LENGTH - WEIGHT RELATIONSHIP
Growth in fish, in terms of length and weight, is more or less a continuous process, though it is subjected to fluctuations due to various physiological and ecological factors. According to Medawar's (1945) first law of growth, size is a monotonic increasing function of age. This is true of fishes when growth is measured in terms of length. Body weight is generally reduced due to various factors such as spawning, less feeding and other factors. However, species which do not have significant changes in their form and specific gravity throughout life, bear specific relationship between length and weight.

Length-weight relationship was expressed by LeCren (1951) by a general equation $W = AL^B$, where 'W' and 'L' represent weight and length of the fish respectively and 'A' and 'B' are constants. Allen (1938) exhibited cubic relationship between weight and length with the value of 'B' equal to 3 in above equation. However, the equation of cubic parabola was found inadequate to explain the length-weight relationship in fishes and the general parabolic equation by LeCren has been accepted unanimously.
LeCren (1951), states "The length-weight relationship formula, besides providing a mean for calculating weight from length, and a direct way of converting logarithmic growth rates calculated on lengths, into growth-rate for weight, may also give indications of taxonomic differences and events in the life history such as metamorphosis and the onset of maturity". In the present study, length and weight of 1503 specimens of *T. mossambica* were measured and the length-weight relationship in male and female has been calculated separately. Fresh specimens were brought to the laboratory, cleaned and measured for its total length and weight after removing surface moisture with blotting paper. Of the total 1503 specimens examined 669 individuals were females, ranging between 41 to 220 mm and 834 males, ranging between 41 to 240 mm. The individuals were grouped into size groups of 20 mm and the mean values for length and weight were calculated for each group.

The general parabolic equation $W = aL^B$ was used to exhibit statistical relationship between length and weight. Since, the weight length ratio is a power relationship, logarithms are used so that the exponential relation can be expressed by linear equation -
\[
\text{Log } W = \text{Log } A + B \text{Log } L,
\]
which is further simplified as
\[
Y = A' + B \cdot X
\]
where \(Y = \text{Log } W, \ X = \text{Log } L\) and \(A' = \text{Log } A\).

Treating the above equation as the equation of regression line, and determining the values of the constants \(A'\) and \(B\), the equations expressing the length - weight relationships in two sexes are derived as follows:

The length-weight relationships in males and females have been found to be:

- **Males**: \(0.0003766 + L^{2.8846}\)
- **Females**: \(0.0005716 + L^{2.9825}\)

Calculations for length - weight relationship in *T. mossambica* (males).

\[
\begin{align*}
\bar{x} &= 21.0401, \\
\bar{y} &= 14.9333, \\
\bar{xy} &= 32.5686, \\
\bar{x^2} &= 44.6668, \\
\bar{X} &= 2.1040, \\
\bar{Y} &= 1.4933, \\
n &= 10 \\
n \cdot \bar{X} \bar{Y} &= 31.4190 \\
n \cdot \bar{X} &= 44.2682
\end{align*}
\]
x and y are the logarithms of average length and average weight and N the number of samples.

The general parabolic equation for length-weight relationship is \( W = A L^B \), which is converted into linear regression equation as:

\[
\log W = \log A + B \log x,
\]
or
\[
Y = A^* + B \cdot X.
\]

The constant \( A^* \) and \( B \) are determined by the formula:

\[
A^* = \frac{\sum y - B \cdot \sum x}{n} \quad \text{and} \quad B = \frac{\sum xy - \frac{n \cdot \sum x \cdot \sum y}{\sum x^2 - n(x)^2}}
\]

\[
B = \frac{\sum xy - N \cdot \sum x \cdot \sum y}{\sum x^2 - n(x)^2} = \frac{32.5688 - 31.4190}{44.6666 - 44.2682} = 2.8846
\]

\[
A^* = \frac{\sum y - B \cdot \sum x}{n} = \frac{14.9333 - 2.8846 \cdot 21.0401}{10} = -4.5759
\]

By fitting the values of constants in the linear regression the equation will be, \( Y = -4.5759 + 2.8846 \cdot X \).

The equation can be expressed in terms of \( W \) and \( L \) as: \( W = 0.0003766 + L^2 \).

Calculations for length-weight relationship in T. mossambica (female):

\[
\sum x = 18.6961
\]
\[
\sum y = 12.9475
\]
\[ \xi x y = 27.8518 \]
\[ \xi x^2 = 39.1573 \]
\[ \bar{x} = 2.0773 \]
\[ \bar{y} = 1.4386 \]
\[ N = 9 \]
\[ n \bar{x} \bar{y} = 26.8956 \]
\[ n(\bar{x}^2) = 38.8367 \]

Where \( x \) and \( y \) are the logarithms of average length and average weight and \( N \) the number of observations.

The general parabolic equation for length-weight relationship is \( W = A L^B \) which is converted into linear regression equation -

\[ \log W = \log A + B \log x \quad \text{OR} \]
\[ y = A' + Bx. \]

The constants \( A' \) and \( B \) are determined by the formulae:

\[ A' = \frac{\xi y - B \xi x}{n} \quad \text{and} \quad B = \frac{\xi x y - n \bar{x} \bar{y}}{\xi x^2 - n(\bar{x})^2} \]
\[ B = \frac{\xi x y - n \bar{x} \bar{y}}{\xi x^2 - n(\bar{x})^2} = \frac{27.8518 - 26.8956}{39.1573 - 38.8367} = 2.9825 \]
\[ A' = \frac{\xi x y - B \xi x}{n} = \frac{12.9475 - 2.9825 (18.6961)}{9} \]
\[ A' = -4.7571 \]
By fitting the values of constants in the linear regression equation the equation will be -

\[ y = -4.7571 + 2.9825 \cdot x \]

The equation can be expressed in terms of 'W' and 'L' as -

\[ W = 0.0005716 + L^{2.9825} \]

The above formulae were tested for accuracy by calculating 'W' for every mean length 'L' by applying the formulae. The calculated values for males and females are given in Tables 16 and 17 and exhibited in the form of curves in Figs. 15 and 16 respectively. The observed values of mean weight are indicated by encircled dots. The observed values, when compared with the calculated values show a very close agreement with each other.

Vaas and Hoftstedæ (1952) plotted the values of average weight against standard length and average standard length against the weight and observed a curve in male and female *T. mossambica* ranging from 7 to 16 cm in standard length. Doha and Dewan (1967) derived the logarithmic form of equation for total length-weight relationship in *T. mossambica* as
### Table - 16

Length-weight relationship in male *T. mossambica*.

<table>
<thead>
<tr>
<th>Length group mm</th>
<th>No. of specimens examined</th>
<th>Average length 'L' mm</th>
<th>Average weight 'W' gms</th>
<th>Log 'L'</th>
<th>Log 'W'</th>
<th>$x^2$</th>
<th>$xy$</th>
<th>Calculated</th>
<th>$Y$</th>
<th>$W$</th>
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<tbody>
<tr>
<td>41 - 60</td>
<td>67</td>
<td>51.71</td>
<td>2.232</td>
<td>1.7090</td>
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<td>2.9207</td>
<td>0.5959</td>
<td>0.3539</td>
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<tr>
<td>61 - 80</td>
<td>77</td>
<td>71.91</td>
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<td>2.6879</td>
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<td>121 - 140</td>
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<td>1.5353</td>
<td>4.4766</td>
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<tr>
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<td>2.0224</td>
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</tbody>
</table>

\[
\sum x = 21,0401 \quad \sum y = 14,9333 \quad \sum x^2 = 44,6668
\]

\[
\sum xy = 32,5668
\]

\[
W = 0.0003766 + L^2.8846
\]
<table>
<thead>
<tr>
<th>Length group mm</th>
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<th>Average weight 'W' gms</th>
<th>Log 'L'</th>
<th>Log W</th>
<th>X</th>
<th>Y</th>
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<td>61 - 80</td>
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<td>93.29</td>
<td>13.748</td>
<td>1.9698</td>
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</table>

\[ x = 18.6961 \quad y = 12.9475 \quad x^2 = 39.1573 \quad xy = 27.8518 \]

\[ n = 9 \]

\[ w = 0.0005716 + L^{2.9825} \]
Fig. 15: Length-weight relationship in male *T. mossambica*.

Fig. 16: Length-weight relationship in female *T. mossambica*. 
Log $W = 5.351 + 3.270 \log TL$. They studied the relationship in 104 individuals ranging from 92 mm to 159 mm in total length, irrespective of sex.

The conclusions drawn during the present investigation are in close agreement with above workers.