STATISTICAL STUDY OF GROWTH
CHAPTER III

GROWTH IN PARALOXIDED ORIENTALIS

BAILIN AND DIO, 1929
INTRODUCTION

In trematodes it is observed that during the growth several changes occur in the disposition of various important organs. Certain structures such as testes, ovary and vitellaria show their prominence while others get differentiated such as internal differentiation of cirrus sac, appearance of ovarian complex etc.

Ward (1910) studied growth changes in _T. sebaeus_ Ward, (1910). Kuslisla (1914) observed the changes during the growth of _Otodistomum velinorum_ (Creplin). Manter (1926) studied changes during the growth in _Otodistomum costoides_ Van Beneden, 1871. Ali and Karyakarte (1970) studied the growth of _Tremiorcidae ranarum_ Mehra and Negi 1926 and described various developmental changes in the fluke. Ubgade and Agarwal (1979) observed the growth in _T. oscilla_ Ubgade and Agarwal, 1979. They used statistical method to show growth of certain parts of the body such as pre- and post-acetabular regions and pre- and post-ovarian regions. Banswal (1981) observed growth changes in _Ganeo tigrina_ Mehra and Negi, 1928.
and statistically showed morphometric relationship between length and width, ratio of oral and ventral sucker, changes in the region between anterior tip of worm and anterior tip of ventral sucker and enormous growth in post-gonadal region. Gaikwad (1983) studied fifty specimens of varying age group of *Monorchis ranarum* Girvasto, 1934 and observed that several regions of the body grow more than other regions. His study was also based on statistical methods.

In the present study 2684 specimens of *Paradistomoides orientalis* Narain and Das, 1929 were collected and observed. Out of these specimens fifty flukes were selected for present study and the changes during the growth were observed and the relationship between various regions was ascertained statistically.
MATERIAL AND METHODS

The host specimens, *Calotes versicolor* were collected from the different places in and around Aurangabad and nearby places. The collection of flukes included immature, just matured and completely matured flukes. The trematodes were studied in live condition, then fixed in 4% formalin, stained in Delafield’s hematoxylin and mounted in DPX.

Fifty flattened, fixed and stained specimens of *Paradistomoides orientalis* representing developmental stages were selected for the present study. The drawings of fifteen specimens selected were made with the help of camera lucida. The arrangements of the flukes were according to their lengths and the growth of the different regions of the body and various organs. All the measurements are in millimeters.
Observations

The juvenile flukes generally occur during the month of July, the maturing and matured flukes are abundant during subsequent months. The youngest fluke measures 0.661 in length and 0.532 in width. The completely matured form measures 7.987 in length and 3.663 in width. In the youngest form the ratio between the body width and body length is 1:1.28 whereas, in the matured form the ratio is 1:2.18.

Generally the position of oral sucker remains sub-terminal but in some forms it is not uncommon to see ventrally placed oral sucker. In the juvenile forms the ventral suckers is equatorial in position whereas in the mature forms it is not only distinctly pre-equitorial but its anterior border touches the line separating first quarter of the body from the second. In the juvenile forms the oral sucker is slightly bigger than the ventral sucker but as the fluke grows it becomes nearly equal and the ratio between the diameters of oral and ventral sucker which was 1:0.83 changes to 1:1.22.
The intestinal caeca occupy maximum available space in the body. These structures are broad but during the growth they become comparatively narrow and occupy less space. The minimum distance between the tip of intestinal caeca and the posterior end of the body is 0.029 in immature fluke, and 0.854 in the mature form.

The testes are in the acetabular zone in the youngest form but gradually these are shifted in the post-acetabular region. The cirrus sac which is not observed in specimen Nos. 1, 2, 3 and 4 is observed in specimen No. 5. It is distinctly post-bifurcal in specimen Nos. 5 and 6. Gradually it is shifted anteriorly and becomes bifurcal in the completely matured form (specimen No. 15). Accordingly the position of genital pore also changes from distinctly post-bifurcal to just post-pharyngeal.

The ovary is contiguous with the posterior margin of ventral sucker in specimen No. 1 and the posterior margin of the testes is in line with anterior margin of the ovary. During the growth ovary changes its position and shifted posteriorly and in some of the forms it is distinctly away from
ventral sucker and also from the posterior margin of the testes. The uterus is not observed in the juvenile forms (Specimen Nos. 1 to 6), a few loops are observed in specimen No. 7. As the fluke develops the uterus occupies the entire space in the post-ovarian region. The vitelline follicles are observed in specimen No. 5 for the first time. The follicles are limited in extension but gradually occupy the marginal region in the middle part of the body.

The golden brown operculated eggs are observed from the specimen No. 7 onwards.

The measurements of the fifty flukes and data showing relationship between various organs are presented in Table No. 3.1 and graphic representation in figure Nos. 1 to 4. The morphometric study reveals certain very important relationships between various organs in *Paradistomoides orientalis*.

(a) **Length-width relation**

The juvenile form is almost rounded and the ratio between the body width and body length is 1:1.28. The biggest specimen is elongated in shape and the ratio between body width and body length is
<table>
<thead>
<tr>
<th>Specimen Number</th>
<th>Body Width (A)</th>
<th>Body Width (B)</th>
<th>Oral Sucker Width (C)</th>
<th>Ventral Sucker Width (D)</th>
<th>Distance between Anterior Margin of Oral Sucker and Posterior Margin of Ventral Sucker (E)</th>
<th>Distance between Posterior Tip of Oral Sucker and Posterior Tip of Ventral Sucker (F)</th>
<th>Distance from Posterior Tip of Ventral Sucker to Posterior Margin of the Body (G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.681</td>
<td>0.532</td>
<td>1.260</td>
<td>0.123</td>
<td>0.103</td>
<td>0.194</td>
<td>0.340</td>
</tr>
<tr>
<td>2</td>
<td>0.788</td>
<td>0.617</td>
<td>1.277</td>
<td>0.177</td>
<td>0.096</td>
<td>0.180</td>
<td>0.363</td>
</tr>
<tr>
<td>3</td>
<td>0.915</td>
<td>0.745</td>
<td>1.228</td>
<td>0.123</td>
<td>0.123</td>
<td>0.100</td>
<td>0.448</td>
</tr>
<tr>
<td>4</td>
<td>1.128</td>
<td>0.596</td>
<td>1.892</td>
<td>0.177</td>
<td>0.128</td>
<td>0.182</td>
<td>0.489</td>
</tr>
<tr>
<td>5</td>
<td>1.150</td>
<td>0.660</td>
<td>1.742</td>
<td>0.158</td>
<td>0.148</td>
<td>0.167</td>
<td>0.468</td>
</tr>
<tr>
<td>6</td>
<td>1.278</td>
<td>0.639</td>
<td>2.000</td>
<td>0.202</td>
<td>0.138</td>
<td>0.180</td>
<td>0.575</td>
</tr>
<tr>
<td>7</td>
<td>1.491</td>
<td>0.702</td>
<td>1.123</td>
<td>0.222</td>
<td>0.167</td>
<td>0.139</td>
<td>0.639</td>
</tr>
<tr>
<td>8</td>
<td>1.810</td>
<td>1.001</td>
<td>1.810</td>
<td>0.308</td>
<td>0.266</td>
<td>0.157</td>
<td>0.830</td>
</tr>
<tr>
<td>9</td>
<td>2.000</td>
<td>0.788</td>
<td>2.539</td>
<td>0.207</td>
<td>0.162</td>
<td>0.277</td>
<td>0.780</td>
</tr>
<tr>
<td>10</td>
<td>2.844</td>
<td>0.894</td>
<td>1.286</td>
<td>0.322</td>
<td>0.266</td>
<td>0.310</td>
<td>0.915</td>
</tr>
<tr>
<td>11</td>
<td>2.577</td>
<td>0.979</td>
<td>2.135</td>
<td>0.336</td>
<td>0.308</td>
<td>0.109</td>
<td>0.873</td>
</tr>
<tr>
<td>12</td>
<td>1.321</td>
<td>1.197</td>
<td>2.096</td>
<td>0.294</td>
<td>0.238</td>
<td>0.125</td>
<td>0.950</td>
</tr>
<tr>
<td>13</td>
<td>2.843</td>
<td>1.022</td>
<td>2.599</td>
<td>0.172</td>
<td>0.143</td>
<td>0.192</td>
<td>0.788</td>
</tr>
<tr>
<td>14</td>
<td>2.385</td>
<td>1.065</td>
<td>2.239</td>
<td>0.143</td>
<td>0.133</td>
<td>0.075</td>
<td>0.780</td>
</tr>
</tbody>
</table>

**Table 3.1**

Measurements of fifty specimens of *Parastitomoides orientalis*, Beilan and Oos, 1929.
Figure 1

A: --- Maximum body length
B: --- Maximum body width

No. of fluke

10 20 30 40 50

mm

1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0
A: Maximum body length.
B: Posterior margin of ventral sucker.
E: Anterior body tip.

No. of fluke: 10
\[ \text{No. of fluke} \]
\[ 10 \]
\[ 20 \]
\[ 30 \]
\[ 40 \]
\[ 50 \]
\[ 60 \]
\[ 70 \]
\[ 80 \]
\[ b \]
\[ 0 \]
\[ 2 \]
\[ 4 \]
\[ 6 \]
\[ 8 \]
A ···· Maximum body length.
F : o o Posterior margin of ventral sucker.
b : — Posterior body tip.

FIGURE: 3
A: Maximum body length.
G: Anterior tip of ovary.
b: Posterior body tip.

FIGURE 4: No. of fluke vs. mm

- Maximum body length.
- Anterior tip of ovary.
- Posterior body tip.

- No. of fluke vs. mm
1:2.18. This relationship is significant as proved by the statistical method. Generally the length-width relationship can be proved by considering the statistical terms and the formulae used separately for body length and width.

Body Length = x

"A"

Body width = y

"B"

ξ Log x² = Total of the square of the log of each body length of the fluke.

ξ Log y² = Total of the square of the log of each body width of the fluke.

ξ Log x = T Total of the log of each body length data.

ξ Log y = Total of the log of each body width data

n = Number of observations

ξ Log \overline{x} = Log of mean (Average body length)

ξ Log x X log y = Summation of the multiplication of body length and body width.
\[ b = \frac{N \xi xy - (\xi x) \times (\xi y)}{N \xi x^2 - (\xi x)^2} = \text{Regression coefficient} \]

\[ a = \text{slope} \]

\[ r = \frac{\xi xy}{\sqrt{\xi xx \times \xi yy}} = \text{Correlation coefficient} \]

\( \xi \) = Calculated value

\( \hat{y} \) = Observed value

\begin{align*}
\xi \log x^2 & = 13.0785 \\
\xi \log x & = 22.7758 \\
n & = 50 \\
\log x & = 0.4555
\end{align*}

\begin{align*}
\xi \log y^2 & = 3.3645 \\
\xi \log y & = 7.5958 \\
n & = 50 \\
\log y & = 0.1519
\end{align*}

\[ \xi \log x \times \xi \log y = 5.3998 \]

\[ \text{Regression coefficient} = \]

\[ b = \frac{N \xi xy - (\xi x) \times (\xi y)}{N \xi x^2 - (\xi x)^2} \]

\[ h = \frac{50 \times 5.7998 - (22.7758 \times 7.5958)}{50 \times 13.0785 - (22.7758)^2} \]
\[
\begin{align*}
\frac{289.99 - 173.00}{653.925 - 518.737} &= b \\
\frac{116.99}{135.188} &= b \\
b &= 0.86538
\end{align*}
\]

Slope \( a = \frac{y - b \times x}{x} \)

\[
\begin{align*}
\log a &= 0.1519 - 0.8653 \times 0.4555 \\
\log b &= 0.1519 - 0.3941 \\
\log a &= -0.2422 \quad \text{antilog} = 0.5725 \\
\hat{E} &= a \times \text{(Body length)}^b = a \times (BL)^b \\
\hat{E} &= 0.5725 \times (4.536)^{0.8653} \quad \text{Body length from the specimen No. 40 (at random)} \\
\hat{E} &= 0.5725 \times 3.700 \\
\hat{E} &= 2.118 \quad \text{calculated value.} \\
\hat{E} &= \text{Calculated value} = 2.118 \\
\hat{E} &= \text{Observed value} = 2.02 \quad \text{(as in Table No. 3.1 and specimen No. 40 mentioned above)}
\]
\[ B = (\log X)^2 - \left( \frac{\sum \log X}{n} \right)^2 \]
\[ = 13.0785 - \left( \frac{22.7756}{50} \right)^2 \]
\[ = 13.0785 - 10.374 \]
\[ = 2.7045 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad B \]

\[ A = \log X \cdot \log y - \left( \frac{\sum \log x \cdot \sum \log y}{50} \right) \]
\[ = 5.7998 - \left( \frac{22.7756 \times 7.5946}{50} \right) \]
\[ = 5.7998 - 3.4594 = 2.3404 \quad \ldots \quad A \]

\[ \frac{A}{B} = \frac{2.3404}{2.7045} = 0.8653 \]

**Values**

\[ s_{yy}^2 = (\frac{\sum \log y}{n})^2 \]
\[ s_{yy} = 3.3645 - \left( \frac{7.5958}{50} \right)^2 \]
\[ s_{yy} = 3.3645 - 1.1539 \]
\[ s_{yy} = 2.2106 \]

**Values**

\[ A = s_{xy} = 2.3404 \]
\[ B = s_{xx} = 2.7045 \]
\[ s_{yy} = 2.2106 \]
The ratio between the width of oral to ventral sucker varies from 1:0.83 to 1:1.22. It is observed that sometimes the oral sucker is bigger than the ventral. In some of the specimens it is equal whereas, in still other specimens it is smaller than the ventral sucker. Thus, the size of the suckers is variable and statistically of no significance.

(b) Oral sucker-ventral sucker relationship

The distance between anterior tip of body and posterior margin of ventral sucker/Total body length).

(c) E/A relationship

The distance between anterior tip of body and the posterior margin of ventral sucker and the distance between posterior margin of ventral sucker and
posterior tip of the body shows considerable variation. Initially the distance between anterior tip of the body and ventral sucker is equal to the distance between posterior margin of ventral sucker and posterior tip of the body (Specimen No. 1 = 0.340 and 0.340). However as the growth proceeds the distance between anterior tip of the body and posterior margin of ventral sucker becomes two times shorter than the distance between posterior margin of ventral sucker and posterior tip of the body (specimen No. 50 = 2.619 and 5.367). Thus, the ratio is initially 1:1 but changes to 1:0.487. There is a definite relationship between the distance between anterior tip of body and posterior margin of ventral sucker and the total body length i.e. $5/\text{A}$, it shows almost a constant which also can be proved statistically.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body length</td>
<td>Distance between anterior tip of body and posterior margin of ventral sucker</td>
</tr>
</tbody>
</table>

$\log x^2 = 13.0785$  
$\log x = 22.7758$  
$n = 50$

$\log y^2 = 1.6161$  
$\log y = 0.6689$  
$n = 50$
\[ \log \bar{x} = 0.4555 \quad \log \bar{y} = 0.01337 \]

\[ \xi \log x \times \xi \log y = 2.3558 \]

\[ b = \frac{N \xi xy - (\xi x) \times (\xi y)}{N \xi x^2 - (\xi x)^2} \]

\[ b = \frac{50 \times 2.3558 - 22.7758 \times 0.6689}{50 \times 13.0785 - (22.7758)^2} \]

\[ b = \frac{117.79 - 15.2347}{653.925 - 518.737} \]

\[ b = \frac{102.555}{135.188} \]

\[ = 0.7586 \]

**Slope**

\[ \log a = \bar{y} - b \times \bar{x} \]

\[ \log a = 0.0133 - 0.7586 \times 0.4555 \]

\[ \log a = 0.0133 - 0.3455 \]

\[ \log a = -0.3322 \quad \text{antilog} = 0.4653 \]

\[ \hat{E} = a \times \text{(body length)}^b = a \times (BL)^b \]

\[ \hat{E} = 0.4653 \times 4.536^{0.7586} \quad \text{Body length from the} \]

\[ \text{specimen No. 40} \]

\[ \hat{E} = 0.4653 \times 3.1488 \]

\[ \hat{E} = 1.465 \]
\[ \hat{\epsilon} = \text{Calculated value} = 1.465 \]

\[ E = \text{observed value} = 1.448 \text{ (as in Table No. 3.1)} \]

(\text{Specimen No. 40 mentioned above})

\[ \xi \log x^2 = \left( \frac{\xi \log x}{50} \right)^2 = \]

\[ = 13.0785 - \left( \frac{22.7758}{50} \right)^2 \]

\[ = 13.0785 - \frac{518.737}{50} = 10.3747 \]

\[ = 13.0785 - 10.3747 = 2.7038 \ldots \ldots \quad B \]

\[ \xi \log x \log y = \left( \frac{\xi \log x \times \xi \log y}{50} \right) \]

\[ = 2.3548 - \left( \frac{22.7758 \times 0.6689}{50} \right) \]

\[ = 2.3548 - \frac{15.2213}{50} = 0.3044 \]

\[ = 2.3548 - 0.3044 = 2.0514 \ldots \ldots \quad A \]

\[ \frac{A}{B} = \frac{2.0512}{2.7038} = 0.7586 \]

\[ S_{yy} = \xi \log y^2 - \left( \frac{\xi \log y}{n} \right)^2 \]

\[ S_{yy} = 1.6161 - \left( \frac{0.6689}{50} \right)^2 \]

\[ S_{yy} = 1.6161 - \left( \frac{0.4474}{50} \right) \]
\[ S_{yy} = 1.6161 - 0.0089 \]
\[ S_{yy} = 1.6072 \]
\[ A = S_{xy} = 2.0512 \]
\[ B = S_{xx} = 2.7045 \]
\[ S_{yy} = 1.6072 \]
\[
\begin{align*}
    r &= \frac{S_{xy}}{\sqrt{S_{xx} \times S_{yy}}} \\
    &= \frac{2.0512}{\sqrt{2.7045 \times 1.6072}} \\
    &= \frac{2.0512}{0.3466} \\
    &= 0.9838
\end{align*}
\]
\[ r = 0.9838 \]
\[ \text{Cor. Coe.} = 0.9838 \]

(d) **P/A relationship**

The distance between posterior margin of ventral sucker and posterior tip of the body.

<table>
<thead>
<tr>
<th>Body length $x_{A}$</th>
<th>Distance between posterior margin of ventral sucker and posterior tip of the body $y_{F}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\log x_{A} = 13.0785$</td>
<td>$\log y_{F} = 6.8857$</td>
</tr>
<tr>
<td>$\log y_{F} = 6.8857$</td>
<td>$\log y_{F} = 12.8029$</td>
</tr>
<tr>
<td>$n = 50$</td>
<td>$n = 50$</td>
</tr>
</tbody>
</table>
\[ \log x = 0.4555 \quad \log y = 0.2560 \]

\[ \xi \log x \times \log y = 8.9472 \]

\[ b = \frac{N \xi xy - (\xi x) \times (\xi y)}{N \times \xi x^2 - (\xi x)^2} \]

\[ b = \frac{50 \times 8.9472 - (22.7758) \times 12.8029}{50 \times 13.0785 - (22.7758)^2} \]

\[ b = \frac{447.36 - 291.596}{653.925 - 518.737} \]

\[ b = 155.764 \quad 135.188 \]

\[ b = 1.1522 \]

\[ \text{Slope } a = \frac{\bar{y} - b \times \bar{x}}{b} \]

\[ a = 0.2560 - 1.1522 \times 0.4555 \]

\[ a = 0.2560 - 0.5248 \]

\[ \text{Log } a = -0.2688 \quad \text{antilog } = 0.53851 \]

\[ E = a \times (\text{body length})^b = a \times (\text{BL})^b \]

\[ E = 0.53851 \times (4.536)^{1.1522} \quad \text{Body length from the specimen No. 40} \]

\[ E = 0.5385 \times 5.7097 \]

\[ E = 3.074 \]

\[ E = \text{Calculated value} = 3.074 \]

\[ E = \text{Observed value} = 3.088 \quad \text{as given in Table No. 3.1} \]

\[ (\text{specimen No. 40 as mentioned above}) \]
\[ \log x^2 - \left( \frac{\log x}{50} \right)^2 = 13.0785 - \left( \frac{22.7758}{50} \right)^2 \]

\[= 13.0785 - 10.3747 = 2.7038 \ldots \ldots \ldots \ldots B \]

\[\log x \log y - \left( \frac{\log x \times \log y}{n} \right)\]

\[= 8.9472 - \left( \frac{22.7758 \times 12.8029}{50} \right)\]

\[= 8.9472 - \frac{291.5962}{50} \]

\[= 8.9472 - 5.8319 \]

\[= 3.1153 \ldots \ldots \ldots \ldots \ldots A \]

\[\frac{A}{B} = \frac{3.1153}{2.7038} = 1.1522 \]

\[S_{yy} = \frac{\log y^2 - \left( \frac{\log y}{n} \right)^2}{n}\]

\[S_{yy} = 6.8857 - \left( \frac{12.8029}{50} \right)^2 = \frac{163.9142}{50} \]

\[S_{yy} = 6.8857 - 3.2782 = 3.6075 \]

\[A = S_{xy} = 3.1153 \]

\[B = S_{xx} = 2.7045 \]

\[S_{yy} = 3.6075 \]

\[r = \frac{S_{yy}}{\sqrt{S_{xx} \times S_{yy}}} = \frac{3.1153}{\sqrt{2.7045 \times 3.6075}} \]
One more variable is observed between the distance from posterior margin of ventral sucker and posterior tip of the body total length of the fluke. Initially P/A is 0.449, it increases to 0.671, indicating the increase in the distance between tip of ventral sucker and the posterior margin of the body.

(e) G/A relationship

(The distance from anterior tip of ovary to the posterior margin of the body/Total body length).

The distance from anterior tip of ovary to the posterior margin of the body and the total length of the body (G/A) remains almost constant showing thereby the equatorial position of ovary with a little margin during the growth of the fluke. This is also proved statistically.
<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body length</td>
<td>Distance from anterior tip of ovary to posterior margin of the body</td>
</tr>
</tbody>
</table>

\[
\log x^2 = 13.0785 \quad \log y^2 = 6.01227
\]

\[
\log x = 22.7758 \quad \log y = 10.8167
\]

\[n = 50\]

\[
\log \bar{x} = 0.4555 \quad \log \bar{y} = 0.21633
\]

\[
\log x \times \log y - 8.06170
\]

\[
b = \frac{N \log xy - (\bar{x})x (\bar{y})}{\sum x^2 - (\bar{x})^2}
\]

\[
b = \frac{50 \times 8.06170 - (22.7758 \times 10.81672)}{50 \times 13.0785 - (22.7758)^2}
\]

\[
b = \frac{403.085 - 246.359}{653.925 - 518.737}
\]

\[
b = \frac{156.726}{135.188} = 1.1593 \quad \text{(b) B)
\]

Slope $a = \bar{y} - b \times \bar{x}$

\[
a = 0.2163 - 1.1593 \times 0.4555
\]

\[
a = 0.2163 - 0.5280
\]

\[
\log a = -0.3117 \quad \text{antilog} = 0.4878 \quad \text{... \textbf{A)}
\]

\[
\hat{E} = a \times (\text{body length})^b = ax(\text{SL})^b
\]

\[
\hat{E} = 0.4878 \times (4.536)^{1.1593} \quad \text{Body length from the specimen No.40 (at Random)}
\]
\[ \hat{E} = 0.4878 \times 5.7713 \]
\[ \hat{E} = 2.815 \]
\[ \hat{E} = \text{Calculated value} = 2.815 \]

\[ E = \text{Observed value} = 2.875 \text{ (as given in Table No. 3.1 mentioned above)} \]

\[ \xi \log x^2 = \left( \frac{\xi \log x}{n} \right)^2 = 13.0785 = \left( \frac{22.7758}{50} \right)^2 \]

\[ = 13.0785 - 10.3747 = 2.7038 \quad \ldots \quad \ldots \quad B \]

\[ \xi \log x \log y = \left( \frac{\xi \log x \times \xi \log y}{n} \right) \]
\[ A = 8.0617 = \left( \frac{22.7758 \times 10.8167}{50} \right) = \frac{246.3589}{50} \]

\[ = 8.0617 - 4.9271 \]
\[ A = 3.1346 \quad \ldots \quad \ldots \quad \quad \ldots \quad A \]

\[ \frac{A}{B} = \frac{3.1346}{2.7038} = 1.1593 \]

\[ S_{yy} = \xi \log y^2 = \left( \frac{\xi \log y}{n} \right)^2 \]
\[ = 6.0122 = \left( \frac{117.00}{50} \right)^2 = \frac{117.00}{50} \]

\[ = 6.0122 - 2.3400 \]
\[ = 3.6722 \]

\[ A = S_{xy} = 3.1346 \]
\[ B = S_{xx} = 2.7045 \]
\[ S_{yy} = 3.6722 \]
The study brings out certain definite relation between various parts of the body. As the body grows the rounded shape of the fluke changes to elongated. The reason for this change is the enormous growth of the post-acetabular region which is mainly occupied by the uterus. The relation between the body length and width is significant as proved by the statistical calculations. The statistically calculated value of width is 2.118 of specimen No. 44 and the observed value is 2.020 and the correlation coefficient is 0.957.

The position of ventral sucker is equatorial in juvenile forms which changes to not only distinctly pre-equatorial but located in the anterior region of the second quarter of the body,
showing thereby the vital growth in the post-acetabular region possessing gonads as compared to the anterior region without any vital growing region. There is no significant relationship between the diameters of oral to ventral sucker.

The caeca generally become narrower during the growth allowing other vital organs to occupy more space.

The testes definitely changed their position from acetabular zone to postacetabular zone living some space for the coils of uterus. The parasite is protandric, as the male reproductive organs develop first and the female reproductive organs later. The cirrus is found in specimen No.5. It occupies distinctly postbifurcal region but gradually shifted to post-pharyngial zone. This change is also correlated with the enormous growth of uterus.

The change in the position of ovary is also conspicuous. It is contiguous with the ventral sucker and the posterior margin of the testes is in line with anterior margin of the ovary but it is distinctly away from testes and also from ventral
sucker in the matured form. The area in between ovary and ventral sucker is also occupied by the enormously developed uterus.

The relation between anterior tip of body and posterior margin of ventral sucker in relation to total body length (E/A) is also significant. The calculated value for specimen No. 40 is 1.46 and the observed value is 1.44 with a correlation coefficient, 0.983. This significant change is important and observed during the growth of the trematode.

Initially the region between anterior tip of the body and posterior margin of ventral sucker is equal to the region between posterior margin of the ventral sucker and posterior tip of the body (Proportion 1:1) but during the growth there is a change with the total body and the distance between anterior tip of the body and posterior margin of the ventral sucker is one half to the distance between posterior margin of the ventral sucker and posterior tip of the body. This observation shows the tremendous growth in the post-acetabular region due to enormous growth of uterus and ovarian complex.
This relation is expressed as $(F/A)$, which is variable and also statistically significant. The calculated value of $(F/A)$ is 3.074 in specimen No. 40 and the observed value is 3.088 with a correlation coefficient 0.997.

The distance from anterior tip of ovary to the posterior margin of body in relation to total length remains constant as the region is proportionally grows with the total length of the body. Statistically the calculated value of $(G/A)$ in specimen No. 40 is 2.815 and the observed value is 2.875 with correlation coefficient 0.994.

After studying the entire growth of Paradistomoides orientalis it observed that the sucker ratio is not a significant parameter as it varies during the growth. The position of ventral sucker also depends upon the developmental stage under study. It is shifted from equatorial region into the anterior region of the second quarter of the body. Testes shift from acetabular to post-acetabular region. Ovary remains equatorial throughout the growth but the genital pore is shifted from post-bifucal to post-pharyngial.

The study is significant for considering the intraspecific variation in Paradistomoides orientalis.