CHAPTER 3

Results

Morphometric Measurements
3.1 Body length vs body weight

The relationship between body length and weight has been established for a number of marine natantians (CMFRI, 1969; Clutter and Theilacker, 1971; Subramanyam and Ganapathi, 1975; Modlin, 1980; Ivanov and Krylov, 1980; Seigfried, 1980). The information available on the biometric analysis of freshwater natantians is on the migratory variety of prawns (Ibrahim, 1962, Rao, 1967), on the palaemonid Macrobrachium lanchesteri (Anantha Raman, 1982; Rao, 1983) and on caridinid prawns (Anantha Raman, 1982).

Mass (weight=W) is generally related to body length (L) by a power expression of the form:

\[ W = aL^b \] .................................................................(1)

(Winberg, 1971; Edmondson and Winberg, 1971; Ricker, 1975), where \( a \) and \( b \) are fitted constants. In many animals, mass is a cubic function of body length:

\[ W = aL^3 \] .................................................................(2)

logarithmic transformation of the equation (1) results in:

\[ \log W = \log a + b \log L \] ........................................(3)

results in a linear relation between mass and length, the slope of which is described by \( b \).

The length-weight relationship of Macrobrachium lanchesteri was determined for females of the three ovarian index classes, as well as for ovigerous females. Each month, after collection and transportation of prawns to the laboratory, the non-ovigerous female prawns were segregated into 3 groups based on their ovarian index: OI <30, OI 30-60 and OI >60. Ovigerous females constituted the fourth group. Immediately after their segregation, representative prawns were selected from the stock, the length of each prawn was measured to the nearest mm. and the weight was
recorded in a monopan-electric balance (Make: AD 100) to 0.1 mg accuracy. Data on the length and weight of female *M. lanchesteri* was used to compute the length-weight relationship.

Allometric and curvilinear relationships between length and weight of females in the three groups were evident (Figs. 6a, 7a, 8a). The relationship conformed to the equation:

\[ W = aL^b \]

**OI <30**

\[ W = 0.0030L^{3.2433} \] (\(L_r = 35-46; \, W_r = 310-765\))

\[ \text{Fig. 6a.} \]

**OI 30-60**

\[ W = 0.0072L^{3.0194} \] (\(L_r = 35-50; \, W_r = 340.00-1015.00\))

\[ \text{Fig. 7a.} \]

**OI >60**

\[ W = 0.0062L^{3.0640} \] (\(L_r = 39-51; \, W_r = 470.00-1060.00\))

\[ \text{Fig. 8a.} \]

(L = total length in mm; W = weight in mg; \(L_r\) = length range in mm and \(W_r\) = weight range in mg)

The corresponding logarithmic equations are represented as:

\[ \log W = \log a + b \log L \] ..............................................(2)

**OI <30**

\[ \log W = 3.2423 \log L - 2.5196 \]  
(r = 0.9910)..............................................Fig. 6b

**OI 30-60**

\[ \log W = 3.0194 \log L - 2.1397 \]  
(r = 0.9940)..............................................Fig. 7b
Figure 6. Length - Weight relationship of female Macrobrachium lanchesteri of ovarian index \(<30\).

A. Curvilinear relationship. Each value is the mean with range.

B. Logarithmic transformation of A.
Log $W = 0.2423 \log L - 2.5198$

$r = 0.9910$

$W = 0.0030L^{3.2423}$

($n = 182$)
Figure 7. Length - Weight relationship of female *Macrobrachium lanchesteri*.

ovarian index 30 - 60.

A. Curvilinear relationship. Each value is the mean with range.

B. Logarithmic transformation of A.
Fig. 7

\[ \log W = 3.0194 \log L - 2.1397 \]

\[ r = 0.994 \]

\[ W = 0.0072 L^{3.0194} \]

\[ (n = 130) \]
Figure 8. Length - Weight relationship of female Macrobrachium lanchesteri 
with ovarian index >60.

A. Curvilinear relationship. Each value is the mean with range.
B. Logarithmic transformation of A
\log W = 3.0641 \log L - 2.2091

\text{r} = 0.983

W = 0.0062 L^{3.0641}

(n = 89)
\[
\log W = 3.0641 \log L - 2.2091 \\
(r = 0.9830) \ ...
\]

In a number of other natantians, similar curvilinear relationships between \( L \) and \( W \) are reported for males and females separately (Thomas, 1975; Ivanov and Krylov, 1980; Rajyalakshmi, 1980; Siegfried, 1980) and populations of both the sexes put together (Rajyalakshmi, 1961a; Rao, 1967; Subramanyam and Ganapathi, 1975; Beck and Cowell, 1976; Ivanov and Krylov, 1980; Modlin, 1980; Sukumaran and Rajan, 1981).

The correlations between the total length and weight relationships were strong (\( r \) values being higher than 0.98). Further, from the Table 1 it is seen that the 't' values are highly significant. The exponent values remained higher than 3. This confirms to the cube law. The present equations conform to the observations of Bhimachar (1965) that, the 'b' values in freshwater prawns are greater than 3. The 'b' values as observed presently is comparable to the values reported for the same species by Rao (1983). As compared to these three groups of \( M. \ lanchesteri \), in ovigerous females Length and Weight relationship exhibited only a straight line correlation conforming to the equation:

\[
W = a + bL 
\]

Ovigerous females with brood

\[
W = 51.99L - 1493.69 \\
(L_r = 35-52; \ W_r = 382.50-1212.20; \ r = 0.9934) \ ...
\]

In a few ovigerous natantians, a linear relationship between \( L \) and \( W \) have been reported by Ponnuchamy et al. (1979) and Rao et al. (1981a). It also appears to be a feature of fishes
Table 1. Regression equations and 't' values for the length-weight relationship of the four ovarian classes of female *Macrobrachium lanchesteri*.

<table>
<thead>
<tr>
<th>Ovarian index (OI)</th>
<th>Regression equation</th>
<th>'t' value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30</td>
<td>log W=3.2423 logL-2.5196</td>
<td>83.1358 (df: 10) P=&gt; 0.005</td>
</tr>
<tr>
<td>30-60</td>
<td>log W=3.0194 logL-2.1397</td>
<td>60.6300 (df: 13) P=&gt;0.005</td>
</tr>
<tr>
<td>&gt;60</td>
<td>log W=3.0641 logL-2.2091</td>
<td>77.2202 (df: 11) P=&gt;0.005</td>
</tr>
<tr>
<td>Ovigerous females</td>
<td>log W=3.1046 logL-2.2196</td>
<td>57.8137 (df: 15) P=&gt;0.005</td>
</tr>
</tbody>
</table>
Figure 9. Length - Weight relationship of ovigerous female *Macrobrachium lanchesteri*.

Linear relationship of ovigerous females. Each value is the mean with range.
Fig. 9

OVIGEROUS FEMALES

\[ W = 51.99L - 1493.69 \]

\[ r = 0.9934 \]

\( n = 132 \)
belonging to the post-recruitment size (Rao et al., 1979; Nagendran et al., 1981).

3.2 Carapace length and ovary weight

The data on carapace length (CL) and corresponding ovary weight of the three ovarian index classes of female *M. lanchesteri* and carapace length vs brood weight of ovigerous females were plotted in Figures 10, 11, 12 and 13 respectively. The realised linear relationship is markedly strong with an 'r' value ranging from 0.9803 to 0.9952. The corresponding equations are:

OI <30

\[ W = 1.8084 \times CL - 12.1877 \]

(\( CL_r = 8-13; \ W_r = 2.49-11.51; \ r = 0.9952 \)) Fig. 10

OI 30-60

\[ W = 6.4486 \times CL - 53.8044 \]

(\( CL_r = 8-15; \ W_r = 3.92-45.36; \ r = 0.9819 \)) Fig. 11

OI >60

\[ W = 11.0259 \times CL - 71.6640 \]

(\( CL_r = 10-15; \ W_r = 38.22-91.13; \ r = 0.9932 \)) Fig. 12

Ovigerous females

\[ W = 5.3816 \times CL - 38.8132 \]

(\( CL_r = 9-14; \ W_r = 9.24-37.21; \ r = 0.9803 \)) Fig. 13

3.3 Carapace length vs hepatopancreas weight

Figures 14, 15, 16 and 17 describe the linear relationships between carapace length (CL) and weight of hepatopancreas in the four classes of female *M. lanchesteri*. The 'r' values ranged
Figure 10. Linear relationship between carapace length and live weight of the ovaries of female *Macrobrachium lanchesteri* of ovarian index <30.
Fig. 10

OI < 30

$W = 1.8084 \times CL - 12.1877$

$r = 0.9952$

$(n = 295)$
Figure 11. Linear relationship between carapace length and live weight of the ovar of female *Macrobrachium lanchesteri* of ovarian index 30 - 60.
W = LIVE WEIGHT OF OVARY (mg)

\[ W = 6.4486CL - 53.8044 \]
Figure 12. Linear relationship between carapace length and live weight of the ovary of female Macrobrachium lanchesteri of ovarian index > 60.
Fig. 12

\[ W = 11.0259 \times CL - 71.6640 \]

\[ r = 0.9932 \]

\( n = 150 \)
Figure 13. Linear relationship between carapace length and dry weight of the brood of ovigerous female Macrobrachium lanchesteri.
Fig. 13

OVIGEROUS FEMALE

$W = 5.3816 CL - 38.8132$

$r = 0.9803$

(n = 102)

$W =$ DRY weight of the brood (mg)

$CL =$ CARAPACE LENGTH (mm)
from 0.9721 to 0.9822 suggesting a strong relationship between the two

**OI <30**

\[ W = 4.8429 \times CL - 30.0345 \]

\[(CLr = 8-14; \ Wr = 9.56-40.80; \ r = 0.9608) \ldots \ldots \ldots \text{Fig. 14}\]

**OI 30-60**

\[ W = 5.3653 \times CL - 33.6936 \]

\[(CLr = 8-15; \ Wr = 9.40-49.88; \ r = 0.9804) \ldots \ldots \ldots \text{Fig. 15}\]

**OI >60**

\[ W = 4.7602 \times CL - 27.8238 \]

\[(CLr = 10-15; \ Wr = 20.21-41.05; \ r = 0.9721) \ldots \ldots \ldots \text{Fig. 16}\]

**Ovigerous females**

\[ W = 4.7571 \times CL - 31.4087 \]

\[(CLr = 8.5-14; \ Wr = 10.20-36.40; \ r = 0.9822) \ldots \ldots \ldots \text{Fig. 17}\]

*(CL = Carapace length in mm; \nW = Weight of ovary, hepatopancreas and brood in mg; \nCLr = Carapace length range in mm; \nWr = Weight range in mg.)*

Table 2 & 3 show the 't' values for the regression equations of carapace length vs. weight of ovary and brood and carapace length vs. hepatopancreas weight respectively. These 't' values show that the relationships are significant.

### 3.4 Reproductive cycle

Each month female prawns of carapace length ≥ 11mm, were selected from the catch and their mean and maximum ovary weights were determined. There was a gradual increase in the
Figure 14. Linear relationship between carapace length and live weight of the females of female H. hanrioum hannkangeri ovarian index.
W = 4.8429 CL - 30.0345
r = 0.9608
(n = 312)

CL = CARAPACE LENGTH (mm)

W = WEIGHT OF HEPA/OPHRENES (mg)
Figure 15. Linear relationship between carapace length and live weight of the hepatopancreas of female Macrobrachium lanchesteri of ovarian index 30 - 60.
Fig. 15

$W = 5.3653 CL - 33.6936$

$r = 0.9804$

(n = 345)

$O I\ 30-60$

CL : CARAPACE LENGTH (mm)

$W = \text{Weight of Hepatopancreas (mg)}$
Figure 16. Linear relationship between carapace length and live weight of the hepatopancreas of female Macrobrachium lanchesteri of ovarian index $>60$. 
Fig. 16

\[ W = 4.7602 \times CL - 27.8238 \]

\[ r = 0.9721 \]

\[ (n = 166) \]

CL = CARAPACE LENGTH (mm)

W = WEIGHT OF HEPATOPANCREAS (mg)
Figure 17. Linear relationship between carapace length and live weight of the hepatopancreas of ovigerous female Macrobrachium lanchesteri.
Fig. 17

\[ W = 4.7571CL - 31.4087 \]

\[ r = 0.9822 \]

\( n = 97 \)

Ovigerous Female

W: Live Weight of Hepatopancreas (mg)

CL: Carapace Length (mm)
Table 2. Regression equations and 't' values for the relationship between carapace length and ovary weight of the three ovarian classes of female *Macrobrachium lanchesteri* and carapace length vs brood weight of ovigerous females.

<table>
<thead>
<tr>
<th>Ovarian index (OI)</th>
<th>Regression equation</th>
<th>'t' value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30</td>
<td>W=1.8084 CL-12.1877</td>
<td>1.0837</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(df: 7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P=&lt;0.10</td>
</tr>
<tr>
<td>30-60</td>
<td>W=6.4486 CL-53.8044</td>
<td>2.6864</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(df: 8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P=&gt;0.025</td>
</tr>
<tr>
<td>&gt;60</td>
<td>W=11.0259 CL-71.6640</td>
<td>5.7549</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(df: 5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P=&gt;0.005</td>
</tr>
<tr>
<td>Ovigerous females</td>
<td>W=5.3816 CL-38.8132</td>
<td>3.0345</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(df: 5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P=&gt;0.025</td>
</tr>
</tbody>
</table>
Table 3. Regression equations and 't' values for the relationship between carapace length and hepatopancreas weight for the four ovarian classes of female *Macrobrachium lanchesteri*.

<table>
<thead>
<tr>
<th>Ovarian index (OI)</th>
<th>Regression equation</th>
<th>'t' value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30</td>
<td>( W=4.8429 \text{ CL}-30.0345 )</td>
<td>2.4793 (df: 8) ( P=&lt;0.025 )</td>
</tr>
<tr>
<td>30-60</td>
<td>( W=5.3653 \text{ CL}-33.6936 )</td>
<td>2.3687 (df: 9) ( P=&gt;0.025 )</td>
</tr>
<tr>
<td>&gt;60</td>
<td>( W=4.7602 \text{ CL}-27.8238 )</td>
<td>2.4844 (df: 5) ( P=&gt;0.05&lt;0.025 )</td>
</tr>
<tr>
<td>Ovigerous females</td>
<td>( W=4.7571 \text{ CL}-31.4087 )</td>
<td>2.2831 (df: 7) ( P=&gt;0.05&lt;0.025 )</td>
</tr>
</tbody>
</table>
mean ovary weight of *M. lanchesteri* from April 1992 and in October, the highest mean value was observed (Fig. 18). Mean weight increased from 11.33 mg. in April to 66.67 mg. in October and thereafter decreased gradually until February when the lowest value of 6.86 mg. was recorded. High standard deviations observed during September and October were partially caused by very low ovary weights in prawns of OL <30. This seasonal trend observed presently confirms the observations of Rao (1983) that the active reproductive period of *M. lanchesteri* extends from late June to early November.

3.5 Gonad Index (GI)

Gonad indices were calculated only for female prawns of carapace length ≥ 11 mm. (Fig. 19). The gonad index showed a well-defined annual cycle. The GI increased gradually from April through August 1992 when the highest value of 9.67 was observed. The index decreased substantially during October and November and then more gradually to reach the lowest value of 1.34 in February 1993.

3.6 Hepatopancreas weights and their seasonal trend

Female prawns of carapace length ≥ 11mm were selected from the collections every month and the mean and maximum weight of hepatopancreas was determined. There was a gradual increase in the mean hepatopancreas weight from April through September 1992, when the highest mean (live weight: 30.28 mg) was noticed (Fig. 20). Thereafter, the hepatopancreas weight decreased until February 1993 when the lowest mean (live weight: 20.24 mg) was recorded. This seasonal trend was similar to that observed for ovaries. Correlation between ovary weight and hepatopancreas weight was strong (r = 0.8398).
Figure 18. *Macrobrachium lanchesteri*: Mean live weight (excluding ovigerous females) of ovary of females > 11 mm carapace length. Vertical bars indicate ± standard deviation.
Figure 19. Gonad index (GI) of female *Macrobrachium lanchesteri* of carapace length $\geq 11\text{mm}$ from June 1992 through May 1993.
Figure 20. *Macrobrachium lanchesteri*: Mean live weight of hepatopancreas of females $\geq 11$mm carapace length. Vertical bars indicate $\pm$ standard deviation.
Figure 1: Pancreas weight (mg) over the years 1992 to 1993.