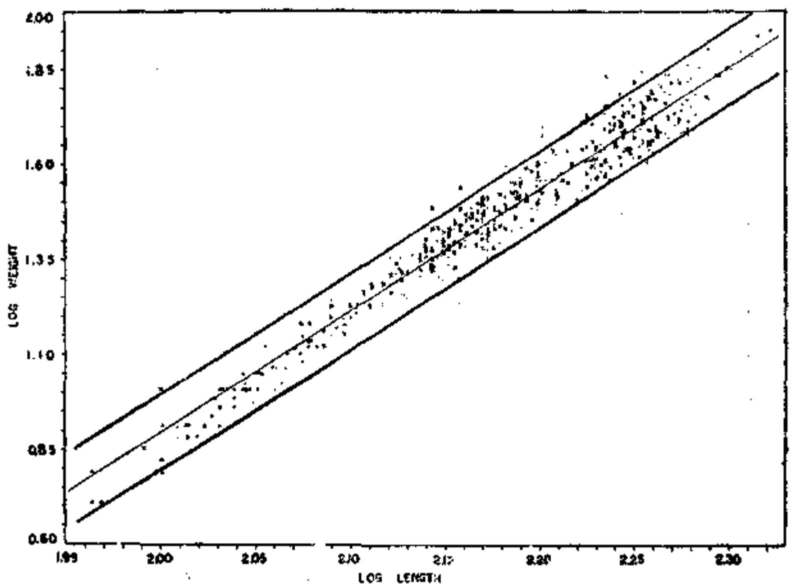

Fig. 4. Showing regression of log. weight on log. length of combined oil sardine. Thick lines indicate 95% confidence.

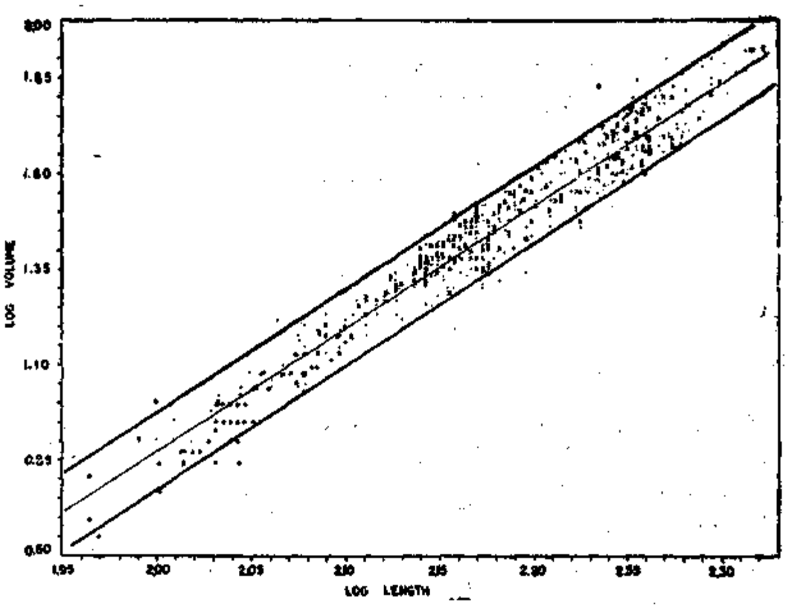

FIG. 5. Showing regression of log. volume on log. length of combined oil sardine. Thick lines indicate 95% confidence limits.

It is seen from Figs. 1 to 5 that only few points are outside the confidence limits, the showing that the samples used for the present study came from a homogeneous population.

SUMMARY

The length-weight and volume relationships for the Indian oil sardine, *Sardinella longiceps* Val., were calculated on the basis of individual observation by the least square method.

The differences between regression coefficients were tested for significance for the *t* test, and were found to be non-significant.

The 95% confidence limits for indeterminate, female, male and combined were calculated, and the results revealed that the samples for the study came from a homogeneous population.

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