Chapter VII.
Observations on
Oreinus plagiosomus (Heckel)
1. General.
   i) Scales.
      a) Type Cycloid.
   b) Arrangement.

      One of the characteristic features here is that unlike Salmo trutta fario and Schizothorax ocellatus, in which scales are present on the posterior region of the skull as well. The abdominal region possesses incipient scales. In some cases, scales have been found completely lacking in the abdominal region.
     c) Scale formula

        \[ L_l = 100-106 \text{ Numbers.} \]
        \[ L_d = 20-25 \text{ Rows.} \]
        \[ L_v = 23-27 \text{ Rows.} \]

   d) Structure.

      The small scales of Oreinus are squarish or oblong in shape with an entire margin. The anterior and lateral margins are sometimes characterized by a notch. The nucleus is very prominent and has been found either centrally located or shifted towards the anterior or posterior field. Usually the two lateral fields are larger than the anterior and posterior fields.

      Although there is a complete demarcation between anterior fields, the shoulders are not very prominent. Of these the anterior shoulders are more prominent than the posterior ones. Radii (both primary and secondary) are present.
One of the remarkable features of Oreinus scales is that the radii are present in all the fields of the scale, though varying in number, being maximum in the posterior field and minimum in the two lateral fields.

The circuli are continuous in all the four fields, though not so very prominent in the posterior field, where the disposition is different from other fields of the scale. The annuli are formed either by the discontinuation of circuli or by crossing over. These are very prominent in the region of shoulders, but their continuation is seen in all the other fields, though faintly. Each annual zone is composed of a wide light summer band and a narrow dark winter band.

The scales of Oreinus closely resemble the scales of Schizotharax in shape and structure.

ii) Otolith.

The Oreinus otolith is rounded to oblong in shape or even heart shaped with irregular margin, one of its surfaces being compressed and flat. The nucleus is well marked and more or less opaque. The portion excluding the nucleus has alternating opaque and transparent bands, the opaque bands constituting the annuli. No radiating bands (otolith radii) are distinguished.

The otolith of the young fish differs from that of the adult both in size and shape, so no definite terminology could be given for its shape.
iii) **Operculum.**

Although the operculum as a whole is composed of the usual preopercular, opercular, sub-opercular and post-opercular bones, the opercular bone is broader than longer. The *annuli* are in the form of thick and dark lines running along the lateral and posterior regions of the opercular bone in the form of an L.

iv) **Vertebra.**

The *annuli* are found in the form of double bands running all round the centre of the vertebra. Each annulus being composed of two bands. The distance between the two bands is usually less than the distance between two *annuli.*

2. 1. **Age group 1.**

a) **Scale studies.**

(Microphotograph 33, fig.18, plate X)

The size of the scale is 0.7 mms. (Table X, graph IX)

The shape is more or less circular with smooth outline. The nucleus is prominent. The shoulders are not well marked.

Only one annulus is seen in the form of discontinuation of circuli, which lies near the margin of the scale. Thus, the fish is aged as one (1 +) year old.

b) **Otolith studies.**

(Microphotograph 34, fig.19a, plate X)

Only one annulus in the form of a thick opaque band lying at some distance from the nucleus and encircling it on
all the sides is seen. The otolith studies, thus confirm the age of the fish as one year, as already seen in scale studies.

c) Opercular studies.

(Microphotograph 35, fig.19b, plate X)

The annulus is clearly discernible as a thick line running along the latera-1 and posterior regions of the opercular bone. This confirms the results of the scale and otolith studies and also the age of the fish as one year.

d) Vertbral studies.

(Microphotograph 35, fig.19c, plate X)

The double banded annulus is clearly seen in the microphotograph 35. This confirms the age of the fish as one year, and also the results of the scale, otolith and vertebral studies.

**Table X.**

To show the size of the scale in fishes of different lengths.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Size (Length) of the scale</th>
<th>Length of the anterior radius</th>
<th>Length of the posterior radius</th>
<th>Length of the fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1+</td>
<td>0.7 mms</td>
<td>0.4 mms</td>
<td>0.3 mms</td>
<td>175.0 mms</td>
</tr>
<tr>
<td>2+</td>
<td>1.05 mms</td>
<td>0.57 mms</td>
<td>0.48 mms</td>
<td>165.0 mms</td>
</tr>
<tr>
<td>3</td>
<td>3.0 mms</td>
<td>0.87 mms</td>
<td>2.13 mms</td>
<td>300.0 mms</td>
</tr>
<tr>
<td>4+</td>
<td>3.0 mms</td>
<td>1.3 mms</td>
<td>2.5 mms</td>
<td>330.0 mms</td>
</tr>
</tbody>
</table>
11) **Age group 2.**

a) **Scale studies.**

(Microphotograph 37, fig. 20, plate XI)

The size of the scale is 1.05 mms (Table X, graph X). The datum scale is more or less circular in shape with smooth outline, though irregular at certain points. The nucleus is prominent and well masked and has shifted its position towards the anterior field. The shoulders are not prominent, but all the four fields are distinguished, the posterior field is largest in area. The radii (both primary and secondary) are present, their number in different fields being given in (Table XI). The number of curculi is given in (Table XII).

Two annuli in the form of discontinuation and overlapping of circuli are easily discernible more clearly in the region of shoulders. The annulus of the first year lies at some distance from the nucleus. The distance between the annuli of second and third years is less than that between the nucleus and the first year annulus. The scale study results thus recorded the age of the fish as two years with +, as the annulus of the second year lies near the margin of the scale.

b) **Otolith studies.**

(Microphotograph 38, fig. 21a, plate XI)

Two, opaque bands are clearly seen running all round the nucleus of the otolith. It is these bands which
are annuli of first and second year growth.

This confirms the age of the fish as two years as recorded from scale studies.

c) Opercular studies.

(Microphotograph 39, fig. 21b, plate XI)

Two annuli in the form of thick, dark lines are clearly seen. The distance between the annuli of first and second years is greater than the distance between the second year annulus and the margin of the opercular bone. This confirms the age of the fish as two years as revealed by the results of scale and otolith studies.

d) Vertebral studies.

(Microphotograph 40, fig. 21c, plate XI)

The annuli, which are two in number are clearly seen in the form of two double bands, thereby, confirming the results of scale, otolith and vertebral studies i.e. the age of the fish as two (2 + ) years.

iii) Age group. 3.

a) Scale studies.

(Microphotograph 41, fig. 22, plate XII)

The average size of the scale is 3.0 mms (Table X, graph IX). The scale is irregular with smooth outline. The nucleus is prominent and has shifted towards the anterior field. The shoulders are prominent. The lateral fields are largest of all the fields of the scale. Both primary and secondary radii are discernible their number being given in
The annuli, which are three in number are in the form of discontinuation of circuli, seen more prominently in the region of shoulders. A continuation of the annuli is seen in the other fields of the scale as well. Thus, the age of the fish is three years (3) as the annulus of third year lies just near the margin of the scale.

b) **Otolith studies.**

(Microphotograph 42, fig. 23a, plate Xll)

The representative otolith shows three annuli in the form of thick, opaque bands running along the entire area of the otolith around the nucleus. This, confirms the age of the fish as three years, also given by the results of scale studies.

c) **Opercular studies.**

(Microphotograph 43, fig. 23b, plate Xll)

Three well marked annuli in the form of thick, dark grooved lines are clearly seen. Thus, the results of scale and otolith studies are confirmed viz; the age being three years.

d) **Vertebral studies.**

(Microphotograph 44, fig. 23c, plate Xll)

Three well marked annuli in the form of double bands are clearly seen. The distance between the annuli of first and second years is greater than the distance between the annuli of second and third years. Thus, by all the four
studies the age of the fish is determined as three years.

iv) **Age group 4.**

a) **Scale studies.**

(Microphotograph 45, fig. 24, plate XLI)

The size of the scale is 3.9mm (Table X, graph IX). The shape is oblong with smooth outline. The nucleus is prominent and has shifted towards the anterior field. The posterior field is the largest of all the fields of the scale.

Four well marked annuli, in the form of discontinuation of circuli in the region of shoulders, are seen clearly. A continuation of these annuli is also seen in other fields of the scale as well. Thus, the age of the fish is four years. As the last annulus lies near the margin of the scale, the age is 4 + years.

b) **Otolith studies.**

(Microphotograph 46, fig. 25, plate XLI)

Four well marked annuli in the form of thick, opaque bands are clearly distinguished. Therefore, the determination of age as four years by scale studies is confirmed.

c) **Opercular studies.**

(Microphotograph 47, fig. 25b, plate XLI)

The annuli, which are four in number, are discernible in the form of thick and dark lines, running all along the lateral and posterior regions of the opercular bone. Thus, the results of the scale and otolith studies, i.e. the age of the fish being four years, is confirmed.
Table XI
To show the average number of radii in the scales of different ages.

<table>
<thead>
<tr>
<th>Age</th>
<th>anterior field</th>
<th>posterior field</th>
<th>left lateral field</th>
<th>right lateral field</th>
</tr>
</thead>
<tbody>
<tr>
<td>1+</td>
<td>-</td>
<td>7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2+</td>
<td>-</td>
<td>8</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>13</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>4+</td>
<td>-</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table XII.
To show the number of circuli in the scales of fishes of different lengths.

<table>
<thead>
<tr>
<th>Age</th>
<th>Total</th>
<th>From nucleus to 1st Annulus</th>
<th>From 1st Annulus to 2nd Annulus</th>
<th>From 2nd Annulus to 3rd Annulus</th>
<th>From 3rd Annulus to 4th Annulus</th>
<th>Length of the fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1+</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>175.0 mms.</td>
</tr>
<tr>
<td>2+</td>
<td>18</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>265.0 mms.</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
<td>8</td>
<td>4</td>
<td>7</td>
<td>7</td>
<td>300.0 mms.</td>
</tr>
<tr>
<td>4+</td>
<td>51</td>
<td>13</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>330.0 mms.</td>
</tr>
</tbody>
</table>
d) **Vertebral studies.**

(Microphotograph 48, fig. 25c, plate Xlll)

Four double banded annuli are clearly seen running continuously around the centre of the vertebra. This also establishes the age of the fish as four years.

Thus, as a result of close corroboration between the results of scale, otolith, opercular and vertebral studies the age of the fish is confirmed as four years.

3. **Double concentric bands on scales.**

In microphotograph 37, the circuli in each annual zone form two (one narrow and the other wide) bands, seen clearly in all the fields of the scales. In the same microphotograph annually of both 1st and 2nd years are distinctly seen.

A perusal of microphotograph 41, shows that the 1st annual zone is composed of a band of narrowly spaced circuli and a band of widely spaced circuli. Similarly, the second and third year annual zones are also seen to be composed of such double bands. Microphotograph 45 and 32 do not show such bands clearly.

4. **False annuals and spawning rings.**

False annuli were often seen on scales, otoliths, opercula and vertebrae by differential focus. In microphotograph 34 just near the margin of the otolith a dark annulus like band is seen near one of the lateral margins of the otolith. It is not however continuous and so promi-
nent in other regions of the otolith and as such it cannot be a true annulus.

Microphotograph 36 shows false annulus in the form of a dark line just like band of the annual zone, after the annulus. False annually are also seen in microphotographs 42 and 46. In microphotograph 42 it lies just near the margin of the otolith.

As regards spawning rings a clear proof for their presence could not be obtained.

5. Contrast in the width of annual zones and the intervening bands.

A perusal of microphotograph 37 shows that the first annual zone is wider than the second annual zone. Moreover, the two bands constituting this zone also differ in their width, the band of widely spaced circuli being wider than the band of narrowly spaced circuli.

Microphotograph 41 shows that the first annual zone is widest of all the annual zones present in the scale. The two bands constituting this zone are also of different widths. The third annual zone is of least width among first second and third annual zones. Microphotograph 45 also shows the first annual zone being widest.

This differentiation in the width of these annual zones shows different rates of feeding in the different years, in the life of the fish.

6. Relation between number of circuli and length with age.
This is clearly illustrated by graph X and table XII, which show that with the increase in age and the length of the fish; the number of circuli also increases. Moreover, the number of circuli is directly proportional to the length with the age of the fish. Graph X shows random statistics plotted against different lengths of the fish.

7. **Length-weight relationship.**

The length weight relationship has been examined for some individuals of each age group. The highest condition factor for *Oreinus plagiostomus* is 4.0 at age 4+ and lowest is 0.7 at age 1+.

The length -weight relationship is clearly illustrated by graph XI.

8. **Scale-annuli, fish-length calculations.**

The measurements as taken from the highest age 4+ in *Oreinus plagiostomus* are as follows:

\[ l = ? \]

\[ L = 330.0 \text{ mms (Table XII)} \]

\[ d = 1.6 \text{ mms, 2.2\text{ mms, 30 mms, and 3.5 mms for}} \]

first, second, third and fourth year annuli respectively.

\[ D = 3.9 \text{ mms (Table)} \]

\[ + = 33.9 \text{ mms.} \]

Therefore calculations are as follows:

i) **Age 1.**

\[ 1 = \frac{330 \times 1.6}{3.9} = 135.3 \text{ mms (for one year only)} \]
Calculated 1 for 1 + = 135.3 + 33.9 = 169.2 mms.
observed 1 for 1 + = 175.0 mms.
Therefore the Error = 169.2 - 175.0 = 5.8 mms.

ii) Age 2.
\[ l = \frac{330 \times 2.2}{3.9} = 186.1 \text{ mms (for two years only)} \]
calculated 1 for 2 + = 186.1 + 33.9 = 220.0 mms.
observed 1 for 2 + = 265.0 mms
Therefore the error in 1 = 256.0 - 220.0 = 45.0 mms.

iii) Age 3.
\[ l = \frac{330 \times 3.0}{3.9} = 253.8 \text{ (for three years only)} \]
calculated 1 for 3 + = 253.8 + 33.9 = 287.7 mms.
observed 1 for 3 + = 300.0 mms.
Therefore the error in 1 = 300.0 - 287.7 = 12.3 mms.

iv) Age 4.
\[ l = \frac{330 \times 3.5}{3.9} = 296.1 \text{ mms (for four years only)} \]
calculated 1 for 4 + = 296.1 + 33.9 = 330.0 mms.
observed 1 for 4 + = 330.0 mms.
Therefore the error in 1 = 330.0 - 330.0 = 0.0 mms.

All these calculations are clearly illustrated by Table XIII, graph XII and histogram III, which clearly illustrate that the error between the length calculated and the length observed is not very high.
Table XII

Giving morphometric data of the fishes examined.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Total Length (mm)</th>
<th>Standard Length (mm)</th>
<th>Weight (gms)</th>
<th>Presence of Discontinuous Circuli</th>
<th>Opaque Narrow Ring</th>
<th>No. of Calculated Thick Annuli</th>
<th>Age of Fish (Year)</th>
<th>Date of Capture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>204.0</td>
<td>175.0</td>
<td>125.0</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1+ 0.7</td>
<td>15-9-'66</td>
</tr>
<tr>
<td>2</td>
<td>310.0</td>
<td>265.0</td>
<td>245.0</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2+ 0.9</td>
<td>3,10-'66</td>
</tr>
<tr>
<td>3</td>
<td>360.0</td>
<td>300.0</td>
<td>356.0</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3 years 1.1</td>
<td>5,10-'66</td>
</tr>
<tr>
<td>4</td>
<td>390.0</td>
<td>330.0</td>
<td>546.0</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>4 + years 4.0</td>
<td>10,10-'66</td>
</tr>
</tbody>
</table>
Table XIII

Showing error between length recorded and length calculated.

<table>
<thead>
<tr>
<th>Age</th>
<th>Length recorded</th>
<th>Length calculated</th>
<th>Length added to the for exact plus (+) age index</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 +</td>
<td>175.0</td>
<td>135.5</td>
<td>169.2</td>
<td>5.8 mm.</td>
</tr>
<tr>
<td>2 +</td>
<td>265.0</td>
<td>186.1</td>
<td>220.0</td>
<td>45.0 mm.</td>
</tr>
<tr>
<td>3</td>
<td>300.0</td>
<td>253.8</td>
<td>287.7</td>
<td>12.3 mm.</td>
</tr>
<tr>
<td>4</td>
<td>330.0</td>
<td>296.1</td>
<td>330.0</td>
<td>0.0 mm.</td>
</tr>
</tbody>
</table>