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The Weight-Length Relationship of the California Sardine (Sardina cærulea) at San Pedro[1]

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1. 1. INTRODUCTION

1.1. 1. Methods of expressing the relationship between weight and length

While weight and length of fishes are closely correlated, a detailed study of the relationship of these two units of measure shows many significant departures from a general mathematical law governing this relationship. These variations from the basic law have been utilized by students of fishery problems in racial studies and in determining the condition of fishes. However, before any study can be made of the significance of such departures from the normal, a clear understanding of the law governing the relationship between weight and length must be assured. The simplest way to arrive at such an understanding is by the construction of a weight-length curve, as figure 1. This curve gives a graphic illustration of the variation of weight with length and shows clearly that an increase in length is accompanied by a much more rapid increase in weight. Since weight is a measure of volume while length is a linear measure, the weight of fishes is said to increase approximately as the cube of the length.

Although a weight-length curve demonstrates the general relation of weight to length, it is limited in its use, for it shows only the absolute change in weight between any two length units and does not demonstrate the relative change in weight. For example, a variation of 30 gm. in weight at 150 mm. of length is of much greater significance than a change of 30 gm. at 280 mm. In order to compare fluctuations in weight at different. length units and to detect small changes in weight at the same length unit, some expression of weight-length relationship other than a weight-length curve must be used.

Since the weight of a fish varies as the cube of its length, the formula, $W = FL^3$, has been most frequently used in weight-length studies of fishes. In this formula, W represents the weight; L, the length; and F, a factor which differs for different species, but varies for any one species only as the weight fluctuates in relation to the cube of the length. The weight-length factor is consequently an index of the relation of weight to length, and from variations in the value of F within a species, fluctuations in the weight-length relationship may be determined. The formula is usually written [$F = 100w/L^3$]. The number 1000 is introduced to eliminate decimals and to bring F nearer to unity.

1.2. 2. Significance of the weight-length factor

One important aspect of the weight-length factor is that its fluctuations in value at any length unit are directly comparable with fluctuations at any other length unit; it thus indicates relative changes in weight. This may be demonstrated as follows: From the formula $FL^3 = W$, we may derive

$$\begin{cases} FL^3_1 = W_1 \text{ or } L^3_1 = \dfrac{W_1}{F} \\ FL^3_2 = W_2 \text{ or } L^3_2 = \dfrac{W_2}{F} \end{cases}$$

when L_1 and W_1 represent length and weight at a certain length unit, and L_2 and W_2, length and weight at a second length unit. If the weight be assumed to vary *a* grams at each of the above length units, and if x_1 and x_2 represent the change in factor resulting from *a* grams change in weight at each of the length units, then

$$\begin{cases} (F+x_1)\, L^3_1 = W_1 + a \text{ or } FL^3_1 + x_1L^3_1 = W_1 + a \\ (F+x_2)\, L^3_2 = W_2 + a \text{ or } FL^3_2 + x_2L^3_2 = W_2 + a \end{cases}$$

$$\text{Since } \begin{cases} FL^3_1 = W_1 \\ FL^3_2 = W_2 \end{cases}$$

$$\text{then } \begin{cases} x_1L^3_1 = a \\ x_2L^3_2 = a \end{cases}$$

$$\text{and } x_1L^3_1 = x_2L^3_2$$

$$\text{Since } \begin{cases} L^3_1 = \dfrac{W_1}{F} \\ L^3_2 = \dfrac{W_2}{F} \end{cases}$$

$$\text{then } x_1\frac{W_1}{F} = x_2\frac{W_2}{F}$$

$$\text{and } \frac{x_1}{x_2} = \frac{W_2}{W_1}$$

Thus the ratio between the fluctuations, x_1 and x_2, in the factors at L_1 and L_2 is inversely proportional to the ratio between the weights at L_1 and L_2. Differences between factors at any length unit are directly comparable, therefore, with variations in factors at any other length unit. Also, a factor at a certain length unit can be compared directly with any other factor at the same length unit. Since $FL^3{}_1 = W_1$ then $(F + x_1)\, L^3{}_1 = W_1 + a$ $(F + x_2)\, L^3{}_1 = W_1 + b$ when x_1 and x_2 represent the change in factor resulting from increasing the weight at a certain length unit by the sums *a* and *b*, respectively. Expanding the equations

$$FL^3_1 + x_1L^3_1 = W_1 + a$$
$$FL^3_1 + x_2L^3_1 = W_1 + b$$

$$\text{and } x_1L^3_1 = a \text{ or } L^3_1 = \frac{a}{x_1}$$

$$x_2 L^3_1 = b \text{ or } L^3_1 = \frac{b}{x_2}$$

$$\text{then } \frac{x_1}{x_2} = \frac{a}{b}$$

Thus the ratio between the fluctuations, x_1 and x_2, in factors at a certain length unit is in direct proportion to the changes in weight at that unit, and weight-length factors for any one length unit are directly comparable. Great caution must be used, however, in comparing factors at one length unit directly with factors at some other length unit. The assumption that weight of fishes increases as the cube of the length is only approximately correct. Because of this fact, weight-length factors derived from a formula based on the cube of the length are not directly comparable at different length units. The more a species departs from this general weight-length relationship, the greater the error involved in the factor. The amount of this error for sardines will be discussed in section III of this paper.

2. II. METHODS

2.1. 1. Collection of material

The material used for the weight-length studies of the San Pedro sardine was obtained by staff members2 of the California State Fisheries Laboratory from the commercial catch landed at San Pedro. Higgins (1926) described the method of collecting the fish and measuring the specimens, and the precautions taken to secure representative data. Two length measurements were made on each fish; the total length from the tip of the lower jaw to the posterior extremity of the caudal fin, and the body length from the tip of the lower jaw to the base of the caudal fin. In all studies made on the California sardine, body length measurements have been used, and in this study weight has been compared to body length.

Weights for individual fish were determined for material taken from January to April, 1921; December, 1924 to March, 1925; November, 1925 to March, 1926; and December, 1926 to May, 1927. For the 1921 data daily samples were taken and all the fish measured were weighed, for the 1924–1925 and 1925–1926 seasons, 250 fish were measured twice a week and fifty of these fish were weighed, giving weights for 100 fish per week. Also, in December, 1926, 100 of the 500 fish measured per week were weighed, but from January to May of the 1926–1927 season, 200 fish were weighed each week. The adequacy of the data thus collected is discussed under section IV.

In addition to the samples taken from the commercial catch, from January to December, 1921, weights were determined for a series of fish less than 150 mm. in length collected by means of special hauls. These data were used in constructing the weight-length curve shown in figure I.

Weights were made on an International Even Balance scale of 2100 gram capacity, graduated to half grams, and read to the nearest gram. The weight, length and sex of each fish was recorded. In the 1921 material, the entire fish was weighed after which a slit was made in the body cavity, the alimentary tract, liver, swim bladder, gonads, and mesenteric fat removed and the fish again weighed. During the years subsequent to 1921 only weights of the entire fish were determined.

2.2. 2. Statistical treatment of the data

The weight-length factors used in this study were obtained from the formula

$$F = \frac{1000W}{L^x}$$

, in which F is the weight-length factor; W, the weight of the fish; L, the length of the fish; and x, the power to which L must be raised in order to express the relation between weight and length. The value assigned to x was three and the error thus resulting is discussed in section III.

The length-frequency curves were smoothed twice by a moving average of three, as were the factor deviations from the four-season average and the length-frequency deviations from a four-season average. The fat indices and the weight-length factors at each millimeter of length were smoothed twice by a moving average of five with the exception of the data shown in figures III, V and VIII. For these graphs, the factors were smoothed twice by a moving average of three, with the exception of the first four graphs of figure V. For these curves the factors were smoothed once by a moving average of five.

The standard deviations, coefficients of variation and standard errors of the factors were calculated from the formulæ

$$\sigma = \sqrt{\frac{\Sigma f (d^1)^2}{n} - \left(\frac{\Sigma f d^1}{n}\right)^2}$$

$$\sigma_M = \pm \frac{\sigma}{\sqrt{n}}$$

$$V = \frac{100 \sigma}{M}$$

[o] represents the standard deviation; f, the frequency; d^1, the deviations from an assumed mean; n, the number of individuals; M, the mean or arithmetic average; $[o]_M$, the standard error of the mean; and V, the coefficient of variation. The standard error of the seasonal average factor, used in section V under the discussion of yearly factor fluctuations, was calculated from the formula

$$\sigma_M = \frac{\sqrt{\frac{\Sigma d_1^2 + \Sigma d_2^2 \ldots \Sigma d_n^2}{n_1 + n_2 \ldots n_n}}}{\sqrt{n_1 + n_2 \ldots n_n}}$$

in which d_1, d_2, ... d_n represent the deviations of the factors from the mean at their respective length units and n_1, n_2 .... n_n, the number of fish at the corresponding length units. The standard error of the difference, $[o]_D$, between the average weight-length factors for any two seasons was calculated by extracting the square root of the sum of the squares of the standard errors of the two average weight-length factors involved.

The weight-length curve of figure I was fitted to the data by the method of least squares and involves the formula $FL^x=W$, when F represents the factor; L, the length; W, the weight; and x, the power to which L must be raised. Then Log F + Log x = Log W and (Log L) (Log F) = $(\text{Log } L)^2 x$ = (Log L) (Log W) The log of L and of W at each millimeter of length was substituted in each equation, the two resulting series of equations summed and solved for the value of F and x.

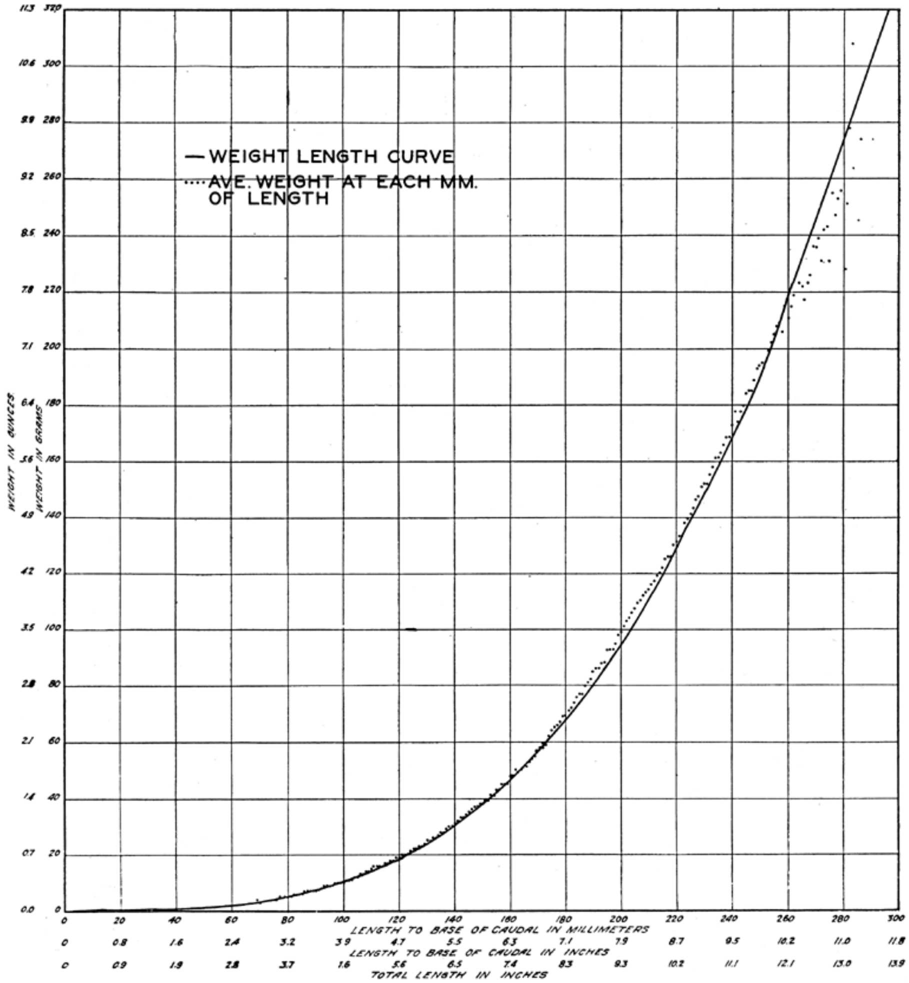

FIG. I. Weight-length curve for sardines taken at San Pedro during January–December, 1921; November, 1924–March, 1925; November, 1925–March, 1926; and December, 1926–May, 1927.

FIG. I. Weight-length curve for sardines taken at San Pedro during January–December, 1926–May, 1927

The formula Y=mX+b was used to fit the straight line to the data of figure II Y represents any point on the ordinate; X, any point on the abscissa; m, the slope of the line; and b, the distance from the zero origin to the point where the straight line cuts the vertical axis.

3. III. MATHEMATICAL RELATIONSHIP BETWEEN WEIGHT AND LENGTH

To ascertain what error might result from determining the weight-length factor on the assumption that weight of the sardine varies as the cube of the length, a detailed analysis was made of the data derived from the four seasons' material. The average weight at each millimeter of length was deternined, and from these data the values of F and x in the equation W=FLx were calculated by the method of least squares described in section II. The value of x was found to be 3.15047 and of F, 0.0000054. Since the value of x is slightly greater than three, the weight of sardines varies, not as the cube of the length, but as the length raised to the 3.15 power.

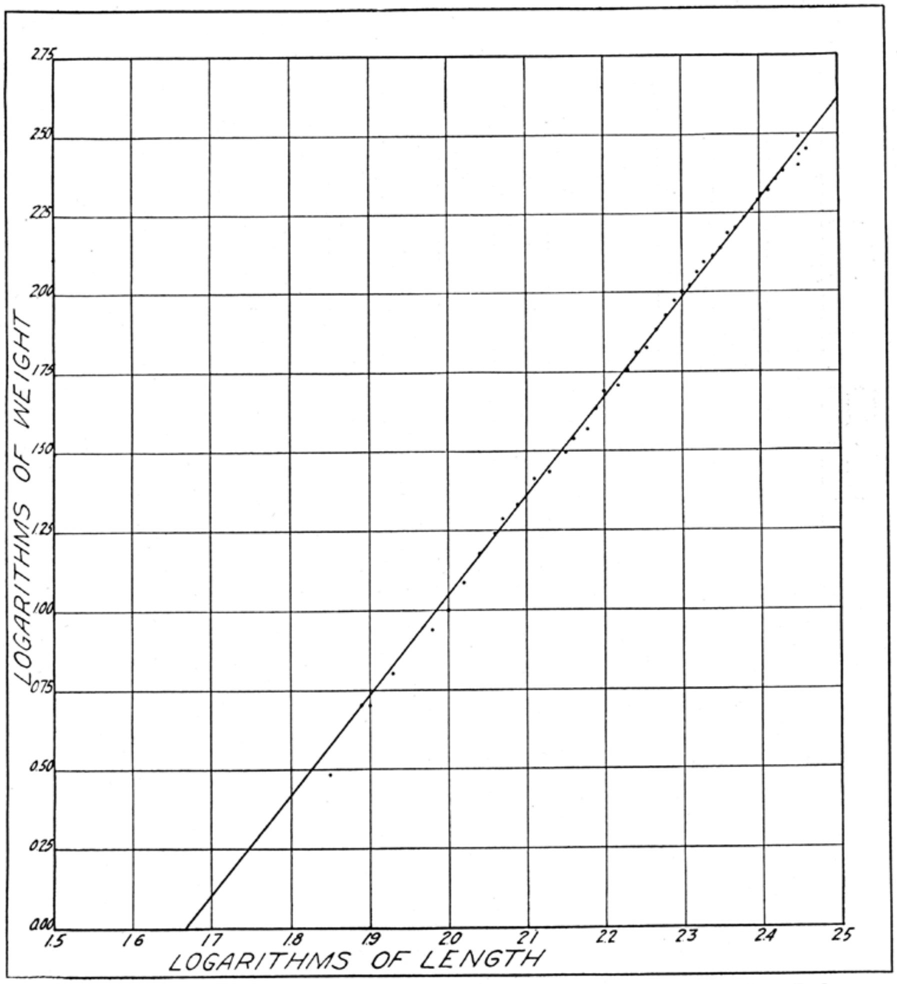

FIG. II. Logarithms of weight and length of sardines taken at San Pedro.

FIG. II. Logarithus of weight and length of sardines taken at San Pedro

Figure I shows the weight-length curve resulting from these calculations. The dots give the average weight at each millimeter of length for all sardines used in this study and the solid line represents the weight at each mill meter of length when x=3.15 and F=0.0000054. It is obvious from this graph, that the weight-length curve does not fit the data throughout its entire length. Between 180 and 240 mm. the weight increased at some rate greater than the length to the 3.15 power, while above 250 mm. the increase in weight fell below the standard increase in length. To determine whether a straight line or a curvilinear relationship exists between weight and length in the sardine, the logs of the weights were plotted against the logs of the lengths as shown in figure II. The straight line of this graph was drawn by means of the formula Y=mX+b when m has a value of 3.15 and b, a value of -6.73, the log of 0.0000054. While the straight line fits the data in a general way, there are discrepancies which lead to the conclusion that the relationship between weight and length in sardines is not truly that of a straight line. Small fish, less than 100 mm. in length, and large fish, more than 250 mm. in length, increase in length more rapidly than in weight, while medium sized fish increase in weight more rapidly than in length. In figure II, 100 mm. and 250 mm. fall on log 2.00 and log 2.40, respectively. This slight departure from a straight line relationship has been disregarded in this study, but it probably explains the frequent drop in the weight-length factor curves above 250 mm.

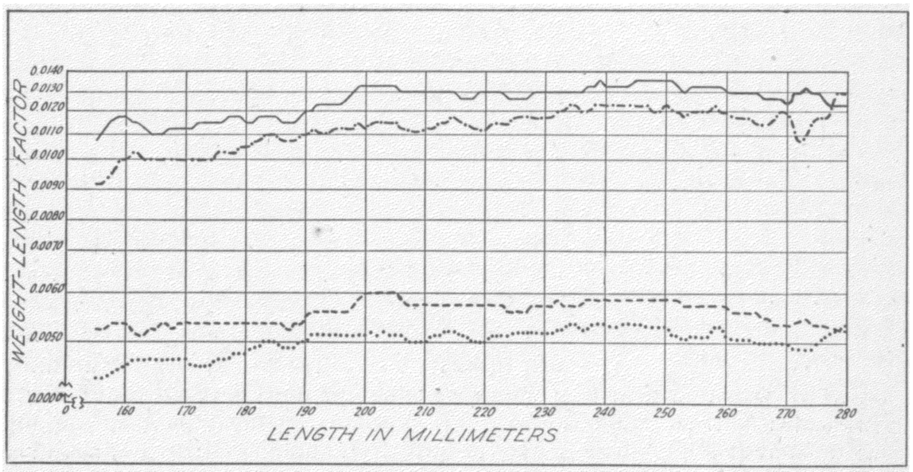

Fig. III. Weight-length factors derived from the formula $F = \frac{1000W}{L^3}$ compared with weight-length factors derived from the formula $F = \frac{1000W}{L^{3.15}}$. Data plotted on a semi-logarithmic scale to make values directly comparable. Factors smoothed twice by a moving average of three.

FIG. III

----- $F = 100W/L^3$, 1924-1925. -. -. $F = 100W/L^3$, 1925-1926.

- - - $F = 100W/L^{3.15}$, 1924-1925. . . . $F = 100W/L^{3.15}$, 1925-1926.

The significance of the error introduced by using the cube of the length, instead of the length to the 3.15 power, in determining the value of F, was tested by comparing the factors obtained by both methods. The average weight at each millimeter of length for January, February and March of each season represented in the data was determined. From this average weight, the weight-length factor at each millimeter was calculated when [$F = 1000W/L^3$] and when [$F = 1000W/L^{3.15}$]. Two weight-length factor curves for each season, representing the factors at each millimeter, were thus obtained. These curves were compared by plotting on a semi-logarithmic scale. Figure III represents the comparisons for the 1924–1925 and the 1925–1926 seasons. In this graph the logs of the factors are plotted against the lengths in millimeters. This method gives equal value to all variations in the factors obtained from either equation and makes the weight-length factor curves resulting from the two methods directly comparable.

In figure III, the factor line based on L^3 practically parallels the factor line based on $L^{3.15}$ for both the 1924–1925 and the 1925–1926 seasons. The same was true for the other two seasons represented in the data. Since the weight of sardines increases at a power higher than the cube of the length, the distance between the two factor curves for 1924–1925 and again for 1925–1926 is slightly greater for the larger fish than for the smaller. Due to the error introduced from calculating F on the basis of the cube of the length, the curve resulting from the equation [$F = 1000W/L^3$] rises consistently throughout the range of sizes represented in the commercial catch at San Pedro. This change in the factors derived from L^3 varies as the *y* power of L, when *y* represents the amount greater than the cube to which L should be raised in order to maintain the factor curve as a straight line. If

$$F_1 L^3 = W$$

then $$F_2 L^{3+y} = W$$

and $$F_1 L^3 = F_2 L^{3+y}$$

or $$\frac{F_1}{F_2} = \frac{L^{3+y}}{L^3}$$

and $$\frac{F^1}{F_2} = L^y$$

The factors derived from the cube of the length increase, therefore, as the *y* power of L. For the California sardine *y* has approximately the value of 0.15. Theoretically, the curve derived from the equation [$F = 1000W/L^{3.15}$] should be level throughout the range from 150 to 280 mm. The rise in the middle with a fall at either end is explained by the fact, as discussed above, that the weight-length relationship for sardines departs slightly from that of a straight line.

Due to the slight upward trend of the weight-length factor curve based on the cube of the length, factors at any one length unit are not directly comparable with factors at any other length unit. If the weight-length relationship was that of a straight line, factors based on the length to the 3.15 power would be directly comparable at all length units. Since a true straight line relationship apparently does not exist for length and weight of sardines and since 3.15 as the value of *x* is based on data taken for only certain months in the year and is therefore only approximately accurate, weight-length factor values which are directly comparable at every length unit can not be obtained.

Comparing further the weight-length factor curves derived from the cube of the length and from the length to the 3.15 power, we find that the minor fluctuations of the two curves are practically identical. Also the 1924–1925 and 1925–1926 curves based on the cube of the length differ from each other precisely as do the 1924–1925 and 1925–1926 curves based on the length raised to the 3.15 power.

Since the use of weight-length factors derived from the cube of the length introduces only a minor error into the work, does not invalidate

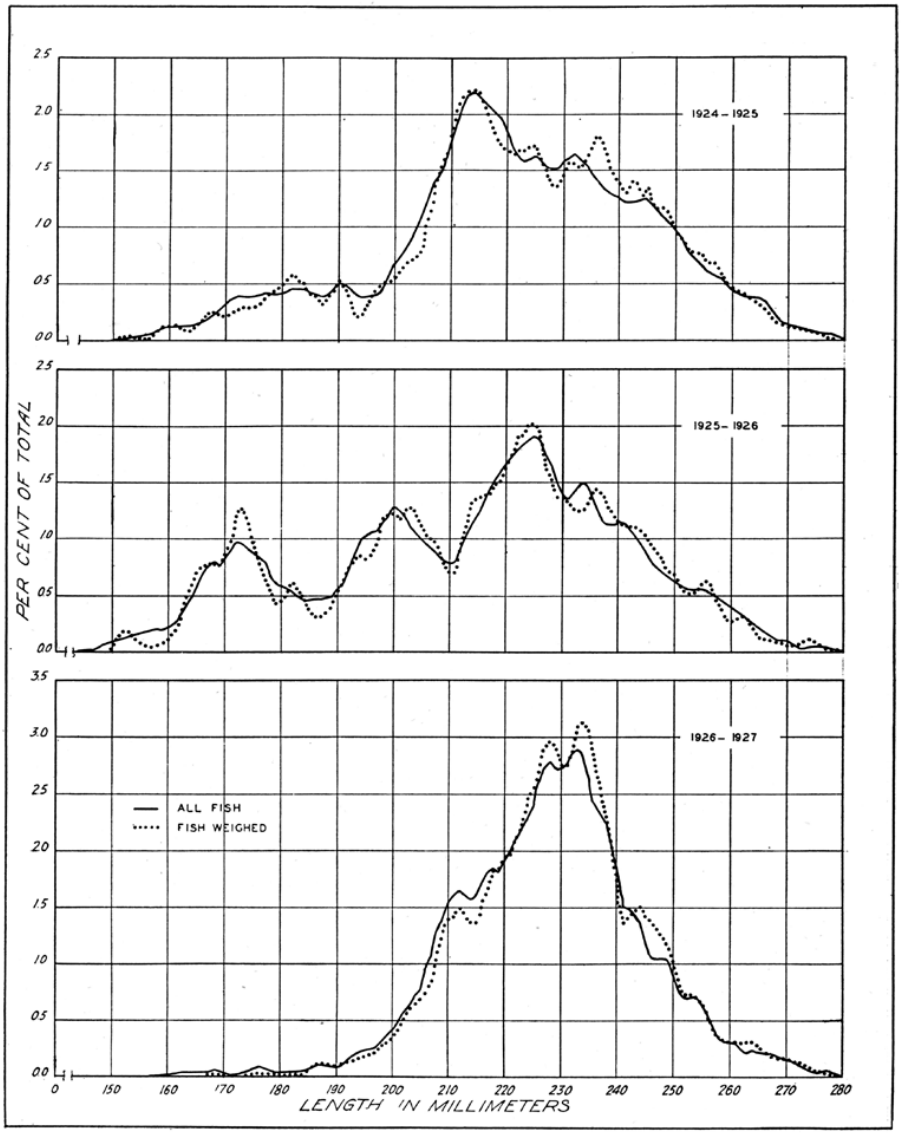

FIG. IV. Length-frequency polygons of all fish measured during January, February and March for four seasons, compared with the length-frequency polygons of the fish weighed during the same periods of time. Frequencies smoothed twice by a moving average of three and expressed in percentage of the total.
——— All fish. . . . . . . Fish weighed.

FIG. IV. Length-frequency polygons of all fish measured during January, February and March for four seasons, compared with the length-frequency polygons of the fish weighed during the same periods of time. Frequencies smoothed twice by a moving average of three and expressed in percentage of the total

comparisons of fluctuations within seasons or from season to season, makes possible direct comparisons of factors at any length unit and relative comparisons at two length units, and since it is impossible to

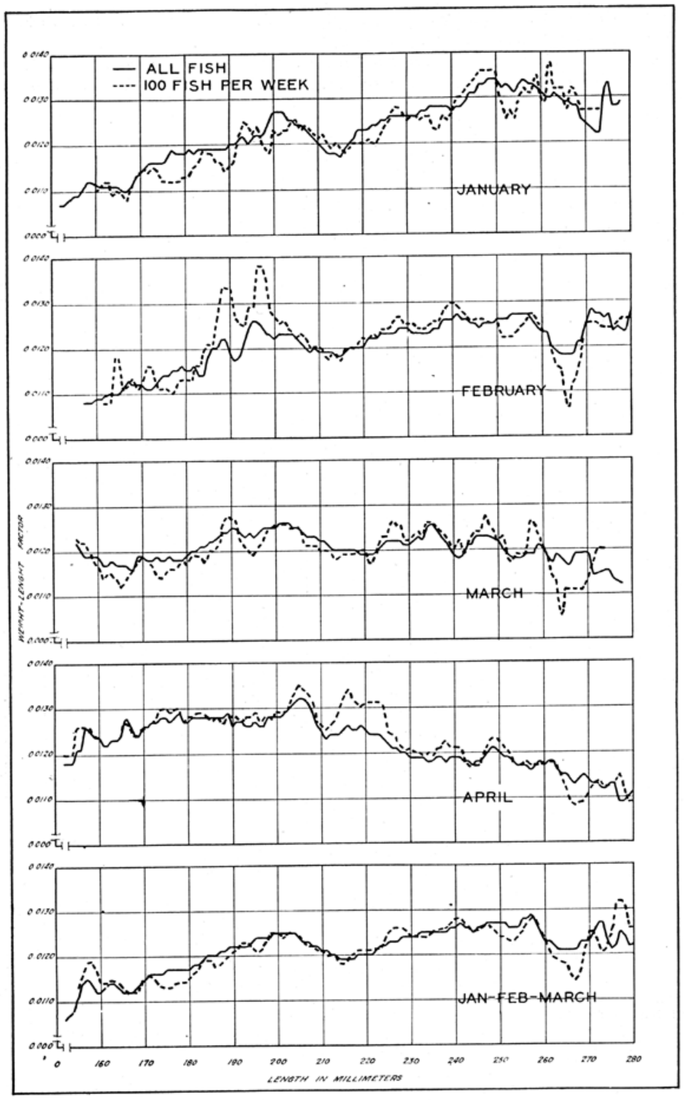

FIG. V. Weight-length factor curves for all fish taken from January to April, 1921, compared with weight-length factor curves for 100 fish per week over the same period of time. Factors for lower graph smoothed twice by a moving average of three, for the other graphs, once by a moving average of five.
——— Weight-length factors for all fish.
— — — Weight-length factors for 100 fish per week.

FIG. V. Weight-length factor curves for all fish taken from January to April, 1921, compared with weight-length factor curves for 100 fish per week over the same period of time. Factors for lower graph smoothed twice by a moving average of three, for the other graphs, once by a moving average of five obtain weight-length factors that are directly comparable at all length units, the formula [$F = 1000W/L^3$] has been used exclusively in this study.

4. IV. ADEQUACY OF THE AMOUNT OF DATA USED

Since the data for the 1924–1925 and the 1925–1926 seasons represented weights of 100 fish per week, the data for 1926–1927 represented weights of 200 fish per week, while the data for 1920–1921 season represented weights of about 400 fish per week; a test was made to determine the adequacy of the data based on the smaller number of weights.

During the seasons in which only 100 fish were weighed each week, length measurements were made on 500 fish comprising five samples taken twice a week. One sample of 50 fish was weighed on each sampling day. Two possible sources of error might have resulted from this method. First, the 50 fish weighed on each day might not have been distributed throughout the same range of lengths as the 250 fish measured. Second, the number of weights might not have been sufficient to give reliable weight-length factors at each millimeter of length.

In order to determine whether the length-frequency distribution of the fish weighed was similar to the length-frequency distribution of all fish measured, both types of data were contrasted for the months of January, February and March of each season. The length-frequency polygons resulting are presented in figure IV. In these graphs the number of fish at each millimeter is expressed in percentage of the total number and the sum of each frequency is therefore 100. From figure IV, it is evident that the weighing of 100 fish per week in the 1924–1925 and the 1925–1926 seasons, or 200 fish per week in the 1926–1927 season, was sufficient to assure a satisfactory distribution of fish throughout the total range of lengths.

During January, February and March of 1925, 1149 or 20 per cent of the 5750 fish measured were weighed. During the same three months of 1926, 994 or 19 per cent of the 5249 fish measured were weighed, while in 1927, 1847 or 37 per cent of the 4998 fish measured were weighed. To test the reliability of the weight-length factors obtained from these data, 100 fish per week were selected from the 1920–1921 material for January, February and March. This gave weights for 1050 or 25 per cent of the 4182 fish measured; a larger percentage than for the 1924–1925 or the 1925–1926 seasons but smaller than for the 1926–1927 season. The resulting weight-length factor curve, compared to the curve for all fish weighed in the 1920–1921 season, is shown in the last graph of figure V. The trend of the two factor curves is the same, and no serious differences are evident at any length unit. The average factor, obtained by dividing the sum of the average weightlength factors at each millimeter by the number of length units involved, was 0.0121 in both cases.

In addition to the above test, the monthly weight-length factor curves resulting from selections on a basis of 100 fish per week were compared with the corresponding factor curves for all fish weighed each month during 1920–1921. These curves are also given in figure V. While, as is to be expected, the differences at various length units are greater than in the curves based on three months' data, the trends of the lines in all cases are identical. In January, the factor average for all fish was

0.0123 and for 100 fish per week 0.0121; and in February, 0.0120 and 0.0122; in March, 0.0120 and 0.0121; and in April, 0.0122 and 0.0122. While monthly factor averages have not been used in this study, the averages for 100 fish per week seem sufficiently reliable to justify their use were it so desired.

Since the length-frequencies of 100 fish per week did not differ markedly from the length-frequencies of all fish measured, and since the weight-length factor curves of 100 fish selected each week parallel very closely the curves of all fish weighed, the amount of data at hand has been considered adequate for this study. To insure a larger margin of safety, however, it is proposed that 200 instead of 100 fish be weighed each week as was done in 1926–1927, and such a procedure has been adopted for future work on the sardine at San Pedro.

5. V. FLUCTUATIONS OF THE WEIGHT-LENGTH FACTOR

5.1. 1. Individual variations

The weight-length factors for fish of the same length varied widely among fish taken on the same day or even in the same sample. A detailed analysis of the data showed, however, that these individual variations were in no way caused by sexual differences in the weight-length relationship. Since no evidence of sexual dimorphism was ascertainable, all data were grouped without regard to sex.

The wide dispersion of the weight-length factors at each length unit is shown in tables I and II. In these tables the standard deviations of the factors at each centimeter of length are given for the months of January and April, 1921. The standard deviations in all cases were large, increasing as the length increased. To make comparable the dispersion at the larger and smaller lengths, the coefficients of variation are given in the last column of each table. There was, apparently, a slight tendency for the dispersion of the weight–length factors to be greater for the larger than for the smaller fish. This was more manifest in the April than in the January data. The indication was slight, however, and has no direct bearing on the problems here discussed.

TABLE I

AVERAGE WEIGHT-LENGTH FACTOR AT EACH CENTIMETER OF LENGTH FOR SARDINES TAKEN AT SAN PEDRO IN JANUARY, 1921

Length, mm.	No. of fish	Weight-length factor*		Coefficient of variation $V = \frac{\sigma 100}{M}$
		Mean	Standard deviation	
156-165	14	112.29	3.88	3.46
166-175	66	113.33	7.32	6.46
176-185	125	118.16	6.78	5.74
186-195	98	119.35	7.86	6.58
196-205	73	123.86	8.62	6.96
206-215	155	120.79	8.16	6.75
216-225	101	122.31	8.70	7.11
226-235	105	126.16	8.97	7.11
236-245	90	128.69	8.54	6.64
246-255	59	132.58	10.17	7.66
256-265	31	132.03	7.82	5.92
266-275	16	124.81	8.80	7.05

*To eliminate decimals the weight-length factors in tables I and II were multiplied by 10,000.

TABLE I AVERAGE WEIGHT-LENGTH FACTOR AT EACH CENTIMETER OF LENGTH FOR SARDINES TAKEN AT SAN PEDRO IN JANUARY, 1921

TABLE II

AVERAGE WEIGHT-LENGTH FACTOR AT EACH CENTIMETER OF LENGTH FOR SARDINES TAKEN AT SAN PEDRO IN APRIL, 1921

Length, mm.	No. of fish	Weight-length factor		Coefficient of variation $V=\frac{\sigma 100}{M}$
		Mean	Standard deviation	
156-165	14	124.79	5.93	4.75
166-175	24	125.25	5.66	4.52
176-185	35	127.94	6.26	4.89
186-195	45	126.91	7.40	5.83
196-205	23	128.22	4.10	3.20
206-215	65	125.48	8.42	6.72
216-225	86	124.60	8.08	6.48
226-235	121	119.17	6.98	5.86
236-245	139	117.81	7.84	6.65
246-255	142	119.20	8.28	6.95
256-265	130	117.04	8.10	6.92
266-275	45	113.11	7.40	6.54

TABLE II AVERAGE WEIGHT-LENGTH FACTOR AT EACH CENTIMETER OF LENGTH FOR SARDINES TAKEN AT SAN PEDRO IN APRIL, 1921

5.2. 2. Monthly fluctuations

Since the weight-length factors varied so widely at any length unit, all data were grouped by months in order to secure a sufficient number of factors at any millimeter of length to give a reliable average. For these reasons, no study of daily or weekly fluctuations was attempted. The monthly averages of the weight-length factors at each millimeter of length were calculated for each month of the four seasons represented in the data. The results are shown in figure VI. In these graphs, the length in millimeters was plotted on the abscissa and the average factor on the intersecting ordinate. The resulting monthly factor curves are shown for each season.

The monthly curves for the 1920–1921 and the 1924–1925 seasons show a consistent trend from month to month in the fluctuations of the weight-length factors. The trend of these fluctuations for fish above 220 mm. in length was downward from January to April, and for fish smaller than 220 mm, upward. The factors of the larger fish consequently, became progressively smaller as the season advanced, while the reverse change took place for the factors of the smaller fish. Data for December fish at all lengths were represented in the 1924–1925 season only. In the 1925–1926 season, the data covered small fish taken in December but not larger fish. In these two seasons, the December factors at all lengths were larger than the January factors.

The data for the 1925–1926 and the 1926–1927 seasons showed a much less consistent trend in the monthly factor fluctuations than was shown by the data of the two earlier seasons. The curve for March, 1926, was very unusual and no explanation can be offered for its striking departure from normal. The factors for the larger fish of January, 1927, were apparently smaller than normal, while the April factors for the same season were larger. The monthly factor curve for the smaller fish taken during the 1926–1927 season showed the usual upward trend, except that March factors were greater than April or May.

Because of these irregularities in the different seasons, the general trend of the monthly factor changes was established by combining the average factors at each millimeter for the corresponding months in all four seasons. Since January, February and March were the only

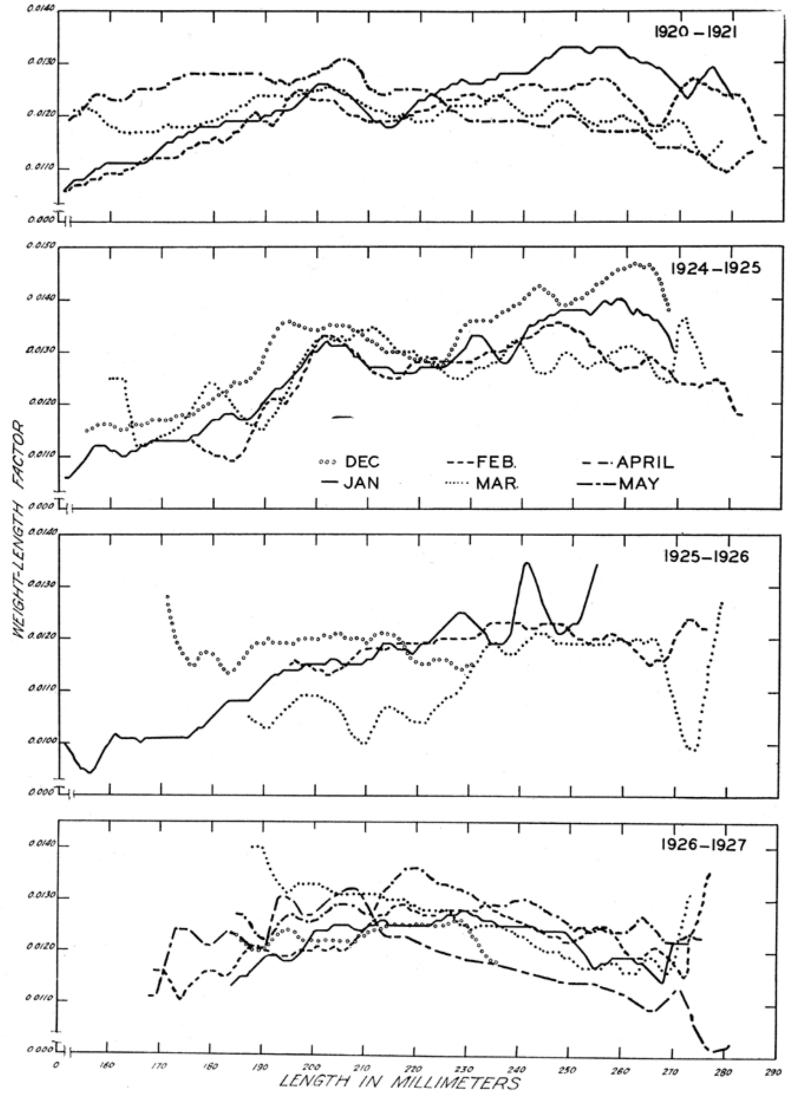

FIG. VI. Weight-length factor curves for each month of four seasons. Factors smoothed twice by a moving average of five.

o o o o December — — — February — . — . April
———— January . . . . . . March — - — May

FIG. VI

months represented in every season, combinations were made for these three months only. The smoothed factors for January of each of the four seasons were summed at each millimeter of length and the sums divided by four. This gave a four-year average weight-length factor at each millimeter for the month of January. In the same manner, the February and March averages were obtained. Figure VII shows the resulting curves. The factors for the larger fish showed the same downward trend from January to March as did the monthly curves for each season. Conversely, the factors for the smaller fish showed the opposite upward trend for the three months, although March factors were scarcely higher than those of February. If the December data of 1924 and 1925 and the April and May data of 1921 and 1927 be considered in addition to the above three months, the trend of the weight-length factors for sardines above 220 mm. was downward from December to May, and for fish between 150 and 220 mm. downward from December to January and then slightly upward from January to May. The trend of these factors during the remaining six months of the year can only be surmised, as data covering the summer months is entirely lacking for

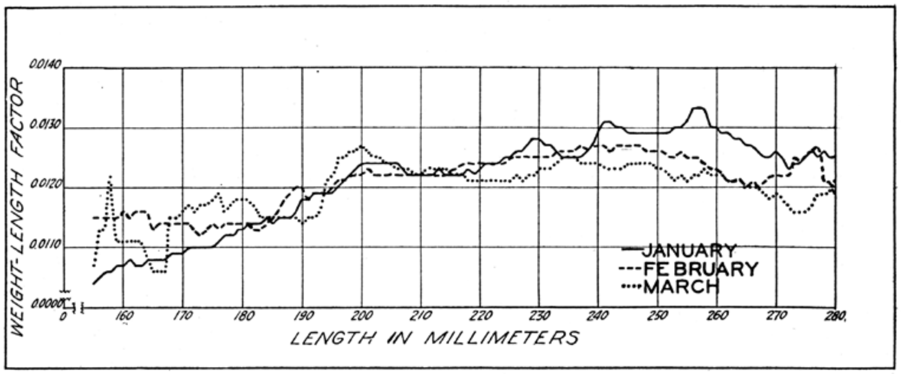

FIG. VII. Weight-length factor curves for January, for February and for March, averaged from data for 1921, 1925, 1926, and 1927. Factors smoothed twice by a moving average of five.

FIG. VII. Weight-length factor curves for January, for February and for March, averaged from data for 1921, 1925, 1926, and 1927. Factors smoothed twice by a moving average of five

sardines of commercial sizes. The causes of these monthly weight-length factor fluctuations and their significance are discussed in sections VI and VII.

5.3. 3. Yearly fluctuations

In addition to the changes of the weight-length factors from month to month, factors for fish of all lengths differed from season to season. Since January, February and March were the only three months represented in every season's data, data for these months were used to obtain a seasonal weight-length factor curve. All the factors at each millimeter of length were summed for these three months of each season and this sum divided by the number of fish at each millimeter. This gave a seasonal average weight-length factor at each millimeter. Figure VIII shows the four resulting seasonal factor curves.

The curves for the 1924–1925 and the 1925–1926 seasons present the greatest contrast. During the three months included in the 1925–1926 data, the factors, for all fish less than 260 mm. in length, were smaller than the factors for any other season. From 260 to 280 mm. the curve coincides with the 1926–1927 curve. On the other hand, the 1924–1925 factors, except those belonging to fish less than 195 mm. in length, were greater than those of any other season. For the smaller fish, factors of 1924–1925 corresponded to those of 1920–1921 and 1926–1927. The 1926–1927 season was unusual in that both the larger and the smaller fish had smaller factors than did the medium sized fish. The 1920–1921 season was probably the most typical of the four seasons studied.

To facilitate comparison of factors from season to season, the average factors at each millimeter of length (within the range 191–260 mm.) for each season were summed and divided by the number of length units involved. This gave an average seasonal factor. This method of obtaining an average weight-length factor for any season was necessary because of the error introduced by the use of the cube rather than a higher power of the length in the formula [$F = 1000W/L^{X}$]. Since, as demonstrated in section III, the weight of sardines increases at a rate slightly greater than the cube of the length, the formula [$F = 1000W/L^{3}$] gave a greater

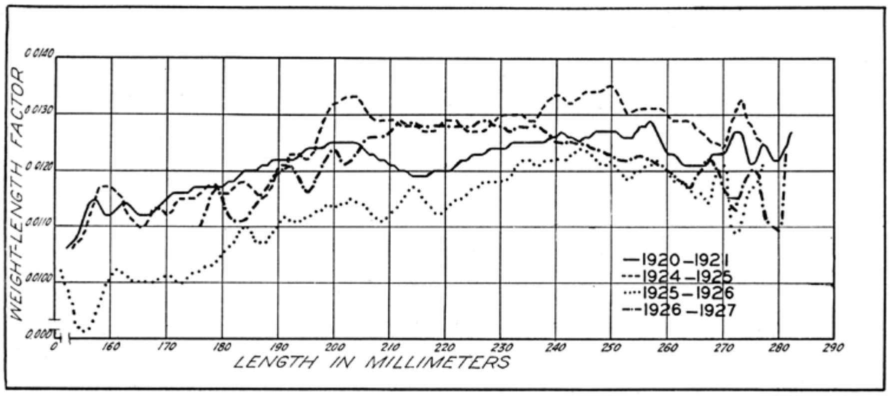

FIG. VIII. Weight-length factor curves for four seasons based on the data for January, February and March of each season. Factors smoothed twice by a moving average of three.

FIG. VIII. Weight-length factor curves for four seasons based on the data for January, February and March of each season. Factors smoothed twice by a moving average of three

value to the weight-length factors for the larger than for the smaller fish, and as the smaller and larger length units are not equally represented from season to season (see Fig. IV), the usual weighted average would not have given as true a seasonal factor average as did the unweighted average obtained by averaging the average factors for each length unit. Averages were based on data from 191 to 260 mm. only, in order to have the same length units represented in all seasons. Data was not complete for length units above and below this range in any season except 1920–1921. The seasons' averages are given in table III.

The average weight-length factor for the 1924–1925 season was greater than for any other season, and that for 1925–1926, less. Although the 1924–1925 and the 1926–1927 averages differed by only one unit, this difference was more than three times its standard error and is therefore significant. The data indicates that the weight-length factors for the 1924–1925 season were on the whole higher than normal and for 1925–1926 unusually low, while in 1920–1921 and 1926–1927 the factors approached the average condition. However, factors for

TABLE III

COMPARISON OF THE AVERAGE WEIGHT-LENGTH FACTORS FOR FOUR SEASONS BASED ON JANUARY, FEBRUARY AND MARCH DATA FOR EACH SEASON

Season	Average factor	Standard error of average* σ M±	Difference between average factors for any two seasons: 1920-1921		1924-1925		1925-1926		1926-1927	
			Difference	σ D±	Difference	σ D±	Difference	σ D±	Difference	σ D±
1920-1921	0.0124	0.000015	----	----	0.0006	0.000052	0.0007	0.000033	0.0001	0.000022
1924-1925	0.0130	0.000028	0.0006	0.000032	----	----	0.0013	0.000040	0.0005	0.000032
1925-1926	0.0117	0.000029	0.0007	0.000033	0.0013	0.000040	----	----	0.0008	0.000033
1926-1927	0.0125	0.000016	0.0001	0.000022	0.0005	0.000032	0.0008	0.000033	----	----

*See section II for method of calculating the standard error of the season's average.

TABLE III COMPARISON OF THE AVERAGE WEIGHT-LENGTH FACTORS FOR FOUR SEASONS BASED ON JANUARY, FEBRUARY AND MARCH DATA FOR EACH SEASON the small fish of the 1924–1925 season, as shown by figure VIII, were not unusually high. In 1925–1926, on the other hand, the factors were abnormally low throughout the entire range of lengths represented in the commercial catch.

6. VI. CAUSES OF THE FACTOR FLUCTUATIONS

The changes in the weight-length factors of sardines from month to month and year to year are obviously due to changes in weight in relation to length. If the weight increases the factor shows a corresponding increase, and conversely, a decrease in weight results in a decrease in the factor. These fluctuations in the weight of sardines may result from changes in the state of maturity of the sex organs, possibly from differences in the amount of undigested food in the alimentary tract, or more probably from changes in the amount of fat stored in the body tissues.

A significant increase in the weight of fishes as the sex organs approach maturity has been demonstrated by several workers. To discount this increase in weight, Reibisch (1908 and 1911) and Heincke and Henking (1908) calculated the value of the weight-length factor for plaice from weights obtained after the gonads had been removed. Johnstone (1910) omitted data on all mature females when calculating the value of the weight-length coefficient for plaice of the Irish Sea. Russell (1914) used data on cleaned haddock to determine fluctuations in the weight-length factor throughout the year.

It does not seem probable that the amount of undigested food in the alimentary tract would have a very great influence on the weight of a fish, and for the sardine, it apparently does not as is shown in the following pages.

Finally, the amount of fat stored in the body tissues undoubtedly does affect the weight of a fish, and changes in fat content result in fluctuations in the weight-length factor.

To determine whether the state of maturity, the amount of food in the alimentary tract, or the amount of fat stored in the body tissue was the chief factor in causing the fluctuations of the weight-length factors for San Pedro sardines, a detailed analysis of the 1920–1921 data was made. Two weights were taken of every fish, first, the total weight and second, the weight after the alimentary tract, liver, swim bladder, gonads, and mesenteric fat had been removed. The weight-length factor calculated from the total weight was designated by F_a and the factor calculated from the weight of eviscerated fish, by F_b. F_b represents, therefore, a weight-length factor which was in no way influenced by the state of maturity of the gonads or by the amount of food in the alimentary tract. Any fluctuations of F_b resulted from changes in weight due to causes other than the state of maturity of the sex organs or the amount of undigested food present.

The weight-length curves for F_a and F_b for January and April, 1921, are presented in figure IX. In the upper graph, the curves for F_b for January and April are contrasted. The values for F_b fluctuated from month to month in the same manner as did the factor values represented by F_a in figure VI. The factors for large fish decreased from January to April and those for small fish increased. February and March values for F_b showed the same progressive monthly fluctuations as did the F_a values for the respective months. To simplify the illustration, these curves were omitted from figure IX. In the two lower graphs of figure IX, the curves for F_a and F_b are contrasted for January and for April. To make the values of F_a and F_b directly comparable, the curves are drawn on a semi-logarithmic scale. Figure IX demonstrates that the weight-length factor values for eviscerated fish fluctuated in the same way as did the factor values based on the total weight of the fish. This similarity held true for minor as well as major fluctuations. The monthly and yearly fluctuations in the weight-length factors of sardines were due, therefore, to some change in the composition of the body tissue of the fish, presumably an increase or decrease in the fat content, and not to the amount of food in the alimentary tract, or to the growth of the sex organs.

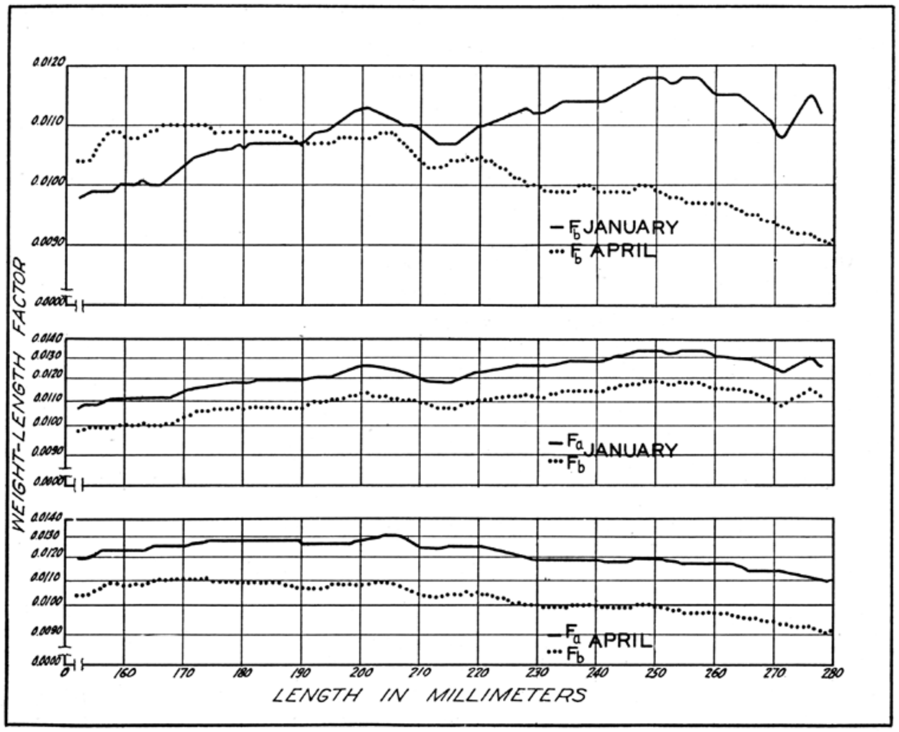

FIG. IX. Comparison of the weight-length factor curves for round fish, F_a, and for eviscerated fish, F_b. Upper graph: F_b for January and April, 1921. Center graph: F_a and F_b for January, 1921, plotted on a semi-logarithmic scale. Lower graph: the same for April, 1921. Data smoothed twice by a moving average of five.

FIG. IX. Comparison of the weight-length factor curves for round fish, F_a, and for eviscerated fish, F_b. Upper graph: F_b for January and April, 1921. Center graph: F_a and F_b for January, 1921, plotted on a semi-logarithmic scale. Lower graph: the same for April, 1921. Data smoothed twice by a moving average of five

That the values of the weight-length factors were not affected by the growth of the gonads is undoubtedly due to the fact that the commercial fishermen do not take, at any time during the season, sardines in a state approaching maturity. Thompson (1919) stated that "the roe in no case examined was so close to a spawning condition as to justify a belief that it was distant less than a month." Observations made since 1919 have substantiated Thompson's findings.

The probability that the fluctuations of the weight-length factor resulted from changes in the fat content of sardines and the reasons for such changes are discussed in the following section.

7. VII. THE WEIGHT-LENGTH FACTOR AS AN INDEX OF CONDITION OF THE SARDINE

The material for 1920–1921, collected, measured and weighed by Mr. Elmer Higgins, was further analyzed by him to determine the state of fat of the sardine throughout the season. Mr. Higgins made a gross determination of the fat content by assigning each fish to one of four groups, 0, 1, 2, 3, and termed these the fat indices. The 0 group represented fish with little fat; the 3 group, fish with a maximum amount of fat; and the 1 and 2 groups, progressive stages between 0 and 3. Fish were grouped according to fat index by an inspection of the amount of fat present in the body cavity.

To determine the percentage of fat in each of the groups, the fish taken on March 17, 1921, were analyzed by Mr. Harry R. Beard, then technologist for the United States Bureau of Fisheries. The following table gives the results:

Fat index	*No. of fish*	*Percentage of fat* [3]
Group 0	48	4.5
Group 1	49	9.8
Group 2	3	12.5
Group 3	0	---

Material for March 29, 1921, was also analyzed but in a slightly different manner. The factors for eviscerated fish were calculated by Mr. Higgins and the fish grouped according to factor. A definite number of fish with varying factors were selected, the average fat index calculated and the fish analyzed by Mr. Beard. The results were as follows:

No. of fish	*Weight-length factor,* F_b	*Fat index*	*Percentage of fat* [4]
9	0.0093–0.0096	0.00	2.2
13	0.0100	0.15	3.1
13	0.0106	0.31	4.3
9	0.0110–0.0118	0.33	4.8

These two groups of analyses showed that fish with a fat index of 0.00 to 0.33 had a fat content of 2.2 to 4.8 per cent; fish with a fat index of 1.00, a fat content of 9.8 per cent; and fish with a fat index of 2.00, a fat content of 12.5 per cent. Since the analysis of the 2 group was based on three fish, the percentage of fat for this group was not as reliable as the percentages for the other two groups. No fish with a fat index of 3 were found on the dates on which the analyses were made, and data on the fat content of this group of sardines are lacking.

The second analysis indicated that the weight-length factors for eviscerated fish reflected the fat content of the fish. Fish with a small factor had a low fat content, and fish with a larger factor a higher fat content. Since the fluctuations of the weight-length factors derived from the total weight were so similar to the fluctuations of the factors for eviscerated fish, the conclusion is justified that the weight-length factor for sardines is a reliable index of the percentage of fat in these fish.

To further correlate the variations in weight-length factors and in fat content, additional studies were made of the fat indices of sardines taken in 1920–1921. The average fat index at each millimeter of length was calculated for January, February, March, and April of 1921. From these average fat indices, curves were constructed for each month. The curves for January and April are presented in the lower graph of figure X. The fat index for fish 150 mm. in length in January was 0.0. From this point the index gradually increased with the increase in size of the fish until it reached a maximum of 2.4 at 250 mm.

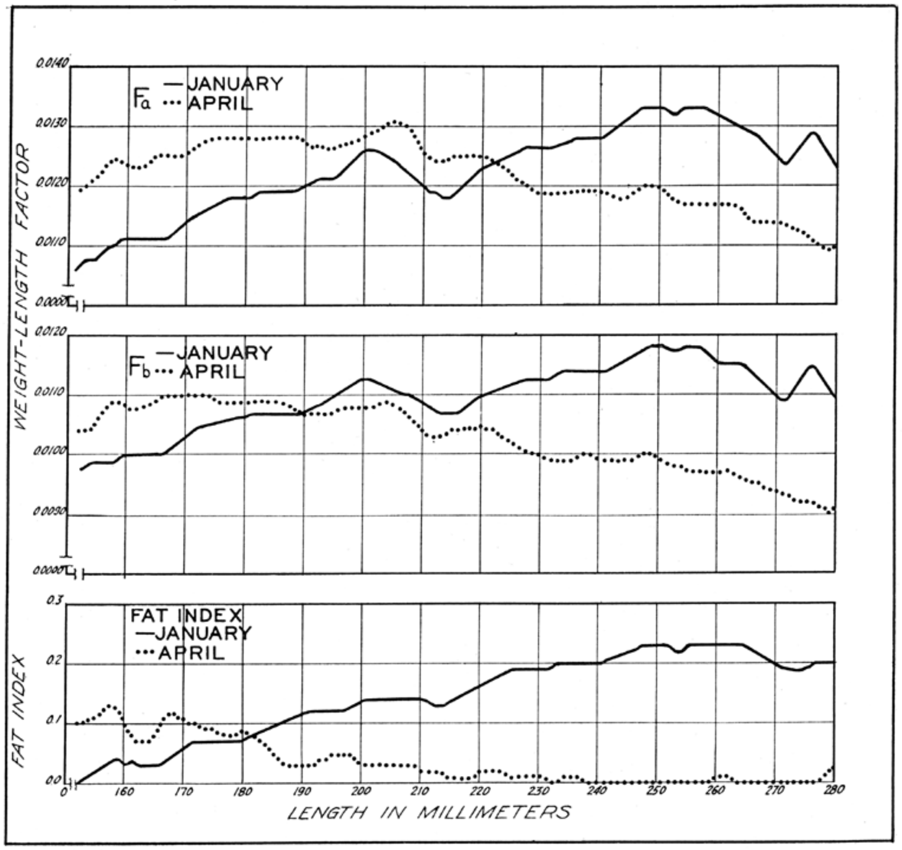

FIG. X. Comparison of the weight-length factor curve based on the total weight of fish, F_a, with the weight-length factor curve based on the weight of eviscerated fish, F_b, and with the fat index curve. Material taken January and April, 1921. Data smoothed twice by a moving average of five.

FIG. X. comparison of the weight-length factor curve based on the total weight of fish, F_a, with the weight-length factor curve based on the weight of eviscerated fish, F_b, and with the fat index curve. Material taken January and April, 1921. Data smoothed twice by a moving average of five

and then fell off slightly for fish between 250 and 280 mm. In April, the fat index curve showed a reverse trend. Sardines 150 mm. in length had a fat index of 1.0, larger fish showed a decreasing index which reached 0.0 at 230 mm. The fat index curves for February and March occupied intermediate points between the January and April curves. Large sardines, therefore, showed a steady decrease in the amount of fat from January to April, while small fish, over the same period of time, showed an increase in the amount of fat. This fluctuation, from January to April, of the fat index, upward for smaller fish and downward for larger fish, was identical with the change in the weight-length factor curves.

To compare the fat index curves with the weight-length factor curves derived from the entire weight of the fish and also from the weight of eviscerated fish, these factor curves for January and April are given in figure X. the upper graph shows the weight-length factors derived from the total weight, and the center graph, the weight-length factors based on the weight of eviscerated fish. The lower graph comprises the fat index curves. In all three graphs the trend of the curves is the same, upward for January and downward for April. However, the F_a weight-length factor curves for January and April cross at 220 mm., the F_b curves cross at 190 mm., and the fat index curves cross at 180 mm. It would seem, therefore, that the weight-length factors for eviscerated fish give a truer index of the fat content than do the factors for round fish. This is undoubtedly true, since the removal of the viscera before weighing eliminates the influence of the size of the sex organs and the amount of undigested food present. The resulting factors consequently reflect smaller changes in the percentage of fat than do factors derived from weights of round fish. For practical purposes, however, factors derived from the total weight of sardines are sufficiently reliable to justify their use in determining the condition of these fish.

A detailed comparison5 of the weight-length factor curves with the fat index curves demonstrates even more clearly the close correlation between changes in factors and changes in fat content. Minor fluctuations of the factor curves are reflected in the minor fluctuations of the fat index curves. This close correspondence between the curves is the more remarkable since fat indices were determined by gross inspection of the fish and the weight-length factors were calculated from accurate measurements of the weight and length. Because of this decided similarity between the factor curves and the fat index curves, the weight-length factors have been considered an index of the condition of sardines.

From the weight-length factors for the portions of the four seasons represented by the data, the conclusion has been drawn that sardines are in their best condition, *i. e.* fattest, in December. Fish larger than 200 mm. decrease in fat content from January to May, and fish between 150 and 200 mm. increase in fat over the same period of time. At what time in the year larger fish reach a minimum and a maximum fat content can not be determined, since data from May to December are entirely lacking. It seems probable, however, that sardines greater than 200 mm. in length have a minimum fat content in the early summer and that this gradually rises to a maximum in the late fall. Evidence for the seasonal change in condition for fish between 150 and 200 mm. is not as conclusive, but the data suggest a minimum condition in January or February, then a rise to a maximum in the late fall.

The reasons for the difference in the condition cycle, for fish above and below 200 mm., can not be explained from the data at hand. Possibly the explanation will be found in maturity. The larger fish comprising the breeders may reach a minimum of condition later in the year than do the smaller, immature fish. The decrease in fat content during the winter months may be due to a decrease in the food supply or to a decrease in the consumption of food because of the lower temperature. With the rise in temperature in the spring, the small fish show a corresponding rise in condition factor. The failure of the larger fish to show a gain in fat content during the spring, as do the smaller fish, may be due to the influence of the spawning season. That fish are in a poor condition during or immediately after the breeding season has been indicated for the plaice by Heincke and Henking (1908) and by Reibisch (1911), for the haddock by Russell (1914) and Sæmundsson (1925), for the whiting by Sæmundsson (1925), for the herring by Johnstone (1915) and Bjerkan (1917), and for the European sardine by Fage (1920). Fage also suggests that the young sardines have a different condition cycle than do the adult fish.

At present too little is known of the size at maturity or of the time of spawning of the California sardine to justify any conclusion concerning the effect of maturity or spawning on the condition cycle of these fish. Such scanty data as are obtainable seem to indicate that maturity is attained between 180 and 220 mm. and that the spawning season occurs in the spring or early summer.

The fat index curves of figure X indicate that smaller fish in April did not have as high a fat content as did the larger fish in January. Dill (1921) in a chemical analysis of California sardines found that small fish, probably less than 190 mm.6, did not attain throughout the year a fat content (percentage of ether extract) greater than 7 per cent. Larger fish, probably greater than 190 mm., in poorest condition had as low a fat content (less than 1 per cent ether extract) as did the smaller fish, but in their best condition these fish far exceeded the small fish in fat content.

From Dill's analyses and from this study of condition factors and fat indices, it is apparent that the smaller sardines have not only a different yearly condition cycle than do the larger fish, but also, they do not attain as high a percentage of fat as do the larger fish. The commercial catch of sardines at San Pedro, consisting as a rule of fish from 150 to 290 mm. in length, may roughly be divided into two groups at the 200 mm. point. In any study of condition, fish smaller than 200 mm. should be considered independently from fish larger than 200 mm.

8. VIII. FLUCTUATIONS OF THE WEIGHT-LENGTH FACTOR WITHIN A YEAR CLASS

The weight-length factors of San Pedro sardines have been compared to the corresponding length-frequency curves to determine whether the factors show any consistent variation within a year class. If the larger fish of a year class were heavier in relation to their length than were the smaller fish, the weight-length factors for the former would be correspondingly higher than those for the latter. Conversely, if the weight of the larger fish was less in relation to the length than that of the smaller fish, the weight-length factors for these larger fish would be smaller than for the smaller individuals. If the first condition holds, the weight-length factor curve for a single year class, when plotted against the length units, will have an upward trend. If the second condition is true, the weight-length factor curve will have a downward trend. Also, if larger fish within a year class had higher factor values than the smaller fish, when the lengths of two year classes coincide,

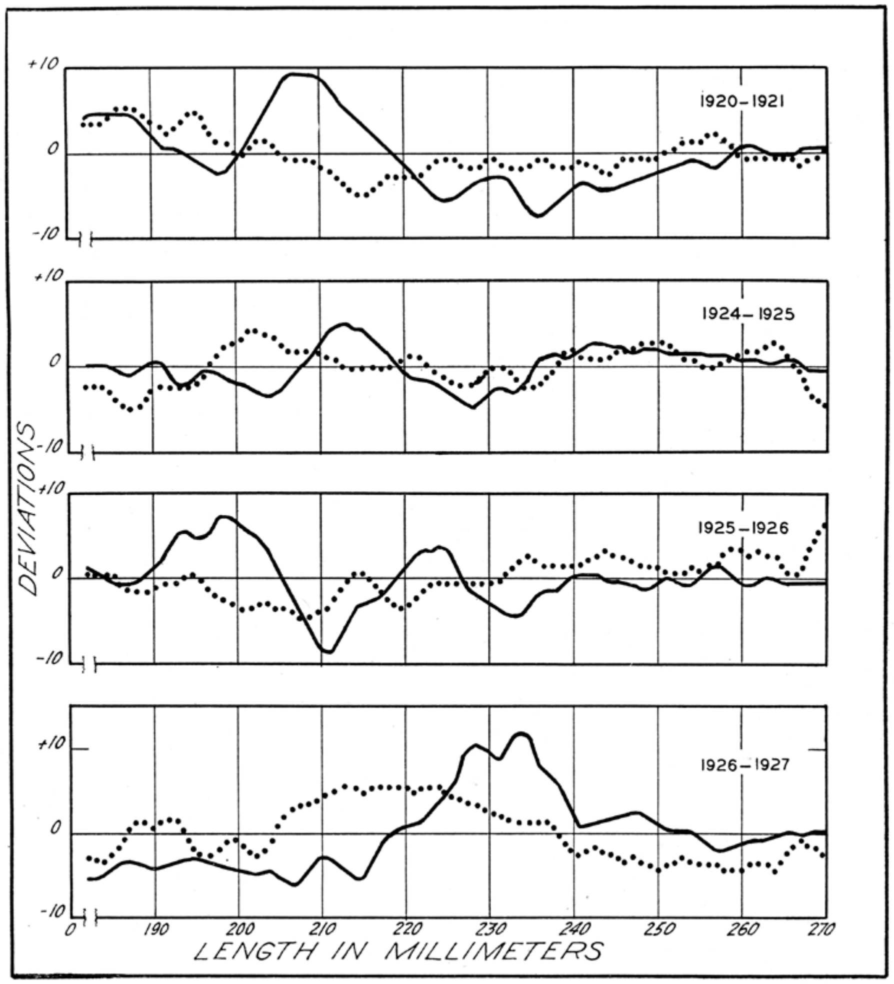

FIG. XI. Comparison of length-frequency and weight-length factor deviations from a four seasons' average. Data smoothed twice by a moving average of three. ————Length-frequency deviations. . . . . . . Weight-length factor deviations.

FIG. XI. Comparison of length-frequency and weight-length factor deviations from a four seasons' average. Data smoothed twice by a moving average of three

older fish at one length unit would have higher factor values than younger fish at the same length unit. On the other hand, if the larger fish of a year class had lower factor values than the smaller fish, then at the same length unit, the older fish would have lower values for the factors than did the younger fish.

Since no means has been devised for determining accurately the age of the California sardine, defining the trend of the weight-length factor curve within a year class is very difficult. The modes in length-frequency curves, such as illustrated in figure IV, probably represents year classes, but these modes do not define the upper and lower limits of a year class; nor, as Thompson (1926) pointed out, is there anything in the length-frequency curves to indicate whether each mode comprises one or more than one year class. It was hoped, if a significant trend in the weight-length factor curves within a year class could be demonstrated, that weight-length factors might be used to break up a length-frequency curve into its component year groups. The results of this study have been far from satisfactory from this viewpoint, but the data suggest a downward trend of the weight-length factor curve within the year class.

To eliminate as far as possible the effect of seasonal changes in the weight-length factor, average factors at each millimeter of length were determined for all the data within a season. The resulting factor curve was then compared with the corresponding length-frequency curve. No consistent downward or upward trend corresponding to the modes of the length-frequency curve could be determined in the factor curve. A downward slope of the factor curve was indicated, however, at the length units comprised in a dominant mode.

To define more clearly this downward trend of the weight-length factors in connection with dominant groups, the deviations of a season's factor curve from the four-seasons' average factor curve were plotted against similar deviations of the length-frequencies from a four-seasons' average. Figure XI shows the resulting curves. To obtain these deviations, the data for January, February and March were summed for each of the seasons, 1920–1921, 1924–1925, 1925–1926, 1926–1927. For the weight-length factors, the average factor for the three months was calculated at each millimeter of length. For the length frequencies, the numbers of fish at each millimeter were summed for the three months, and the resulting numbers at each length unit were expressed in percentages of the total. The average weight-length factors for each of the four seasons were summed at each millimeter and these sums divided by four. This gave a four-season average weight-length factor curve derived from the factors for January, February and March of each season. By using the average factors for each season to obtain the four-seasons' average, each time unit was equally represented in the final average. In a similar manner, the four percentage curves of the length-frequencies for the three months of each of the seasons were summed and the resulting percentages divided by four at each millimeter. This gave a four-season average length-frequency curve derived from data equally representative of each of the four seasons. The deviations, at each millimeter, of the 1920–1921 weight-length factors from the four-seasons' average factors were calculated. Similarly, the 1920–1921 deviations of the numbers of fish at each millimeter, expressed in percentages of the total, were derived from the four-seasons' average percentage curve of the length frequencies. The data for 1924–1925, 1925–1926 and 1926–1927 were treated in the same manner.

The four resulting length-frequency deviation curves fluctuated around the zero line. Dominant modes in the original length-frequency curve for any season appeared as positive deviations in the deviation curve. Similarly, a trend upward of the original weight-length factor curve was represented in the upward slope of the factor deviation curve and a downward trend, in a downward slope. However, since the weight-length factor values for 1924–1925 were all high, the 1924–1925 deviation curve showed no negative deviations. Conversely, the 1925–1926 factor values were all low, and this season's deviation curve was negative throughtout. To facilitate comparison of the weight-length factor deviations with the length-frequency deviations, the factor deviations for each season were weighted by a constant such as would cause the deviations to fluctuate around the zero line. This constant for each season was obtained by summing algebraically the length-frequency deviations and the weight-length factor deviations and dividing each sum by the number of length units involved. This gave the average length-frequency deviation and the average factor deviation for each season. The average factor deviation was then subtracted algebraically from the average frequency deviation and the resulting constant added algebraically to the factor deviation at each millimeter. The last column of the following table gives the constant used for each of the four seasons:

Date	*Average length-frequency deviation*	*Average factor deviation*	*Frequency deviation—factor deviation*
1920–1921	0.0	+0.7	-0.7
1924–1925	0.0	+5.3	-5.3
1925–1926	0.0	-6.5	+6.5
1926–1927	0.0	+0.6	-0.6

In figure XI, the weight-length factor deviation curves, weighted by the constants, are given and not the original deviation curves. The length-frequency deviations of figure XI show a dominant group between 205 and 215 mm. for 1920–1921; between 210 and 220 mm., for 1924–1925; between 195 and 205 mm., for 1925–1926; and between 225 and 240 mm., for 1926–1927. Each of these dominant groups corresponds with a downward trend of the weight-length factor deviations. The downward slope of the line is steeper for some seasons than for others, but the corresponding trends occur in each season's curves.

Positive length-frequency deviations occurring between 220 and 227 mm. in the 1925–1926 data suggest a second mode in the length-frequency curve for this season. This minor mode is accompanied by a slight downward trend of the factor deviations, but the curve slopes upward again too quickly to justify the conclusion that the slope resulted from the influence of the length-frequency mode. In the 1926–1927 graph, the continued downward slope of the factor deviation curve for lengths greater than those involved in the mode, indicates that this trend may have been caused by influences other than the dominant mode.

If the modes occurring in the length-frequency curves for sardines comprise only one-year class, then the data indicate that larger fish of a year group have lower weight-length factor values than do smaller fish of the same year class. The failure of the weight-length factor curves to show downward trends which correspond to minor modes may be explained by the overlapping of the year classes and the consequent maintenance of the weight-length factor curves at a relatively constant level. Only when the factor curve is associated with a dominant year class are the numbers of fish at any length unit sufficiently great to overshadow the influence of overlapping year groups and thus reveal the true trend of the weight-length factor curve. If, on the other hand, it could be demonstrated that the trend of the weight-length factor curve, within a year class, is downward, the data would indicate that each of the dominant groups occurring in the length-frequency curves for sardines comprise only one year class.

The consistent downward trend of the factor curves above 260 mm. may result from this tendency of larger fish of a year class to have a lower factor than smaller fish of the same year class. Only the exceptionally large fish of any year group reach lengths greater than 260 mm., and the piling up of such fish at lengths above 260 mm. would result in a drop in the factor curves. The failure of the weight-length curve to fit the data for large fish in figures I and II, may be accounted for in the same manner. Similarly young fish, growing rapidly, would have a smaller weight in relation to the length than would older fish growing more slowly. This is demonstrated also, by figure II, for fish less than 100 mm. in length.

Little discussion of the fluctuations of the weight-length factors within a year class has been found in the literature. Menzies (1922, 1924) stated that for salmon of equal lengths, the older fish have a smaller factor value than the younger fish, and that the younger fish are in better condition. He also found that factors within a year group increased in value with increase in length. Bjerkan (1917) gave weight-length factors at each centimeter of length for three year groups of North Sea herring. The trend of the factors within the first year group was slightly upward, for the second practically constant, and for the third decidedly downward.

Neither of these citations has any direct bearing on the fluctuations within a year class of the weight-length factors for sardines, nor do the data on which this study was based justify any more definite conclusion than that the trend of the factors within a year group was apparently downward.

IX. SUMMARY

1. The weight-length factors for sardines were derived from the formula $F=\frac{1000W}{L^3}$.

2. Weight-length factors, derived from the above formula, are directly comparable with other factors at the same length unit, but not with factors at any other length unit.

3. The difference between two factors at one length unit is directly comparable with factor differences at any other length unit.

4. The weight of sardines increases at a rate slightly greater than the cube of the length. For the data studied the correct formula for the weight-length factor was found to be $F=\frac{1000W}{L^{3.15}}$. But for the purpose of the present study, the formula $F=\frac{1000W}{L^3}$ was sufficiently accurate.

5. The factor values fluctuated from month to month and differed from season to season.

6. Factors for fish larger than 200 mm. had a different yearly variation than did factors for fish between 150 and 200 mm. The factor values for the larger fish decreased from December to May. The values for the smaller fish decreased from December to January or February

and then increased from February to May. No data was available from May to December.

7. The weight-length factor reflects the fat content of sardines, and is a reliable index of condition for these fish.

8. The fluctuations of the weight-length factor within a year class could not be definitely determined. Data indicated that larger fish of a year group had a smaller factor value than smaller fish of the same age.

X. BIBLIOGRAPHY

Since the literature on the relationship of weight to length of fishes is so widely scattered, the following bibliography has been compiled with the hope that it may be of aid to other workers in this field. No attempt has been made to complete an exhaustive list of references, the papers here noted being those which have been consulted in connection with the study of the weight-length relationship of the sardine. Many of the papers listed contain only brief reference to the relationship between weight and length, and some merely present tables of weight-length data. The important papers are marked with an asterisk (*).

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XI. APPENDIX

Tables of data on which the figures given in the text are based. The tables bear the same numbers as the figures, suffixed by letters.

TABLE IA

AVERAGE WEIGHT AT EACH MILLIMETER OF LENGTH FOR ALL SARDINES. INCLUSIVE DATES: JANUARY TO DECEMBER, 1921; NOVEMBER, 1924 TO MARCH. 1925; NOVEMBER, 1925 TO MARCH, 1926; DECEMBER, 1926 TO MAY, 1927

Body length, mm.	Average weight, gm.	No. of fish	Body length, mm.	Average weight, gm.	No. of fish
69	4	1	139	31	270
70	3	1	140	31	294
71			141	32	260
72			142	33	217
73			143	33	197
74			144	34	178
75			145	35	141
76	4	1	146	36	147
77	5	1	147	37	103
78			148	37	106
79	5	2	149	38	82
80	5	3	150	38	82
81	5	3	151	39	56
82	6	10	152	39	38
83	6	14	153	42	48
84	6	8	154	41	48
85	6	21	155	43	32
86	7	15	156	43	37
87	7	13	157	45	34
88	7	14	158	45	26
89	7	21	159	45	25
90	7	16	160	48	34
91	8	26	161	48	40
92	8	21	162	50	35
93	9	37	163	49	41
94	9	26	164	50	39
95	9	37	165	51	52
96	9	36	166	51	48
97	10	43	167	53	48
98	10	38	168	54	48
99	10	35	169	55	66
100	10	41	170	57	68
101	11	32	171	58	60
102	11	40	172	58	78
103	11	40	173	59	67
104	12	39	174	62	61
105	12	48	175	64	71
106	13	45	176	65	69
107	13	38	177	66	70
108	14	56	178	67	63
109	14	43	179	69	53
110	15	39	180	69	70
111	16	69	181	71	82
112	16	59	182	72	91
113	16	60	183	74	72
114	16	59	184	76	88
115	17	86	185	77	75
116	17	103	186	77	70
117	18	91	187	80	80
118	18	112	188	80	93
119	19	107	189	82	76
120	19	140	190	85	75
121	20	135	191	86	80
122	20	140	192	86	88
123	20	138	193	88	69
124	21	174	194	88	80
125	22	191	195	93	85
126	22	204	196	93	105
127	23	218	197	93	68
128	23	269	198	95	109
129	24	302	199	98	92
130	25	332	200	99	108
131	25	390	201	101	127
132	26	464	202	103	143
133	26	415	203	104	139
134	27	438	204	106	163
135	28	416	205	107	151
136	28	379	206	109	195
137	29	370	207	110	188
138	30	330	208	112	212

TABLE IA AVERAGE WEIGHT AT EACH MILLIMETER OF LENGTH FOR ALL SARDINES. INCLUSIVE DATES: JANUARY TO DECEMBER, 1921; NOVEMBER, 1924 TO MARCH. 1925; NOVEMBER, 1925 TO MARCH, 1926; DECEMBER, 1926 TO MAY, 1927

TABLE IA—Continued

AVERAGE WEIGHT AT EACH MILLIMETER OF LENGTH FOR ALL SARDINES. INCLUSIVE DATES: JANUARY TO DECEMBER, 1921; NOVEMBER, 1924 TO MARCH, 1925; NOVEMBER, 1925 TO MARCH, 1926; DECEMBER, 1926 TO MAY, 1927

Body length, mm.	Average weight, gm.	No. of fish	Body length, mm.	Average weight, gm.	No. of fish
209	113	211	250	194	104
210	114	218	251	195	77
211	116	196	252	195	64
212	117	230	253	199	74
213	119	202	254	202	85
214	120	212	255	205	82
215	122	201	256	208	74
216	125	204	257	209	58
217	126	193	258	206	63
218	126	199	259	215	50
219	130	160	260	211	53
220	131	199	261	215	52
221	133	161	262	219	56
222	133	175	263	220	51
223	138	164	264	223	41
224	139	200	265	222	32
225	141	173	266	217	22
226	143	189	267	223	26
227	146	187	268	226	24
228	147	197	269	236	21
229	151	191	270	236	20
230	152	187	271	239	19
231	152	181	272	231	10
232	155	196	273	242	10
233	158	206	274	243	15
234	161	178	275	231	8
235	161	187	276	255	11
236	163	181	277	247	3
237	166	169	278	253	3
238	169	162	279	256	6
239	169	143	280	257	3
240	173	138	281	251	2
241	178	102	282	278	3
242	174	141	283	308	1
243	178	131	284	----	----
244	180	126	285	245	2
245	184	120	286	274	1
246	185	109	287	----	----
247	185	104	288	294	1
248	189	115			
249	193	90	Total	----	21,956

TABLE IA AVERAGE WEIGHT AT EACH MILLIMETER OF LENGTH FOR ALL SARDINES. INCLUSIVE DATES: JANUARY TO DECEMBER, 1921; NOVEMBER, 1924 TO MARCH. 1925; NOVEMBER, 1925 TO MARCH, 1926; DECEMBER, 1926 TO MAY, 1927

TABLE IIIA AND VIIIA

WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1921

Body length, mm.	Average weight, gm.	Weight-length factor		Number of fish
		$F = \frac{1000W}{L^{3.15}}$	$F = \frac{1000W}{L^3}$	
152	37	0.0049	0.0106	1
153	38	0.0050	0.0106	1
154	39	0.0050	0.0107	1
155	41	0.0052	0.0111	3
156	43	0.0053	0.0113	3
157	46	0.0056	0.0119	2
158	47	0.0056	0.0119	1
159	42	0.0049	0.0104	1
160	46	0.0052	0.0113	6
161	48	0.0054	0.0114	5
162	49	0.0054	0.0115	4
163	49	0.0053	0.0114	9
164	49	0.0052	0.0111	5
165	51	0.0053	0.0114	12
166	50	0.0051	0.0110	14
167	52	0.0052	0.0112	17
168	55	0.0054	0.0115	12
169	54	0.0052	0.0112	22
170	57	0.0054	0.0115	19
171	59	0.0055	0.0118	21
172	59	0.0053	0.0115	32
173	60	0.0053	0.0115	21
174	60	0.0052	0.0114	24
175	64	0.0055	0.0119	18
176	64	0.0054	0.0117	23
177	64	0.0053	0.0116	28
178	67	0.0055	0.0118	24
179	67	0.0054	0.0117	20
180	68	0.0054	0.0117	27
181	70	0.0054	0.0118	44
182	71	0.0054	0.0118	41
183	73	0.0055	0.0119	37
184	75	0.0055	0.0120	44
185	76	0.0055	0.0120	32
186	77	0.0054	0.0120	28
187	80	0.0056	0.0122	32
188	80	0.0055	0.0120	43
189	82	0.0056	0.0121	36
190	85	0.0056	0.0124	20
191	86	0.0056	0.0123	21
192	86	0.0055	0.0122	24
193	86	0.0054	0.0120	18
194	90	0.0056	0.0123	16
195	93	0.0057	0.0126	16
196	93	0.0056	0.0124	17
197	93	0.0055	0.0122	13
198	97	0.0056	0.0125	15
199	99	0.0057	0.0125	17
200	101	0.0057	0.0126	19
201	101	0.0056	0.0124	45
202	103	0.0056	0.0125	46
203	105	0.0057	0.0126	50
204	108	0.0057	0.0127	64
205	105	0.0055	0.0122	72
206	108	0.0055	0.0124	93
207	109	0.0055	0.0123	92
208	110	0.0055	0.0122	92
209	110	0.0054	0.0121	94
210	112	0.0054	0.0121	108
211	115	0.0055	0.0122	85
212	114	0.0054	0.0120	100
213	116	0.0054	0.0120	84
214	116	0.0053	0.0118	94
215	118	0.0053	0.0119	91
216	120	0.0053	0.0119	74
217	122	0.0053	0.0119	74
218	123	0.0053	0.0119	77
219	128	0.0054	0.0122	64
220	129	0.0054	0.0121	64
221	128	0.0053	0.0119	65
222	131	0.0053	0.0120	60
223	135	0.0054	0.0122	54
224	138	0.0055	0.0123	64
225	140	0.0055	0.0123	46
226	142	0.0055	0.0123	66

TABLE IIIA AND VIIIA WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1921

TABLE IIIA AND VIIIA—Continued

WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1921

Body length, mm.	Average weight, gm.	Weight-length factor		Number of fish
		$F=\frac{1000W}{L^{3.15}}$	$F=\frac{1000W}{L^3}$	
227	145	0.0055	0.0124	52
228	146	0.0054	0.0123	59
229	149	0.0055	0.0124	67
230	153	0.0056	0.0126	49
231	152	0.0054	0.0123	62
232	155	0.0055	0.0124	69
233	159	0.0056	0.0126	68
234	160	0.0055	0.0125	41
235	161	0.0055	0.0124	46
236	166	0.0056	0.0126	44
237	168	0.0055	0.0126	40
238	167	0.0054	0.0124	42
239	172	0.0056	0.0126	38
240	174	0.0055	0.0126	28
241	181	0.0057	0.0129	42
242	176	0.0054	0.0124	33
243	182	0.0055	0.0127	34
244	177	0.0054	0.0122	34
245	188	0.0056	0.0128	30
246	189	0.0055	0.0127	27
247	188	0.0054	0.0125	29
248	195	0.0056	0.0128	30
249	196	0.0056	0.0127	21
250	195	0.0054	0.0125	31
251	202	0.0056	0.0128	18
252	202	0.0055	0.0126	14
253	204	0.0055	0.0126	26
254	205	0.0054	0.0125	23
255	212	0.0055	0.0128	23
256	215	0.0056	0.0128	17
257	224	0.0057	0.0132	9
258	216	0.0054	0.0126	18
259	221	0.0055	0.0127	21
260	211	0.0052	0.0120	18
261	215	0.0052	0.0121	18
262	227	0.0055	0.0126	18
263	220	0.0052	0.0121	17
264	213	0.0050	0.0116	7
265	229	0.0053	0.0123	12
266	233	0.0053	0.0124	2
267	219	0.0050	0.0115	12
268	243	0.0055	0.0126	6
269	243	0.0054	0.0125	12
270	242	0.0053	0.0123	4
271	237	0.0051	0.0119	8
272	256	0.0055	0.0127	3
273	289	0.0061	0.0142	1
274	247	0.0052	0.0120	6
275	225	0.0047	0.0108	3
276	261	0.0053	0.0124	3
277	289	0.0059	0.0136	1
278	254	0.0051	0.0118	3
279	263	0.0052	0.0121	3
280	266	0.0052	0.0121	2
281	271	0.0052	0.0122	1
282	298	0.0057	0.0133	1
Total				4,173

TABLE IIIA AND VIIIA WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1921

TABLE IIIB AND VIIIB

WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1925

Body length, mm.	Average weight, gm.	Weight-length factor $F=\frac{1000W}{L^{3.15}}$	Weight-length factor $F=\frac{1000W}{L^{3}}$	Number of fish
152	37	0.0050	0.0105	1
153				
154	39	0.0050	0.0108	1
155				
156				
157				
158	45	0.0053	0.0115	1
159				
160	50	0.0057	0.0122	1
161	47	0.0052	0.0112	4
162				
163				
164	50	0.0053	0.0114	1
165	48	0.0050	0.0107	2
166	49	0.0050	0.0107	2
167	53	0.0053	0.0114	4
168	55	0.0054	0.0115	2
169	55	0.0053	0.0114	3
170	54	0.0051	0.0109	2
171	55	0.0051	0.0110	2
172	62	0.0056	0.0121	4
173	59	0.0053	0.0113	3
174	61	0.0053	0.0115	3
175	61	0.0052	0.0114	3
176	65	0.0055	0.0119	3
177	63	0.0052	0.0114	5
178	66	0.0054	0.0117	4
179	69	0.0055	0.0121	7
180	64	0.0050	0.0110	3
181	71	0.0055	0.0119	7
182	69	0.0052	0.0115	9
183	73	0.0055	0.0119	4
184	75	0.0055	0.0120	7
185	74	0.0053	0.0117	4
186	75	0.0053	0.0117	6
187	72	0.0050	0.0110	1
188	78	0.0054	0.0117	5
189	79	0.0054	0.0117	3
190	86	0.0057	0.0126	9
191	82	0.0054	0.0117	6
192	88	0.0057	0.0125	6
193				
194				
195	92	0.0056	0.0124	5
196	89	0.0054	0.0118	6
197	97	0.0058	0.0127	4
198	102	0.0059	0.0132	8
199	103	0.0059	0.0131	6
200	106	0.0060	0.0132	3
201	106	0.0059	0.0130	9
202	114	0.0063	0.0138	8
203	109	0.0059	0.0130	8
204	111	0.0059	0.0131	9
205	118	0.0062	0.0137	6
206	113	0.0058	0.0129	13
207	112	0.0057	0.0126	16
208	117	0.0058	0.0130	19
209	118	0.0058	0.0129	18
210	119	0.0058	0.0129	16
211	121	0.0058	0.0129	28
212	122	0.0057	0.0128	26
213	123	0.0058	0.0127	24
214	126	0.0058	0.0129	25
215	128	0.0058	0.0129	29
216	126	0.0056	0.0125	22
217	132	0.0058	0.0129	22
218	130	0.0056	0.0125	22
219	137	0.0058	0.0130	17
220	135	0.0057	0.0127	21
221	142	0.0059	0.0132	19
222	140	0.0057	0.0128	18
223	141	0.0057	0.0127	18
224	144	0.0057	0.0128	26
225	142	0.0055	0.0125	14
226	145	0.0056	0.0126	18

TABLE IIIB AND VIIIB WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1925

TABLE IIIB AND VIIIB—Continued

WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1925

Body length, mm.	Average weight, gm.	Weight-length factor		Number of fish
		$F=\frac{1000W}{L^{3.15}}$	$F=\frac{1000W}{L^{3}}$	
227	153	0.0058	0.0131	22
228	147	0.0055	0.0124	13
229	155	0.0057	0.0129	11
230	161	0.0058	0.0132	18
231	159	0.0057	0.0129	24
232	164	0.0058	0.0131	14
233	163	0.0057	0.0129	15
234	168	0.0058	0.0131	23
235	167	—0.0057	0.0129	14
236	166	0.0056	0.0126	25
237	176	0.0058	0.0132	21
238	177	0.0058	0.0131	22
239	182	0.0059	0.0133	13
240	188	0.0060	0.0136	15
241	188	0.0059	0.0134	16
242	186	0.0058	0.0131	18
243	187	0.0057	0.0130	13
244	195	0.0059	0.0134	24
245	200	0.0060	0.0136	12
246	198	0.0058	0.0133	15
247	200	0.0058	0.0133	13
248	203	0.0058	0.0133	14
249	210	0.0060	0.0136	11
250	209	0.0058	0.0134	15
251	217	0.0060	0.0137	8
252	213	0.0058	0.0133	8
253	202	0.0054	0.0125	9
254	218	0.0058	0.0133	10
255	215	0.0056	0.0130	10
256	225	0.0058	0.0134	4
257	214	0.0055	0.0126	11
258	230	0.0058	0.0134	7
259	228	0.0057	0.0131	5
260	229	0.0057	0.0130	4
261	231	0.0056	0.0130	6
262	228	0.0055	0.0127	7
263	224	0.0053	0.0123	1
264	258	0.0061	0.0140	5
265	231	0.0054	0.0124	5
266	233	0.0053	0.0124	1
267	242	0.0055	0.0127	4
268	241	0.0054	0.0125	1
269	253	0.0056	0.0130	1
270	220	0.0048	0.0112	1
271	267	0.0058	0.0134	3
272				
273	279	0.0059	0.0137	1
274	261	0.0055	0.0127	2
275				
276	261	0.0053	0.0124	2
277				
278				
279				
280				
281				
282	265	0.0051	0.0118	1
Total				1,149

TABLE IIIB AND VIIIB WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1925

TABLE IIIC AND VIIIC

WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1926

Body length, mm.	Average weight, gm.	Weight-length factor		Number of fish
		$F=\frac{1000W}{L^{3.15}}$	$F=\frac{1000W}{L^3}$	
151	35	0.0048	0.0102	1
152	35	0.0047	0.0101	2
153	35	0.0046	0.0099	3
154	31	0.0040	0.0085	1
155				
156	35	0.0043	0.0092	1
157				
158	38	0.0045	0.0096	1
159				
160	40	0.0046	0.0098	1
161	45	0.0050	0.0109	2
162				
163	42	0.0045	0.0096	8
164	46	0.0049	0.0104	4
165	45	0.0047	0.0100	8
166	44	0.0045	0.0097	9
167	48	0.0048	0.0102	6
168	47	0.0046	0.0100	8
169	48	0.0046	0.0100	8
170	51	0.0048	0.0103	8
171	51	0.0047	0.0103	5
172	50	0.0045	0.0098	17
173	51	0.0045	0.0099	16
174	54	0.0047	0.0102	9
175	54	0.0046	0.0101	9
176	56	0.0047	0.0102	9
177	58	0.0048	0.0105	6
178	57	0.0047	0.0101	6
179	60	0.0048	0.0105	2
180	61	0.0048	0.0104	5
181	63	0.0049	0.0106	2
182	65	0.0049	0.0108	11
183	65	0.0049	0.0106	5
184	72	0.0053	0.0115	3
185	69	0.0050	0.0109	4
186	66	0.0047	0.0103	3
187	71	0.0049	0.0108	3
188	71	0.0049	0.0107	3
189	74	0.0050	0.0109	3
190	75	0.0050	0.0109	7
191	80	0.0052	0.0115	4
192	78	0.0050	0.0110	9
193	81	0.0051	0.0112	7
194	80	0.0050	0.0109	10
195	84	0.0051	0.0113	9
196	86	0.0052	0.0114	5
197	85	0.0050	0.0111	8
198	88	0.0051	0.0113	18
199	91	0.0052	0.0115	8
200	90	0.0051	0.0112	15
201	95	0.0053	0.0117	9
202	89	0.0049	0.0108	12
203	102	0.0055	0.0122	15
204	93	0.0049	0.0110	13
205	97	0.0051	0.0113	10
206	101	0.0052	0.0116	8
207	98	0.0050	0.0110	11
208	101	0.0050	0.0112	12
209	99	0.0049	0.0108	6
210	105	0.0051	0.0113	5
211	106	0.0051	0.0113	6
212	107	0.0050	0.0112	12
213	114	0.0053	0.0118	5
214	115	0.0053	0.0117	20
215	117	0.0053	0.0118	15
216	116	0.0051	0.0115	8
217	115	0.0050	0.0113	15
218	119	0.0051	0.0115	19
219	116	0.0049	0.0110	10
220	118	0.0050	0.0111	17
221	126	0.0052	0.0117	17
222	124	0.0050	0.0113	24
223	128	0.0051	0.0115	15
224	131	0.0052	0.0117	19
225	133	0.0052	0.0117	24

TABLE IIIC AND VIIIC WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1926

TABLE IIIC AND VIIIC—Continued

WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1926

Body length, mm.	Average weight, gm.	Weight-length factor		Number of fish
		$F=\frac{1000W}{L^{3.15}}$	$F=\frac{1000W}{L^{3}}$	
226	132	0.0051	0.0114	21
227	142	0.0054	0.0121	12
228	138	0.0052	0.0116	17
229	141	0.0052	0.0117	10
230	145	0.0053	0.0119	16
231	145	0.0052	0.0118	15
232	145	0.0051	0.0116	8
233	153	0.0054	0.0121	16
234	160	0.0055	0.0125	11
235	161	0.0055	0.0124	11
236	155	0.0052	0.0118	18
237	157	0.0052	0.0118	17
238	169	0.0055	0.0125	8
239	167	0.0054	0.0122	11
240	167	0.0053	0.0121	17
241	172	0.0054	0.0123	7
242	170	0.0052	0.0120	9
243	178	0.0054	0.0124	16
244	180	0.0054	0.0124	9
245	184	0.0055	0.0125	9
246	185	0.0054	0.0124	10
247	176	0.0051	0.0117	9
248	188	0.0054	0.0123	8
249	187	0.0053	0.0121	5
250	192	0.0054	0.0123	6
251	190	0.0052	0.0120	11
252	194	0.0053	0.0121	4
253	175	0.0047	0.0108	3
254	213	0.0056	0.0130	7
255	191	0.0050	0.0115	4
256	205	0.0053	0.0122	6
257	202	0.0052	0.0119	9
258	211	0.0053	0.0123	5
259	217	0.0054	0.0125	3
260	209	0.0052	0.0119	3
261	203	0.0049	0.0114	2
262	220	0.0053	0.0122	2
263	213	0.0051	0.0117	5
264	219	0.0051	0.0119	3
265	197	0.0046	0.0106	1
266	241	0.0055	0.0128	1
267	200	0.0045	0.0105	1
268	223	0.0050	0.0116	2
269				
270	258	0.0057	0.0131	1
271				
272	193	0.0041	0.0096	1
273				
274	245	0.0051	0.0119	1
275	239	0.0050	0.0115	2
276	250	0.0051	0.0119	1
277				
278				
279	287	0.0057	0.0132	1
Total				994

TABLE IIIC AND VIIIC WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1926

TABLE IIID AND VIIID

WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1927

Body length, mm.	Average weight, gm.	Weight-length factor		Number of fish
		$F=\frac{1000W}{L^{3.15}}$	$F=\frac{1000W}{L^{3}}$	
169	56	0.0054	0.0116	1
170				
171				
172				
173				
174				
175				
176	60	0.0050	0.0110	1
177				
178				
179	68	0.0054	0.0119	1
180				
181	65	0.0050	0.0110	1
182				
183				
184	70	0.0051	0.0112	1
185				
186	71	0.0050	0.0110	1
187	78	0.0054	0.0119	4
188	78	0.0054	0.0117	2
189	80	0.0054	0.0119	1
190	82	0.0054	0.0120	1
191	84	0.0055	0.0121	3
192	85	0.0055	0.0120	1
193	91	0.0057	0.0126	3
194	83	0.0052	0.0113	4
195	85	0.0052	0.0114	2
196	90	0.0054	0.0119	4
197	89	0.0053	0.0116	3
198	98	0.0057	0.0126	7
199	93	0.0053	0.0118	4
200	102	0.0058	0.0128	6
201	103	0.0057	0.0127	7
202	93	0.0051	0.0113	10
203	104	0.0056	0.0124	9
204	105	0.0055	0.0124	17
205	108	0.0056	0.0125	10
206	108	0.0055	0.0124	14
207	116	0.0059	0.0131	9
208	112	0.0056	0.0124	25
209	112	0.0055	0.0123	23
210	120	0.0058	0.0130	29
211	119	0.0057	0.0127	21
212	123	0.0058	0.0129	32
213	125	0.0058	0.0129	28
214	125	0.0057	0.0128	24
215	127	0.0057	0.0128	16
216	131	0.0058	0.0130	36
217	129	0.0057	0.0126	32
218	134	0.0058	0.0129	33
219	136	0.0058	0.0129	30
220	135	0.0057	0.0127	45
221	138	0.0057	0.0128	28
222	140	0.0057	0.0128	40
223	143	0.0057	0.0129	42
224	144	0.0057	0.0128	47
225	145	0.0056	0.0127	46
226	150	0.0058	0.0130	45
227	150	0.0057	0.0128	60
228	153	0.0057	0.0129	55
229	155	0.0057	0.0129	57
230	156	0.0057	0.0128	50
231	157	0.0056	0.0127	42
232	159	0.0056	0.0127	56
233	161	0.0056	0.0127	61
234	165	0.0057	0.0129	57
235	166	0.0056	0.0128	65
236	166	0.0056	0.0126	43
237	173	0.0057	0.0130	45
238	173	0.0056	0.0128	49
239	169	0.0055	0.0124	34
240	171	0.0054	0.0124	28
241	175	0.0055	0.0125	13
242	177	0.0055	0.0125	35
243	182	0.0055	0.0127	25

TABLE IIID AND VIIID—Continued

WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1927

Body length, mm.	Average weight, gm.	Weight-length factor		Number of fish
		$F=\frac{1000W}{L^{3.15}}$	$F=\frac{1000W}{L^{3}}$	
244	182	0.0055	0.0125	29
245	184	0.0055	0.0125	27
246	185	0.0054	0.0124	23
247	185	0.0054	0.0123	24
248	189	0.0054	0.0124	27
249	191	0.0054	0.0124	21
250	191	0.0053	0.0122	18
251	193	0.0053	0.0122	15
252	194	0.0053	0.0121	8
253	201	0.0054	0.0124	18
254	198	0.0053	0.0121	14
255	204	0.0053	0.0123	9
256	205	0.0053	0.0122	12
257	211	0.0054	0.0124	6
258	206	0.0052	0.0120	4
259	212	0.0053	0.0122	6
260	209	0.0052	0.0119	7
261	212	0.0052	0.0119	5
262	212	0.0051	0.0118	5
263	216	0.0051	0.0119	6
264	212	0.0050	0.0115	6
265	220	0.0051	0.0118	6
266	224	0.0051	0.0119	4
267	240	0.0054	0.0126	1
268	235	0.0053	0.0122	5
269	240	0.0053	0.0123	2
270	230	0.0051	0.0117	4
271	221	0.0048	0.0111	2
272	221	0.0047	0.0110	1
273	236	0.0050	0.0116	3
274	241	0.0050	0.0117	1
275	268	0.0056	0.0129	1
276				
277	240	0.0049	0.0113	1
278				
279	237	0.0047	0.0109	1
280				
281				
282				
283	308	0.0058	0.0136	1
Total				1,847

TABLE IIID AND VIIID WEIGHT-LENGTH DATA FOR SARDINES TAKEN DURING JANUARY, FEBRUARY AND MARCH, 1927

TABLE VIA

AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920-1921 SEASON. $F_a = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

Body length, mm.	January		February		March		April	
	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a
152	1	0.0106					1	0.0120
153			1	0.0106				
154	1	0.0107					1	0.0118
155	2	0.0107			1	0.0118		
156	3	0.0113						
157			1	0.0109	1	0.0129	3	0.0126
158					1	0.0119		
159			1	0.0104				
160	1	0.0112	4	0.0114	1	0.0112	1	0.0125
161			2	0.0108	3	0.0118	2	0.0121
162	1	0.0108			3	0.0117	2	0.0125
163	4	0.0114	3	0.0111	2	0.0118	1	0.0118
164	2	0.0110	2	0.0106	1	0.0122		
165	3	0.0113	5	0.0113	4	0.0117	5	0.0127
166	3	0.0108	8	0.0110	3	0.0111		
167	7	0.0109	6	0.0112	4	0.0116	1	0.0127
168	3	0.0111	5	0.0115	4	0.0118	2	0.0131
169	12	0.0109	6	0.0113	4	0.0118	3	0.0117
170	3	0.0119	5	0.0109	11	0.0117	2	0.0122
171	6	0.0116	6	0.0111	9	0.0124	4	0.0125
172	11	0.0115	8	0.0113	13	0.0116	2	0.0134
173	8	0.0116	2	0.0111	11	0.0115	2	0.0130
174	9	0.0113	8	0.0110	7	0.0120	4	0.0124
175	4	0.0122	8	0.0117	6	0.0120	4	0.0124
176	11	0.0116	2	0.0115	10	0.0118	3	0.0130
177	10	0.0115	6	0.0116	12	0.0117	2	0.0133
178	9	0.0120	9	0.0114	6	0.0119	5	0.0125
179	4	0.0121	9	0.0114	7	0.0118		
180	12	0.0117	4	0.0118	11	0.0118	3	0.0127
181	14	0.0118	11	0.0116	19	0.0120	4	0.0123
182	17	0.0116	7	0.0112	17	0.0121	4	0.0133
183	13	0.0121	11	0.0117	13	0.0121	2	0.0130
184	18	0.0118	9	0.0119	17	0.0122	8	0.0129
185	17	0.0120	2	0.0108	13	0.0121	4	0.0126
186	8	0.0120	3	0.0116	17	0.0121	3	0.0123
187	12	0.0117	1	0.0128	19	0.0125	5	0.0132
188	23	0.0118	1	0.0129	19	0.0122	6	0.0131
189	19	0.0118	2	0.0119	15	0.0125	3	0.0128
190	3	0.0120	4	0.0120	13	0.0126	7	0.0128
191	5	0.0122	1	0.0112	15	0.0124	6	0.0124
192	11	0.0121	2	0.0115	11	0.0126	5	0.0120
193	7	0.0117	4	0.0119	7	0.0122	2	0.0135
194	6	0.0126	1	0.0126	9	0.0120	4	0.0126
195	4	0.0125	3	0.0131	9	0.0124	4	0.0125
196	4	0.0113	6	0.0127	7	0.0128	2	0.0125
197	5	0.0123	1	0.0126	7	0.0120	3	0.0125
198	2	0.0123	3	0.0118	10	0.0128	4	0.0128
199	4	0.0125	3	0.0124	10	0.0125	2	0.0129
200	3	0.0132	5	0.0122	11	0.0126	2	0.0131
201	7	0.0124	10	0.0125	28	0.0124	1	0.0127
202	8	0.0129	13	0.0123	25	0.0124	3	0.0125
203	17	0.0123	8	0.0120	25	0.0130	2	0.0128
204	10	0.0128	10	0.0127	44	0.0126	3	0.0133
205	13	0.0120	14	0.0121	45	0.0124	1	0.0136
206	21	0.0126	26	0.0122	46	0.0123	4	0.0133
207	24	0.0121	16	0.0121	52	0.0124	5	0.0129
208	16	0.0125	15	0.0116	61	0.0122	6	0.0130
209	18	0.0122	24	0.0118	52	0.0122	4	0.0127
210	12	0.0116	27	0.0118	69	0.0123	5	0.0122
211	16	0.0119	15	0.0125	54	0.0122	6	0.0123
212	13	0.0120	27	0.0120	60	0.0120	9	0.0125
213	13	0.0118	14	0.0115	57	0.0121	8	0.0120
214	11	0.0116	24	0.0116	59	0.0120	8	0.0129
215	11	0.0118	30	0.0121	50	0.0119	10	0.0122
216	14	0.0116	21	0.0120	39	0.0121	14	0.0124
217	9	0.0119	19	0.0120	46	0.0119	6	0.0128
218	9	0.0124	23	0.0117	45	0.0119	11	0.0126
219	10	0.0124	19	0.0122	35	0.0121	6	0.0123
220	13	0.0124	25	9.0122	26	0.0120	9	0.0126
221	8	0.0122	31	0.0121	26	0.0117	7	0.0129
222	11	0.0123	25	0.0120	24	0.0118	9	0.0122

TABLE VIA AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920–1921 SEASON. [$F_a = 100w/L^3$], WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

TABLE VIA—Continued

AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920-1921 SEASON. $F_a = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

Body length, mm.	January		February		March		April	
	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a
223	11	0.0121	27	0.0124	16	0.0118	6	0.0122
224	11	0.0128	32	0.0124	21	0.0121	10	0.0123
225	5	0.0126	27	0.0122	14	0.0124	8	0.0124
226	10	0.0125	43	0.0123	13	0.0123	9	0.0122
227	12	0.0126	23	0.0123	17	0.0123	10	0.0121
228	6	0.0131	38	0.0123	15	0.0120	11	0.0117
229	14	0.0124	42	0.0125	11	0.0120	10	0.0119
230	12	0.0126	23	0.0126	14	0.0125	15	0.0121
231	11	0.0125	38	0.0124	13	0.0116	11	0.0120
232	8	0.0125	47	0.0123	14	0.0122	10	0.0116
233	11	0.0128	47	0.0119	10	0.0127	16	0.0117
234	10	0.0128	24	0.0124	7	0.0123	14	0.0120
235	11	0.0127	29	0.0124	6	0.0122	15	0.0120
236	13	0.0129	26	0.0124	5	0.0129	18	0.0119
237	7	0.0130	28	0.0126	5	0.0127	15	0.0116
238	9	0.0126	26	0.0123	7	0.0122	11	0.0120
239	11	0.0130	25	0.0125	2	0.0115	8	0.0121
240	6	0.0126	17	0.0130	5	0.0115	14	0.0116
241	15	0.0130	21	0.0128	6	0.0127	10	0.0121
242	9	0.0125	19	0.0125	5	0.0117	20	0.0119
243	4	0.0131	25	0.0128	5	0.0118	16	0.0118
244	8	0.0130	21	0.0120	5	0.0118	12	0.0115
245	8	0.0131	17	0.0127	5	0.0126	15	0.0116
246	4	0.0136	22	0.0126	1	0.0126	16	0.0119
247	6	0.0129	18	0.0123	5	0.0126	9	0.0123
248	9	0.0138	16	0.0125	5	0.0119	15	0.0119
249	8	0.0129	13	0.0126			15	0.0122
250	4	0.0138	20	0.0124	7	0.0120	14	0.0121
251	3	0.0136	11	0.0127	4	0.0124	11	0.0121
252	4	0.0127	7	0.0128	3	0.0119	21	0.0118
253	10	0.0128	12	9.0126	4	0.0120	10	0.0114
254	6	0.0136	13	0.0124	4	0.0110	14	0.0119
255	5	0.0132	15	0.0129	3	0.0118	17	0.0117
256	3	0.0133	11	0.0128	3	0.0124	19	0.0115
257	2	0.0137	7	0.0130			12	0.0120
258	6	0.0134	11	0.0122	1	0.0119	18	0.0116
259	4	0.0131	15	0.0126	2	0.0122	7	0.0113
260	3	0.0128	11	0.0121	4	0.0114	14	0.0121
261	2	0.0129	13	0.0119	3	0.0126	13	0.0119
262	3	0.0131	11	0.0127	4	0.0120	16	0.0117
263	2	0.0132	13	0.0122	2	0.0109	13	0.0118
264	2	0.0132	5	0.0110			12	0.0117
265	4	0.0131	7	0.0119	1	0.0116	6	0.0111
266	1	0.0125			1	0.0124	11	0.0112
267	2	0.0126	5	0.0112	5	0.0114	3	0.0118
268	2	0.0129	4	0.0125			6	0.0113
269	4	0.0130	8	0.0122			2	0.0113
270			3	0.0125	1	0.0117	8	0.0116
271	4	0.0116	3	0.0122	1	0.0125	2	0.0116
272	1	0.0122	2	0.0130			4	0.0110
273			1	0.0142			4	0.0112
274	2	0.0128	3	0.0116	1	0.0115	5	0.0111
275			1	0.0124	2	0.0100		
276	1	0.0140	1	0.0117	1	0.0116	3	0.0115
277			1	0.0136				
278	2	0.0117			1	0.0121		
279			3	0.0121			1	0.0103
280			2	0.0121			1	0.0109
281			1	0.0122				
282			1	0.0133			1	0.0121
283								
284								
285			1	0.0108			1	0.0103
286			1	0.0117				
287								
288					1	0.0123		
Totals	940		1,584		1,652		878	

TABLE VIA AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920–1921 SEASON. [$F_a = 100w/L^3$], WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

TABLE VIB

AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1921-1925 SEASON. $F_a = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

Body length, mm.	December		January		February		March	
	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a
152			1	0.0105				
153								
154			1	0.0108				
155	1	0.0114						
156	1	0.0112						
157	1	0.0119						
158	1	0.0112	1	0.0115				
159	2	0.0124						
160	1	0.0114			1	0.0122		
161	5	0.0114	3	0.0108			1	0.0125
162	4	0.0112						
163	2	0.0115						
164	5	0.0116	1	0.0114				
165	4	0.0120	2	0.0107				
166	6	0.0114	2	0.0107				
167	7	0.0117	4	0.0114				
168	3	0.0116	1	0.0119			1	0.0110
169	11	0.0116	2	o.0113			1	0.0116
170	9	0.0115	2	0.0110				
171	8	0.0121	1	0.0109			1	0.0110
172	4	0.0115	2	0.0117			2	0.0124
173	6	0.0121	2	0.0117			1	0.0104
174	7	0.0116	2	0.0113			1	0.0121
175	5	0.0116	1	0.0104			2	0.0118
176	4	0.0121	3	0.0119				
177	1	0.0117	4	0.0113			1	0.0119
178	3	0.0121	2	0.0114	1	0.0115	1	0.0124
179	2	0.0120	6	0.0120			1	0.0129
180	4	0.0117	2	0.0113	1	0.0105		
181	1	0.0131	4	0.0121	2	0.0112	1	0.0124
182	1	0.0120	7	0.0114			2	0.0119
183	5	0.0117	4	0.0119				
184	2	0.0130	5	0.0120			2	0.0122
185	4	0.0122	2	0.0119			2	0.0115
186	1	0.0120	5	0.0118	1	0.0109		
187	3	0.0126	1	0.0110				
188	1	0.0131	4	0.0118			1	0.0116
189	1	0.0121	3	0.0117				
190	3	0.0131	7	9.0129	1	0.0123	1	0.0113
191	4	0.0132	6	0.0117				
192			4	0.0128	1	0.0119	1	0.0119
193	1	0.0142						
194	2	0.0134						
195	7	0.0138	3	0.0124			2	0.0124
196	3	0.0133	4	0.0116	2	0.0121		
197	1	0.0135	1	0.0129			3	0.0127
198			6	0.0133			2	0.0126
199	3	0.0130	3	0.0131	2	0.0130	1	0.0136
200	4	0.0139	3	0.0132				
201	5	0.0130	5	0.0127			4	0.0133
202	6	0.0134	3	0.0136	1	0.0134	4	0.0139
203	8	0.0135	6	0.0129	1	0.0136	1	0.0127
204	4	0.0141	5	0.0130	1	0.0135	3	0.0131
205	13	0.0134	3	0.0137	1	0.0130	2	0.0140
206	8	0.0131	6	0.0133	2	0.0127	5	0.0125
207	9	0.0134	12	0.0124	3	0.0131	1	0.0127
208	11	0.0139	15	0.0129	3	0.0130	1	0.0142
209	15	0.0133	10	0.0128	5	0.0128	3	0.0134
210	13	0.0131	12	0.0127	1	0.0127	3	0.0135
211	11	0.0131	18	0.0127	4	0.0127	6	0.0136
212	13	0.0130	14	0.0128	8	0.0126	4	0.0135
213	9	0.0131	17	0.0126	2	0.0122	5	0.0131
214	11	0.0132	10	0.0127	5	0.0124	10	0.0132
215	7	0.0126	11	0.0127	6	0.0124	12	0.0133
216	6	0.0130	12	0.0125	4	0.0125	6	0.0126
217	10	0.0131	6	0.0130	6	0.0125	10	0.0132
218	5	0.0127	8	0.0119	5	0.0125	9	0.0129
219	3	0.0132	4	0.0124	6	0.0135	7	0.0129
220	8	0.0129	6	0.0130	5	0.0122	10	0.0128
221	4	0.0129	4	0.0129	8	0.0132	7	0.0133
222	3	0.0126	4	0.0123	5	0.0130	9	0.0129

TABLE VIB AVERAGE WEIGHT-LENGTH FACTOR (F^a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1921–1925 SEASON. [F_a, = $100w/L^3$] WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

TABLE VIB—Continued

AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1924-1925 SEASON. $F_a = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

Body length, mm.	December		January		February		March	
	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a
223	3	0.0130	4	0.0130	9	0.0126	5	0.0127
224	2	0.0120	5	0.0132	11	0.0128	10	0.0127
225	6	0.0132	3	0.0120	4	0.0128	7	0.0126
226	2	0.0129	4	0.0125	5	0.0129	9	0.0124
227	1	0.0121	4	0.0133	5	0.0135	13	0.0129
228	5	0.0135	2	0.0129	3	0.0117	8	0.0126
229	1	0.0149	4	0.0128	6	0.0133	1	0.0109
230	1	0.0139	3	0.0140	6	0.0126	9	0.0132
231					15	0.0127	9	0.0132
232	1	0.0131	2	0.0134	7	0.0134	5	0.0125
233	2	0.0137	1	0.0128	5	0.0129	9	0.0129
234	2	0.0131	7	0.0135	8	0.0130	8	0.0128
235	3	0.0135	1	0.0138	9	0.0131	4	0.0123
236	2	0.0145	3	0.0116	15	0.0126	7	0.0131
237	3	0.0138	3	0.0125	15	0.0133	3	0.0130
238	2	0.0139	1	0.0125	11	0.0132	10	0.0130
239	2	0.0135			9	0.0130	4	0.0139
240	8	0.0141	3	0.0138	8	0.0136	4	0.0134
241			1	0.0135	9	0.0129	6	0.0140
242	2	0.0141	3	0.0139	12	0.0133	3	0.0117
243	1	0.0149	3	0.0129	7	0.0136	3	0.0115
244			5	0.0137	13	0.0135	6	0.0129
245	8	0.0142	1	0.0140	11	0.0136		
246	2	0.0143	2	0.0135	8	0.0135	5	0.0128
247	2	0.0132	2	0.0138	6	0.0136	5	0.0128
248	2	0.0141			11	0.0136	3	0.0135
249	3	0.0135	4	0.0139	7	0.0135		
250	2	0.0151	3	0.0139	8	0.0134	4	0.0131
251	4	0.0130	2	0.0140	4	0.0138	2	0.0133
252	1	0.0145	3	0.0139	4	0.0132	1	0.0117
253	4	0.0135	2	0.0125	4	0.0125	3	0.0126
254	3	0.0150	1	0.0143	6	0.0135	3	0.0127
255	6	0.0143			8	0.0131	2	0.0130
256	7	0.0140	1	0.0149	2	0.0126	1	0.0136
257	2	0.0146	1	0.0129	4	0.0126	6	0.0127
258	1	0.0150	3	0.0137	3	0.0133	1	0.0125
259	3	0.0143	1	0.0153	2	0.0119	2	0.0133
260					4	0.0130		
261	1	0.0150	1	0.0127	2	0.0126	3	0.0135
262	2	0.0147			4	0.0124	3	0.0129
263	4	0.0140			1	0.0123		
264	2	0.0152	1	0.0143	1	0.0141	3	0.0138
265					3	0.0129	2	0.0117
266							1	0.0124
267			2	0.0130	2	0.0123		
268	1	0.0137			1	0.0125		
269					1	0.0130		
270	1	0.0148			1	0.0112		
271	1	0.0126			3	0.0134		
272	1	0.0126						
273							1	0.0137
274					1	0.0116	1	0.0138
275								
276					1	0.0131	1	0.0117
277								
278								
279								
280								
281								
282					1	0.0118		
Totals	448		400		400		349	

TABLE VIB AVERAGE WEIGHT-LENGTH FACTOR (F^a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1921–1925 SEASON. [F_a, = $100w/L^3$] WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

TABLE VIC

AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1925-1926 SEASON. $F_a = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

Body length, mm.	December		January		February		March	
	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a
151			1	0.0102				
152			2	0.0101				
153			2	0.0103			1	0.0092
154			1	0.0085				
155								
156			1	0.0092				
157								
158			1	0.0096				
159								
160			1	0.0098				
161			2	0.0109				
162								
163			7	0.0097			1	0.0090
164			4	0.0105				
165			8	0.0100				
166			9	0.0097				
167			6	0.0102				
168			8	0.0100				
169			8	0.0100				
170			8	0.0103				
171	1	0.0138	5	0.0103				
172			17	0.0098				
173	1	0.0112	16	0.0099				
174			9	0.0102				
175			9	0.0101				
176	1	0.0108	9	0.0102				
177			6	0.0104				
178	1	0.0127	6	0.0101				
179			2	0.0104				
180			5	0.0104				
181	1	0.0116	2	0.0107				
182	1	0.0111	11	0.0108				
183			5	0.0106				
184			3	0.0115				
185			4	0.0109				
186	1	0.0109	3	0.0103				
187	8	0.0121	2	0.0108			1	0.0107
188	5	0.0117	3	0.0107				
189	6	0.0121	3	0.0109				
190	6	0.0119	6	0.0111			1	0.0101
191	11	0.0123	3	0.0119			1	0.0103
192	10	0.0121	9	0.0110				
193	5	0.0113	5	0.0113			2	0.0107
194	9	0.0121	6	0.0114			4	0.0100
195	12	0.0119	6	0.0115	1	0.0113	2	0.0108
196	21	0.0121			1	0.0119	4	0.0113
197	14	0.0120	4	0.0113	1	0.0114	3	0.0106
198	18	0.0118	13	0.0114			5	0.0108
199	12	0.0121	5	0.0118			3	0.0111
200	16	0.0119	9	0.0113	1	0.0117	5	0.0109
201	11	0.0122	5	0.0116	1	0.0111	3	0.0120
202	15	0.0122	7	0.0112	2	0.0113	3	0.0097
203	7	0.0115	8	0.0118			7	0.0106
204	14	0.0122	4	0.0117	2	0.0115	7	0.0105
205	1	0.0125	6	0.0113	1	0.0111	3	0.0113
206	9	0.0122	4	0.0119	2	0.0115	2	0.0111
207	6	0.0115	6	0.0115	2	0.0112	3	0.0101
208	8	0.0120	8	0.0115	1	0.0123	3	0.0101
209	10	0.0121	3	0.0107	2	0.0120	1	0.0090
210	4	0.0117	2	0.0120	2	0.0120	1	0.0086
211	1	0.0117	3	0.0116	1	0.0116	2	0.0108
212	4	0.0125	5	0.0114	3	0.0115	4	0.0106
213	5	0.0121	3	0.0119			2	0.0117
214	5	0.0119	7	0.0123	7	0.0117	6	0.0108
215	2	0.0124	6	0.0126	3	0.0118	6	0.0110
216	7	0.0121	2	0.0117	4	0.0125	2	0.0093
217	2	0.0121	6	0.0113	2	0.0116	7	0.0113
218	5	0.0116	8	0.0118	5	0.0123	6	0.0104
219	5	0.0114	2	0.0111	4	0.0112	4	0.0107
220	5	0.0116	2	0.0122	5	0.0120	10	0.0104
221	1	0.0114	2	0.0119	12	0.0121	3	0.0098

TABLE VIC AVERAGE WEIGHT-LENGTH FACTOR (F^a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1925–1926 SEASON. [F_a, = $100w/L^3$] WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

TABLE VIC—Continued

AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1925-1926 SEASON. $F_a = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

Body length, mm.	December		January		February		March	
	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a
222	2	0.0107	6	0.0124	8	0.0120	10	0.0101
223	3	0.0118	3	0.0114	7	0.0121	5	0.0106
224	4	0.0123	4	0.0119	9	0.0118	6	0.0113
225			4	0.0123	14	0.0120	6	0.0105
226			2	0.0120	10	0.0116	9	0.0111
227			2	0.0126	6	0.0123	4	0.0115
228	1	0.0111	1	0.0134	11	0.0122	5	0.0100
229	2	0.0111	1	0.0127	7	0.0120	2	0.0105
230	1	0.0120	1	0.0118	12	0.0120	3	0.0117
231			3	0.0122	9	0.0117	3	0.0118
232					6	0.0117	2	0.0115
233			2	0.0132	10	0.0120	4	0.0119
234			1	0.0103	7	0.0128	3	0.0125
235			2	0.0118	6	0.0131	3	0.0116
236			2	0.0121	10	0.0118	6	0.0119
237					9	0.0118	8	0.0118
238					8	0.0125		
239					8	0.0126	3	0.0111
240					13	0.0124	4	0.0113
241					5	0.0123	2	0.0125
242			2	0.0135	6	0.0115	1	0.0119
243					13	0.0125	3	0.0123
244					8	0.0123	1	0.0127
245					7	0.0124	2	0.0118
246			2	0.0124	7	0.0125	1	0.0118
247					6	0.0117	3	0.0118
248			1	0.0111	4	0.0128	3	0.0121
249			1	0.0133	2	0.0119	2	0.0117
250					5	0.0125	1	0.0113
251			1	0.0116	8	0.0118	2	0.0129
252					2	0.0122	2	0.0119
253					3	0.0108		
254			1	0.0140	5	0.0130	1	0.0119
255					3	0.0117	1	0.0112
256					2	0.0119	4	0.0121
257					4	0.0119	5	0.0119
258					4	0.0122	1	0.0125
259					1	0.0125	2	0.0125
260					2	0.0123	1	0.0110
261					1	0.0116	1	0.0111
262					1	0.0115	1	0.0130
263					4	0.0115	1	0.0124
264					2	0.0122	1	0.0114
265					1	0.0106		
266					1	0.0128		
267					1	0.0105		
268					1	0.0112	1	0.0119
269								
270					1	0.0131		
271								
272							1	0.0096
273								
274					1	0.0119		
275					1	0.0128	1	0.0102
276					1	0.0119		
277								
278								
279							1	0.0132
Totals	300		396		348		250	

TABLE VIC AVERAGE WEIGHT-LENGTH FACTOR (F^a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1925–1926 SEASON. [F_a, = $100w/L^3$] WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

TABLE VID

AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1926-1927 SEASON. $F_a = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

Body length, mm.	December		January		February		March		April		May	
	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a	No. of fish	F_a
168											1	0.0112
169					1	0.0116						
170												
171												
172												
173												
174												
175											1	0.0123
176					1	0.0110					1	0.0125
177												
178												
179					1	0.0119						
180											1	0.0118
181							1	0.0110				
182												
183											1	0.0127
184					1	0.0112						
185	1	0.0128							1	0.0128	2	0.0126
186			1	0.0110							1	0.0120
187	2	0.0121	1	0.0119	2	0.0121	1	0.0116	2	0.0125		
188	2	0.0121	1	0.0113	1	0.0122			2	0.0128	1	0.0119
189	1	0.0110	1	0.0119							1	0.0119
190	1	0.0122			1	0.0120						
191	1	0.0122	1	0.0119	2	0.0121			1	0.0115		
192	4	0.0123			1	0.0120			2	0.0119		
193	8	0.0124	3	0.0126					2	0.0124		
194	2	0.0127	1	0.0114	3	0.0113			2	0.0137	2	0.0130
195			2	0.0113					4	0.0127		
196	1	0.0124	2	0.0122	2	0.0118					1	0.0135
197	4	0.0125	2	0.0111	1	0.0127						
198	6	0.0120	4	0.0127	2	0.0120	1	0.0133	2	0.0125	2	0.0122
199	9	0.0122	3	0.0120	1	0.0113			1	0.0121		
200	9	0.0119	5	0.0122			1	0.0156				
201	4	0.0121	3	0.0129	4	0.0125			1	0.0124	1	0.0126
202	11	0.0124	5	0.0123	3	0.0119	2	0.0126	2	0.0136		
203	7	0.0126	7	0.0121			2	0.0133	2	0.0119	1	0.0134
204	7	0.0120	13	0.0126	4	0.0120			4	0.0133		
205	9	0.0121	5	0.0128	4	0.0122	1	0.0130				
206	13	0.0123	9	0.0124	3	0.0119	2	0.0132	2	0.0128		
207	7	0.0120	4	0.0128			5	0.0134	4	0.0135	1	0.0129
208	10	0.0124	15	0.0121	4	0.0121	6	0.0133	6	0.0129		
209	14	0.0123	15	0.0121	3	0.0118	5	0.0133	6	0.0128	1	0.0137
210	12	0.0120	17	0.0127	4	0.0127	8	0.0137	3	0.0120		
211	14	0.0125	10	0.0122	2	0.0124	9	0.0132	5	0.0128		
212	7	0.0125	16	0.0125	4	0.0129	12	0.0134	3	0.0131	1	0.0125
213	10	0.0122	13	0.0128	5	0.0126	10	0.0130	5	0.0129	3	0.0125
214	8	0.0128	9	0.0129	5	0.0126	10	0.0128	5	0.0133		
215	10	0.0125	4	0.0123	6	0.0129	6	0.0130	8	0.0134	3	0.0117
216	10	0.0125	13	0.0125	9	0.0129	14	0.0135	11	0.0132		
217	10	0.0126	13	0.0122			19	0.0129	2	0.0144	3	0.0126
218	7	0.0126	15	0.0126	7	0.0131	11	0.0132	7	0.0125	2	0.0125
219	4	0.0126	10	0.0127	7	0.0129	13	0.0132	4	0.0145	2	0.0127
220	5	0.0120	15	0.0122	12	0.0132	18	0.0129	9	0.0130	6	0.0118
221	5	0.0130	10	0.0128	3	0.0118	15	0.0130	2	0.0135	3	0.0120
222	6	0.0125	16	0.0124	6	0.0129	18	0.0131	1	0.0150	8	0.0122
223	8	0.0124	14	0.0126	10	0.0127	18	0.0133	2	0.0130	10	0.0122
224	10	0.0126	8	0.0125	13	0.0127	26	0.0130	1	0.0120	13	0.0117
225	4	0.0125	18	0.0126	13	0.0127	15	0.0128	6	0.0135	16	0.0122
226	4	0.0124	8	0.0128	11	0.0131	26	0.0131	5	0.0136	14	0.0120
227	5	0.0123	23	0.0127	18	0.0128	19	0.0129	5	0.0131	18	0.0119
228	5	0.0129	19	0.0127	17	0.0127	19	0.0134	6	0.0136	24	0.0119
229	5	0.0126	9	0.0129	24	0.0129	24	0.0128	9	0.0130	19	0.0119
230	4	0.0130	8	0.0128	24	0.0127	18	0.0129	8	0.0131	23	0.0119
231	4	0.0123	11	0.0127	14	0.0129	17	0.0127	3	0.0131	20	0.0116
232	3	0.0118	10	0.0127	24	0.0127	22	0.0128	9	0.0130	25	0.0117
233	2	0.0125	19	0.0126	18	0.0130	24	0.0126	8	0.0131	18	0.0120
234	2	0.0115	19	0.0129	19	0.0130	19	0.0130	3	0.0130	25	0.0117
235	1	0.0111	11	0.0125	27	0.0129	27	0.0128	4	0.0124	28	0.0117
236	1	0.0123	7	0.0119	16	0.0126	20	0.0128	6	0.0128	23	0.0118
237			8	0.0127	20	0.0130	17	0.0131	3	0.0134	24	0.0118
238			14	0.0128	22	0.0128	13	0.0126	2	0.0121	26	0.0116

TABLE VID AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1926–1927 SEASON. [$F_a = 100w/L^3$]WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

TABLE VID—Continued

AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1926-1927 SEASON. $F_a = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

Body length, mm.	December		January		February		March		April		May	
	No. of fish	Fa	No. of fish	Fa	No. of fish	Fa	No. of fish	Fa	No. of fish	Fa	No. of fish	Fa
239			9	0.0126	11	0.0123	14	0.0123	8	0.0136	29	0.0117
240			9	0.0123	11	0.0124	8	0.0125	7	0.0130	20	0.0118
241			6	0.0124	6	0.0128	1	0.0117	3	0.0131	11	0.0116
242			7	0.0122	12	0.0124	16	0.0126	1	0.0130	23	0.0113
243			4	0.0126	11	0.0126	10	0.0128	4	0.0125	22	0.0117
244			4	0.0128	17	0.0123	8	0.0127	3	0.0133	15	0.0117
245			7	0.0125	8	0.0123	12	0.0126	3	0.0124	15	0.0115
246			4	0.0124	11	0.0125	8	0.0124	1	0.0134	14	0.0115
247			2	0.0118	13	0.0123	9	0.0124	2	0.0122	16	0.0115
248			4	0.0122	12	0.0123	11	0.0125	1	0.0128	18	0.0115
249					11	0.0123	10	0.0124	1	0.0128	13	0.0113
250			2	0.0131	8	0.0118	8	0.0124	1	0.0125	16	0.0115
251			1	0.0126	4	0.0121	10	0.0121	1	0.0119	8	0.0111
252			1	0.0121	1	0.0124	6	0.0120	1	0.0134	6	0.0115
253			4	0.0116	8	0.0128	6	0.0125	2	0.0117	2	0.0119
254			1	0.0110	4	0.0118	9	0.0123	4	0.0120	10	0.0110
255					3	0.0128	6	0.0120	1	0.0127	11	0.0115
256			4	0.0123	5	0.0126	3	0.0112	2	0.0134	7	0.0117
257					2	0.0134	4	0.0119	2	0.0121	7	0.0110
258					2	0.0119	2	0.0122	1	0.0119	8	0.0113
259			1	0.0112	2	0.0124	3	0.0125			5	0.0112
260			1	0.0126	4	0.0117	2	0.0120	1	0.0124	6	0.0109
261			1	0.0119	3	0.0120	1	0.0116			6	0.0116
262			1	0.0117	3	0.0120	1	0.0112	1	0.0119	5	0.0113
263			1	0.0120	3	0.0117	2	0.0121	1	0.0132	4	0.0115
264					5	0.0114	1	0.0118	1	0.0133	5	0.0110
265			2	0.0114	3	0.0123	1	0.0113	1	0.0122	1	0.0099
266					2	0.0124	2	0.0114			3	0.0106
267					1	0.0126					5	0.0112
268					2	0.0115	3	0.0127	1	0.0118	2	0.0112
269							2	0.0123	1	0.0124	3	0.0113
270					2	0.0127	2	0.0106	1	0.0124		
271					2	0.0112					3	0.0114
272					1	0.0110						
273			1	0.0122	1	0.0117	1	0.0110			1	0.0114
274							1	0.0117				
275							1	0.0129			2	0.0102
276									2	0.0123		
277					1	0.0113					1	0.0099
278												
279							1	0.0109				
280												
281											1	0.0104
282												
283							1	0.0136				
Totals	299		547		600		700		250		700	

TABLE VID AVERAGE WEIGHT-LENGTH FACTOR (F_a) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1926–1927 SEASON. [$F_a = 100w/L^3$]WHEN W REPRESENTS THE TOTAL WEIGHT OF THE FISH

TABLE IXA

AVERAGE WEIGHT-LENGTH FACTOR (F_b) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920-1921 SEASON. $F_b = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE WEIGHT OF EVISCERATED FISH

Body length, mm.	January		February		March		April	
	No. of fish	F_b	No. of fish	F_b	No. of fish	F_b	No. of fish	F_b
152	1	0.0097					1	0.0105
153			1	0.0095				
154	1	0.0099					1	0.0101
155	2	0.0097			1	0.0102		
156	3	0.0102						
157			1	0.0101	1	0.0111	3	0.0112
158					1	0.0104		
159			1	0.0095				
160	1	0.0098	4	0.0102	1	0.0100	1	0.0110
161			2	0.0097	3	0.0100	2	0.0107
162	1	0.0099			3	0.0101	2	0.0108
163	4	0.0104	3	0.0101	2	0.0103	1	0.0104
164	2	0.0099	2	0.0098	1	0.0102		
165	3	0.0103	5	0.0102	4	0.0101	5	0.0111
166	3	0.0098	8	0.0100	3	0.0095		
167	7	0.0099	6	0.0102	4	0.0102	1	0.0110
168	3	0.0101	5	0.0105	4	0.0102	2	0.0118
169	12	0.0099	6	0.0102	4	0.0103	3	0.0102
170	3	0.0107	5	0.0100	11	0.0102	2	0.0106
171	6	0.0105	6	0.0100	9	0.0106	4	0.0110
172	11	0.0104	8	0.0103	13	0.0101	2	0.0116
173	8	0.0106	2	0.0101	11	0.0101	2	0.0112
174	9	0.0103	8	0.0099	7	0.0102	4	0.0107
175	4	0.0108	8	0.0106	6	0.0103	4	0.0105
176	11	0.0105	2	0.0105	10	0.0102	3	0.0110
177	10	0.0104	6	0.0105	12	0.0101	2	0.0114
178	9	0.0108	9	0.0103	6	0.0102	5	0.0106
179	4	0.0109	9	0.0103	7	0.0103		
180	12	0.0104	4	0.0106	11	0.0103	3	0.0108
181	14	0.0107	11	0.0104	19	0.0103	4	0.0105
182	17	0.0105	7	0.0102	17	0.0104	4	0.0114
183	13	0.0109	11	0.0106	13	0.0105	2	0.0111
184	18	0.0106	9	0.0107	17	0.0104	8	0.0108
185	17	0.0108	2	0.0098	13	0.0105	4	0.0107
186	8	0.0107	3	0.0104	17	0.0104	3	0.0106
187	12	0.0105	1	0.0116	19	0.0106	5	0.0111
188	23	0.0106	1	0.0117	19	0.0105	6	0.0110
189	19	0.0106	2	0.0107	15	0.0107	3	0.0107
190	3	0.0107	4	0.0107	13	0.0107	7	0.0107
191	5	0.0110	1	0.0102	15	0.0104	6	0.0105
192	11	0.0109	2	0.0103	11	0.0106	5	0.0102
193	7	0.0106	4	0.0107	7	0.0105	2	0.0112
194	6	0.0113	1	0.0112	9	0.0102	4	0.0107
195	4	0.0113	3	0.0115	9	0.0105	4	0.0105
196	4	0.0101	6	0.0112	7	0.0108	2	0.0109
197	5	0.0111	1	0.0111	7	0.0102	3	0.0107
198	2	0.0116	3	0.0105	10	0.0108	4	0.0107
199	4	0.0110	3	0.0110	10	0.0107	2	0.0108
200	3	0.0117	5	0.0108	11	0.0106	2	0.0111
201	7	0.0110	10	0.0112	28	0.0105	1	0.0107
202	8	0.0114	13	0.0109	25	0.0107	3	0.0106
203	17	0.0110	8	0.0108	25	0.0111	2	0.0109
204	10	0.0115	10	0.0112	44	0.0108	3	0.0106
205	13	0.0108	14	0.0107	45	0.0107	1	0.0113
206	21	0.0112	26	0.0110	46	0.0106	4	0.0111
207	24	0.0109	16	0.0108	52	0.0106	5	0.0108
208	16	0.0112	15	0.0104	61	0.0105	6	0.0106
209	18	0.0109	24	0.0106	52	0.0105	4	0.0104
210	12	0.0105	27	0.0105	69	0.0106	5	0.0102
211	16	0.0107	15	0.0111	54	0.0105	6	0.0103
212	13	0.0108	27	0.0107	60	0.0103	9	0.0103
213	13	0.0106	14	0.0103	57	0.0105	8	0.0101
214	11	0.0105	24	0.0103	59	0.0104	8	0.0106
215	11	0.0106	30	0.0107	50	0.0103	10	0.0102
216	14	0.0104	21	0.0106	39	0.0103	14	0.0103
217	9	0.0107	19	0.0107	46	0.0103	6	0.0106
218	9	0.0111	23	0.0104	45	0.0103	11	0.0105
219	10	0.0110	19	0.0108	35	0.0104	6	0.0103
220	13	0.0111	25	0.0107	26	0.0103	9	0.0106
221	8	0.0109	31	0.0107	26	0.0102	7	0.0107
222	11	0.0110	25	0.0106	24	0.0102	9	0.0102

TABLE IXA AVERAGE WEIGHT-LENGTH FACTOR (F_b) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920–1921 SEASON. [$F_a = 100w/L^3$]WHEN W REPRESENTS THE WEIGHT OF EVIS-CERATED FISH

TABLE IXA

AVERAGE WEIGHT-LENGTH FACTOR (F_b) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920-1921 SEASON. $F_b = \frac{1000W}{L^3}$, WHEN W REPRESENTS THE WEIGHT OF EVISCERATED FISH

Body length, mm.	January		February		March		April	
	No. of fish	F_b	No. of fish	F_b	No. of fish	F_b	No. of fish	F_b
152	1	0.0097					1	0.0105
153			1	0.0095				
154	1	0.0099					1	0.0101
155	2	0.0097			1	0.0102		
156	3	0.0102						
157			1	0.0101	1	0.0111	3	0.0112
158					1	0.0104		
159			1	0.0095				
160	1	0.0098	4	0.0102	1	0.0100	1	0.0110
161			2	0.0097	3	0.0100	2	0.0107
162	1	0.0099			3	0.0101	2	0.0108
163	4	0.0104	3	0.0101	2	0.0103	1	0.0104
164	2	0.0099	2	0.0098	1	0.0102		
165	3	0.0103	5	0.0102	4	0.0101	5	0.0111
166	3	0.0098	8	0.0100	3	0.0095		
167	7	0.0099	6	0.0102	4	0.0102	1	0.0110
168	3	0.0101	5	0.0105	4	0.0102	2	0.0118
169	12	0.0099	6	0.0102	4	0.0103	3	0.0102
170	3	0.0107	5	0.0100	11	0.0102	2	0.0106
171	6	0.0105	6	0.0100	9	0.0106	4	0.0110
172	11	0.0104	8	0.0103	13	0.0101	2	0.0116
173	8	0.0106	2	0.0101	11	0.0101	2	0.0112
174	9	0.0103	8	0.0099	7	0.0102	4	0.0107
175	4	0.0108	8	0.0106	6	0.0103	4	0.0105
176	11	0.0105	2	0.0105	10	0.0102	3	0.0110
177	10	0.0104	6	0.0105	12	0.0101	2	0.0114
178	9	0.0108	9	0.0103	6	0.0102	5	0.0106
179	4	0.0109	9	0.0103	7	0.0103		
180	12	0.0104	4	0.0106	11	0.0103	3	0.0108
181	14	0.0107	11	0.0104	19	0.0103	4	0.0105
182	17	0.0105	7	0.0102	17	0.0104	4	0.0114
183	13	0.0109	11	0.0106	13	0.0105	2	0.0111
184	18	0.0106	9	0.0107	17	0.0104	8	0.0108
185	17	0.0108	2	0.0098	13	0.0105	4	0.0107
186	8	0.0107	3	0.0104	17	0.0104	3	0.0106
187	12	0.0105	1	0.0116	19	0.0106	5	0.0111
188	23	0.0106	1	0.0117	19	0.0105	6	0.0110
189	19	0.0106	2	0.0107	15	0.0107	3	0.0107
190	3	0.0107	4	0.0107	13	0.0107	7	0.0107
191	5	0.0110	1	0.0102	15	0.0104	6	0.0105
192	11	0.0109	2	0.0103	11	0.0106	5	0.0102
193	7	0.0106	4	0.0107	7	0.0105	2	0.0112
194	6	0.0113	1	0.0112	9	0.0102	4	0.0107
195	4	0.0113	3	0.0115	9	0.0105	4	0.0105
196	4	0.0101	6	0.0112	7	0.0108	2	0.0109
197	5	0.0111	1	0.0111	7	0.0102	3	0.0107
198	2	0.0116	3	0.0105	10	0.0108	4	0.0107
199	4	0.0110	3	0.0110	10	0.0107	2	0.0108
200	3	0.0117	5	0.0108	11	0.0106	2	0.0111
201	7	0.0110	10	0.0112	28	0.0105	1	0.0107
202	8	0.0114	13	0.0109	25	0.0107	3	0.0106
203	17	0.0110	8	0.0108	25	0.0111	2	0.0109
204	10	0.0115	10	0.0112	44	0.0108	3	0.0106
205	13	0.0108	14	0.0107	45	0.0107	1	0.0113
206	21	0.0112	26	0.0110	46	0.0106	4	0.0111
207	24	0.0109	16	0.0108	52	0.0106	5	0.0108
208	16	0.0112	15	0.0104	61	0.0105	6	0.0106
209	18	0.0109	24	0.0106	52	0.0105	4	0.0104
210	12	0.0105	27	0.0105	69	0.0106	5	0.0102
211	16	0.0107	15	0.0111	54	0.0105	6	0.0103
212	13	0.0108	27	0.0107	60	0.0103	9	0.0103
213	13	0.0106	14	0.0103	57	0.0105	8	0.0101
214	11	0.0105	24	0.0103	59	0.0104	8	0.0106
215	11	0.0106	30	0.0107	50	0.0103	10	0.0102
216	14	0.0104	21	0.0106	39	0.0103	14	0.0103
217	9	0.0107	19	0.0107	46	0.0103	6	0.0106
218	9	0.0111	23	0.0104	45	0.0103	11	0.0105
219	10	0.0110	19	0.0108	35	0.0104	6	0.0103
220	13	0.0111	25	0.0107	26	0.0103	9	0.0106
221	8	0.0109	31	0.0107	26	0.0102	7	0.0107
222	11	0.0110	25	0.0106	24	0.0102	9	0.0102

TABLE IXA AVERAGE WEIGHT-LENGTH FACTOR (F_b) AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920–1921 SEASON. [$F_b = 100w/L^3$]WHEN W REPRESENTS THE WEIGHT OF EVISCERATED FISH

TABLE XA

AVERAGE FAT INDEX AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920-1921 SEASON

Body length, mm.	January		February		March		April	
	No. of fish	Fat index	No. of fish	Fat index	No. of fish	Fat index	No. of fish	Fat index
152	1	0.0					1	1.0
153			1	0.0				
154	1	0.0					1	1.0
155	2	0.0	1	0.0	4	0.0		
156	5	0.2						
157	4	0.5	1	0.0	2	0.5	3	1.7
158	1	1.0	1	0.0	2	0.0		
159	1	0.0	1	0.0	3	0.0		
160	2	0.0	4	0.0	2	0.0	1	1.0
161	1	1.0	3	0.3	5	0.0	2	0.5
162	2	0.0			3	0.3	2	1.0
163	4	0.0	4	0.2	4	0.5	1	0.0
164	4	0.5	3	0.0	1	0.0		
165	5	0.6	7	0.1	4	0.0	5	1.0
166	3	0.0	9	0.0	3	0.0		
167	9	0.1	6	0.5	6	0.2	1	2.0
168	10	0.5	6	0.0	5	0.2	2	1.0
169	13	0.4	7	0.1	5	0.4	3	0.7
170	6	0.8	5	0.0	11	0.2	2	1.0
171	9	0.9	6	0.0	9	0.1	4	0.8
172	15	0.7	8	0.4	13	0.2	2	1.0
173	10	0.7	2	0.0	11	0.3	2	1.5
174	11	0.7	10	0.2	7	0.1	4	0.7
175	8	1.0	11	0.5	6	0.2	4	0.5
176	11	0.6	2	0.5	10	0.3	3	0.7
177	10	0.5	7	0.4	12	0.0	2	1.0
178	10	0.6	9	0.4	7	0.3	5	0.6
179	6	1.0	12	0.5	7	0.0	1	1.0
180	12	0.6	4	0.5	11	0.2	3	1.0
181	15	0.9	11	0.4	19	0.3	4	0.8
182	19	0.7	7	0.4	17	0.2	4	1.0
183	16	0.6	11	0.4	13	0.3	2	0.5
184	22	1.1	9	0.6	17	0.6	8	0.9
185	18	0.9	2	0.5	13	0.2	5	0.2
186	13	1.5	4	0.3	18	0.3	3	0.7
187	13	0.8	1	0.0	19	0.2	6	0.3
188	29	0.9	1	1.0	19	0.3	6	0.0
189	21	0.8	2	1.0	15	0.4	3	0.0
190	7	1.6	4	1.2	13	0.5	7	0.4
191	6	1.2	1	1.0	15	0.3	7	0.7
192	13	1.0	2	0.5	11	0.6	4	0.2
193	10	1.2	4	1.0	7	0.1	2	0.0
194	10	1.4	1	1.0	9	0.2	4	0.5
195	6	1.2	3	1.7	9	0.3	4	0.5
196	6	1.2	6	1.3	7	0.1	2	0.5
197	7	0.9	1	2.0	7	0.4	3	0.7
198	3	1.3	3	1.0	10	0.7	4	0.8
199	5	1.4	3	1.3	10	0.7	3	0.0
200	6	1.7	5	1.6	11	0.5	2	0.5
201	8	1.4	10	1.5	28	0.7	1	0.0
202	9	1.2	13	1.2	25	0.8	3	0.3
203	17	1.4	8	0.9	26	1.0	2	0.0
204	13	1.5	10	1.4	44	0.9	3	0.7
205	14	1.3	14	1.4	45	0.9	2	0.0
206	21	1.6	26	1.4	46	0.8	5	0.6
207	27	1.3	16	1.4	52	0.9	5	0.4
208	16	1.4	15	0.9	60	0.8	7	0.1
209	18	1.6	24	1.3	51	0.8	4	0.3
210	13	1.1	26	1.2	67	0.9	5	0.0
211	17	1.4	15	1.5	53	0.9	6	0.5
212	15	1.5	27	1.4	59	0.8	9	0.1
213	13	1.1	14	1.2	56	0.8	9	0.3
214	12	1.5	24	1.3	57	0.7	8	0.1
215	13	1.3	30	1.5	49	0.8	10	0.0
216	15	1.1	21	1.5	38	0.8	16	0.1
217	10	1.5	19	1.5	46	0.7	6	0.2
218	9	1.6	23	1.5	43	0.7	11	0.0
219	12	1.7	19	1.6	33	0.8	6	0.0
220	13	1.8	25	1.6	24	0.9	10	0.2
221	10	1.4	31	1.6	25	0.9	8	0.3
222	15	1.9	25	1.8	24	0.8	11	0.1
223	17	1.4	27	1.5	15	0.9	6	0.3
224	12	2.2	32	1.7	20	0.9	10	0.2
225	6	2.0	27	1.5	13	0.9	8	0.1

TABLE XA AVERAGE FAT INDEX AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920–1921 SEASON

TABLE XA—Continued

AVERAGE FAT INDEX AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920-1921 SEASON

Body length, mm.	January		February		March		April	
	No. of fish	Fat index	No. of fish	Fat index	No. of fish	Fat index	No. of fish	Fat index
226	11	1.7	43	1.5	12	1.0	10	0.1
227	13	1.8	23	1.7	12	0.9	11	0.2
228	12	2.2	38	1.7	14	0.9	12	0.0
229	17	1.7	42	1.7	11	0.8	11	0.0
230	13	1.8	23	1.9	13	1.0	16	0.2
231	12	1.7	38	1.8	13	0.9	12	0.0
232	8	1.9	47	1.7	14	0.8	10	0.0
233	12	2.2	47	1.7	9	1.3	19	0.0
234	11	2.1	24	1.8	7	1.3	15	0.1
235	13	2.0	29	1.9	5	0.8	15	0.1
236	13	1.8	26	1.8	5	1.2	20	0.0
237	9	2.0	28	1.8	5	1.4	18	0.1
238	10	2.0	26	1.7	6	1.2	12	0.0
239	16	2.2	25	1.8	2	1.5	11	0.1
240	6	1.8	17	2.1	5	0.6	16	0.0
241	16	1.9	22	1.9	6	0.8	10	0.0
242	10	2.0	19	1.8	5	0.6	20	0.1
243	7	2.4	25	2.0	4	0.7	18	0.1
244	8	2.0	21	1.8	5	1.0	13	0.0
245	9	1.8	16	2.0	5	1.2	16	0.0
246	4	2.7	22	1.7	1	1.0	20	0.0
247	7	2.0	18	1.8	4	1.3	10	0.0
248	10	2.5	16	1.9	5	1.0	16	0.1
249	10	2.2	13	1.8			16	0.0
250	4	2.5	20	1.8	6	0.7	18	0.0
251	3	3.0	11	2.2	4	0.7	16	0.1
252	4	2.0	7	2.1	3	0.3	23	0.0
253	10	1.7	12	2.1	4	1.3	14	0.0
254	6	2.3	13	1.9	3	0.0	16	0.0
255	5	2.2	15	2.2	3	1.0	21	0.0
256	3	2.3	11	2.0	3	1.0	21	0.0
257	2	2.5	7	2.0			15	0.0
258	6	2.5	11	1.7	1	0.0	19	0.0
259	4	2.5	15	1.8	1	1.0	9	0.0
260	3	2.0	11	1.6	3	0.3	15	0.2
261	3	2.0	13	1.4	3	1.0	14	0.0
262	3	2.3	11	1.8	4	0.8	16	0.1
263	2	2.5	13	1.7	2	2.0	17	0.0
264	2	2.5	5	1.2			13	0.0
265	5	2.4	7	1.3	1	2.0	10	0.1
266	1	2.0					11	0.0
267	2	2.0	5	1.6	3	0.7	3	0.0
268	2	2.5	4	1.5			6	0.0
269	4	2.0	8	2.1			4	0.0
270			3	2.0	1	1.0	9	0.0
271	4	1.5	3	1.7	1	2.0	2	0.0
272	1	2.0	2	1.5			5	0.0
273			1	3.0			4	0.0
274	2	2.0	3	1.7	1	0.0	7	0.0
275			1	2.0	2	0.0		
276	1	2.0	1	2.0	1	1.0	3	0.0
277			1	3.0				
278	2	2.0			1	1.0		
279			3	2.0			1	0.0
280			2	2.0			1	0.0
281			1	2.0				
282			1	2.0			1	1.1
283								
284								
285			1	1.0			1	0.0
286			1	2.0				
287								
288					1	1.0		
Totals	1,107		1,603		1,631		970	

TABLE XA AVERAGE FAT INDEX AT EACH MILLIMETER OF LENGTH FOR SARDINES TAKEN DURING THE 1920–1921 SEASON

CALIFORNIA FISH AND GAME COMMISSION FISH BULLETINS

* No. 1. Report on Fish Conditions. 1913; 48 pp., 3 figs. Contains:

a. The Abalone Industry in California. By Charles Lincoln Edwards.
b. The Towing of Salmon and Steelhead Fry from Sacramento to the Sea in a "Live Car." By N. B. Scofield.
c. The Problem of the Spiny Lobster. By Bennet M. Allen.
d. Investigation of the Clams of California. By Harold Health.
e. Investigation of the Life History of the Edible Crab (Cancer magister). By F. W. Weymouth.
f. A General Report on a Quinnat Salmon Investigation Carried on during the Spring and Summer of 1911. By N. B. Scofield.
g. Trout and Black Bass Planting and Transplanting in the San Joaquin and Southern Sierra Districts. By A. D. Ferguson.

* No. 2. The Scientific Investigation of Marine Fisheries as Related to the Work of the Fish and Game Commission in Southern California. By Will F. Thompson. 1919; 27 pp., 4 figs.

* No. 3. The Spawning of the Grunion (Leuresthes tenuis). By Will F. Thompson, assisted by Julia Bell Thompson. July 15, 1919; 29 pp., 9 figs.

No. 4. The Edible Clams, Mussels and Scallops of California. By Frank W. Weymouth. Jan. 10, 1921; 74 pp., 19 pls., 26 figs.

* No. 5. A Key to the Families of Marine Fishes of the West Coast. By Edwin C. Starks. March 3, 1921; 16 pp., 4 figs.

* No. 6. A History of California Shore Whaling. By Edwin C. Starks. October, 1922; 38 pp., 22 figs.

* No. 7. The Life History and Growth of the Pismo Clam. By Frank W. Weymouth. 1923; 120 pp., 15 figs., 18 graphs.

* No. 8. Racial and Season Variation in the Pacific Herring, California Sardine and California Anchovy. By Carl L. Hubbs. February, 1925; 23 pp., 4 pls.

* No. 9. Preliminary Investigation of the Purse Seine Industry of Southern California. By Tage Skogsberg. 95 pp., 23 figs.

* No. 10. The Life History of Leuresthe tenuis, an Atherine Fish with Tidecontrolled Spawning Habits. By Frances N. Clark. October, 1925; 51 pp., 6 graphs, 7 pls.

No. 11. The California Sardine. By the Staff of the California State Fisheries Laboratory. 1926; 221 pp., 74 figs.

Thompson, Will F. The California Sardine and the Study of the Available Supply.

Sette, Oscar Elton. Sampling the California Sardine: A study of the adequacy of various systems at Monterey.

Higgins, Elmer H. A Study of Fluctuations in the Sardine Fishery at San Pedro.

Scofield, W. L. The Sardine at Monterey: Dominant size classes and their progression, 1919–1923.

Thompson, Will F. Errors in the Method of Sampling Used in the Study of the California Sardine.

No. 12. The Weight-Length Relationship of the California Sardine (Sardina cœulea) at San Pedro. By Frances N. Clark. 1928.

These bulletins are offered in exchange for the publications of other bodies engaged in marine research. Address: California State Fisheries Laboratory, Terminal Island, California.

1 The writer is indebted to the past and present members of the staff of the California State Fisheries Laboratory for the collection of the material used in this paper. Miss Annie Gillespie rendered invaluable assistance with the mathematical calculations, Mrs. R. M. Thompson aided in revising the manuscript, Mr. W. L. Scofield gave much advice and counsel, and Mr. W. F. Thompson instigated the study and followed the work critically from its inception to its completion.

2 From 1921 to 1923 the field work was done by Elmer Higgins; the 1923–1924 season was covered by H. H. Greene; 1924–1925, by G. A. Rounsefell; 1925–1926, by C. B. Andrews; and 1926–1927, by V. G. Russell.

3 The fish were dried to a constant weight in an air oven kept at 110° C. The dried samples were then extracted in Dnorr extractors until free of fat. The ether extract was then heated to remove the ether, after which the fat was dried in the air oven at the above temperature until the loss in weight ceased.

4 These samples were analyzed as above except that all drying was done in a vacuum oven at 50–60° C, under 650–700 mm. of vacuum.