Chapter-VIII.
Observations on
Crossochilus latius diplochilus (Heckel)
1. General

i) Scales.

a) Type. The scales are of Cycloid type.

b) Arrangement.

The scales of *crossochilus* are overlapping with free posterior margins. The region of the head is completely devoid of scales.

c) Scale formula.

\[ L_1 = 35-38 \text{ Numbers.} \]
\[ L_d = 3-3\frac{1}{2} \text{ Rows.} \]
\[ L_v = 2-2\frac{1}{2} \text{ Rows.} \]

d) Structure.

The scales are circular to squarish in shape with entire margin. The nucleus does not lie exactly in the centre, but has shifted towards the anterior field (which is a characteristic feature in all the scales of *Crossochilus*). The nucleus is marked by the point of convergence of radii in the posterior field. There is a clear demarcation between the anterior, the posterior and the two lateral fields of the scale. The shoulders are well marked, and both anterior and posterior shoulders well distinguishable demarcating the area of the fields. Of these, the posterior field is largest in area. The radii are altogether absent in the anterior and the lateral fields, whereas the posterior field has large numbers of radii (both primary and secondary). The circuli are clearly seen in the anterior half of the scale, whereas their faint continuity is seen in the
posterior field as well.

The annuli are formed as a result of discontinuation or overlapping of circuli, which are more prominent in the region of shoulders, though their continuity is seen in almost all the fields of the scale. Annual-zones are clearly distinguished.

ii) Otolith.

The crossed otolith is altogether different from the otolith of *Salmo trutta fario*, *Schizothorax esocinus* and *Oreinus plagiostomus*. The shape is with uneven margin; the nucleus occupies a lesser space and does not lie exactly at the centre. No "otolith radii are seen. The size of the otolith increases with the age and the length of the fish.

The annuli are seen in the form of lines, which are more or less translucent, whereas these are seen in the form of opaque bands in the otolith of *Salmo*, *Schizothorax* and *Oreinus*.

iii) Operculum.

The operculum is comparatively smaller, though composed of usual, preopercular, opercular, subopercular and postopercular bones. The operculum is thin and more or less translucent. The annuli are seen in the form of thin lines, running all along the lateral and posterior margins of the opercular bone only.

iv) Vertebra.

The annuli on vertebra are seen in the form of do-
uble translucent (light) bands (thick lines) running all round the centre of the vertebra. Two such bands constitute one annulus.

2. **Age and annuli.**

   1) **Age group 1.**

   a) **Scale studies.**

      (Microphotograph 49, fig. 26, plate XIV).

      The size of the scale is 1.4 mm. (Table XV, graph XII). The shape is with anterior margin drawn out. The nucleus, which has shifted to the anterior field of the scale is marked by the presence of faint circuli. The anterior shoulders are prominent and well marked, clearly separating the anterior field from the two lateral fields; the posterior field being the largest. The number of circuli is given in Table XVII for different age groups.

      Both primary and secondary radii are seen (which are confined to the posterior field only) their number being given in (Table XV). Only one annulus in the form of discontinuation of circuli is distinguished prominently in the region of shoulders. Its continuity is not seen in the posterior field. The annulus lies near the margin of the scale so its age can be fixed as one year old, with (1+).

   b) **Otolith studies.**

      (Microphotograph 50, fig. 27a, plate XIV).

      Only one annulus in the form of a translucent band is clearly seen, there by confirming the age of the fish as one year, as revealed by scale studies.
opercular bone. It lies near the margin of the bone, thus, confirming scale and otolith studies, i.e., the age of the fish 1+ years old.

d) **Vertebral studies.**

(Microphotograph 52, fig. 27c, plate XIV)

Only one double banded translucent annulus is seen running all along the vertebral section near its margin. Thus all the four studies viz: scale, otolith, opercular and vertebral studies, confirm the age of the fish as 1+ years.

ii) **Age group 2.**

a) **Scale studies.**

(Microphotograph 53, fig. 28, plate XV).

The size of the scale is 1.7 mm (Table XV, graph XIII). The shape is more or less squarish with posterior margin somewhat drawn out. The nucleus has shifted to the anterior field. The prominence of shoulders is confined to the anterior ones only, posterior shoulders are not distinguishable. The posterior field is the largest of all other fields of the scale. The radii (both primary and secondary) are present in the posterior field only (Table XV).

Two annuli are distinguishable by the discontinuation of circuli in the region of shoulders only. Their continuity however can be traced in the lateral fields as well. The age of the fish is thus established as two years.
Table XV

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

<table>
<thead>
<tr>
<th>Age</th>
<th>Size (length)</th>
<th>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>1.4 mms.</td>
<td>0.4 mms.</td>
<td>1.0 mms.</td>
<td>44.0 mms.</td>
<td></td>
</tr>
<tr>
<td>2+</td>
<td>1.7 mms.</td>
<td>0.4 mms.</td>
<td>1.3 mms.</td>
<td>65.0 mms.</td>
<td></td>
</tr>
<tr>
<td>3+</td>
<td>2.7 mms.</td>
<td>0.5 mms.</td>
<td>2.2 mms.</td>
<td>72.0 mms.</td>
<td></td>
</tr>
</tbody>
</table>

Table XVI

To show the number of radii in the scales of fishes of different lengths.

<table>
<thead>
<tr>
<th>Age</th>
<th>Average number of radii</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In the anterior field</td>
</tr>
<tr>
<td>1+</td>
<td>-</td>
</tr>
<tr>
<td>2+</td>
<td>-</td>
</tr>
<tr>
<td>3+</td>
<td>-</td>
</tr>
</tbody>
</table>

C) Opercular studies.

(Microphotograph 51, fig. 27b, plate XIV)

The annulus is seen in the form of a thin line running all along the lateral and posterior regions of the
b) **Otolith studies.**

(Microphotograph 54, fig. 29a, plate XV)

Two annuli in the form of thin translucent bands are seen. The annulus of the second year lies near the margin of the otolith, thus, confirming the age of the fish as two years old (2 + ).

c) **Opercular studies.**

(Microphotograph 55, fig. 29b, plate XV)

Two annuli in the form of thin lines lying at some distance from each other are seen. The first year annulus is more prominent than the second year annulus, which lies near the margin of the opercular bone, thus, confirming scale and otolith studies i.e. the age of the fish as two years.

d) **Vertebral studies.**

(Microphotograph 56, fig. 29c, plate XV)

Two annuli in the form of double translucent bands are seen, each double band constituting one annulus, are distinguishable.

Thus, by all the four studies viz; scale, otolith, operculum and vertebral studies, the age of the fish is confirmed as two years with (2 + ).

iii) **Age group 3.**

a) **Scale studies.**

(Microphotograph 57, fig. 30, plate XV1)

The size of the scale is 2.7 mms. (Table XV, graph X111). The shape is more or less oblong with smooth
margin. The nucleus has shifted to the anterior field. The posterior field is the largest of all fields of the scale. The *radii* (both primary and secondary are seen in the posterior field only (Table XV).

The annuli are seen by the formation of double bands and discontinuation of circuli, more clearly in the left lateral field. The annulus of the third year lies near the margin of the scale, thus the age of the fish is expressed as 3 + years.

b) Otolith studies.

(Microphotograph 58, fig.31a, plate XVI)

Three annuli in the form of translucent bands are soon clearly. The first year annulus lies near the nucleus of the otolith. The distance between second and third year annuli is less than that of the distance between first and second year annuli.

Thus the age of the fish as three years (revealed by scale studies) is confirmed.

c) Opercular studies.

(Microphotograph 59, fig.31b, plate XVI)

Three annuli in the form of thin lines are seen lying almost at equal distance from each other. The age of the fish as three years is thus confirmed.

d) Vertebral studies.

(Microphotograph 60, fig.31c, plate XVI)

Three well marked annuli in the form of thin, translucent, double bands are clearly seen.
Thus, as a result of close corroboration in scale, otolith, opercular and vertebral studies, the age of the fish is confirmed as three years (3+).

3. Double concentric bands on scales.

The double bands formed as a result of approximation of circuli are not seen commonly in the scales of *crossoc hilarus*. This character is seen absent in the scales of younger age groups, though present in the scales of older age groups.

In microphotographs 49 and 53, this character is not seen at all in the scales. Microphotograph 57 shows such double bands clearly. Here each annulus zone is composed of a dark band of narrowly spaced circuli and a light band of widely spaced circuli. This is again followed by a dark and a light band constituting annual zone of the second year. Similarly, third year annual zone too has a dark and a light band.

4. False annuli and spawning rings.

False annuli were often seen in scales, otoliths and vertebrae as well (more commonly in otoliths). Microphotograph 50, a translucent annulus like band is seen near the margin of the otolith, but its false nature was confirmed by differential focusing and by its discontinuity in other regions of the otolith. Microphotograph 58 shows false annuli in between the annuli of first and second years.

Microphotographs 52, 56 and 60 of vertebral sections also show such false annuli. In microphotograph 60, false
annuli are distinguished between second and third year annuli, in the form of discontinuous annuli like bands. All false annuli are either shallow(not pervading the entire thickness of the scale, otolith, vertebra and operculum) and can be identified by differential focussing. Also they are never continuous all round the nucleus.

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

As already stated in other fishes like *Salmo, Schizothorax* and *Oreinus*, the annual zones are composed of wide and narrow bands. The width of these bands and the zones constituted by them differs. Similarly, in *Crossochilus* as well the width of those annual zones and the bands constituting them differs.

In microphotograph 53 the second annual zone is wider than the first annual zone. In microphotograph 57, the second annual zone is widest and the third annual zone is narrowest. In all the three annual zones, the band of narrowly spaced circuli (winter) is narrower. The band of broadly spaced circuli (summer) is widest in the second annual zone.

6. **Relation between number of circuli and length with age.**

It has been found that a direct relationship occurs between the circuli and length of the fish with the age. This is clearly illustrated (Table XVI) which shows number of circuli in the scales of fishes of different ages. The
relationship is also demonstrated by graph which is linear and shows random statistics plotted against fishes of different lengths.

Table XVII
To show the number of circuli on the scales of fishes of different lengths.

<table>
<thead>
<tr>
<th>Age</th>
<th>Average number of circuli</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total From nucleus to 1st annulus</td>
</tr>
<tr>
<td>1+</td>
<td>12  7  4</td>
</tr>
<tr>
<td>2+</td>
<td>18 11  7</td>
</tr>
<tr>
<td>3+</td>
<td>27  8  6  5  5</td>
</tr>
</tbody>
</table>

7. Length-weight relationship.

As no other species, in crossohiilus latius diplochilus as well relation has been found to exist between the length and the weight of the fish, which is illustrated by graph XV.

Applying the simple formula $K = \frac{Wt}{L}$, the value of $K$ has been found. The lowest $K$ value is 0.02 and the hight 0.13 in ages (1+) and (3+) respectively.

8. Scale-annuli, fish-length calculations.
The measurements in *crossochilus latius diplochilus* age group 3 (highest age) are as follows:

1 = ?

L = 72.0 mms (Table XVIII)

d = 1.4 mms, 2.0 mms and 2.5 mms for first, second and third annuli respectively.

D = 2.7 (Table XV)

value of + = 5.4 mms.

Thus, the calculations for exact length for different years of age of *Crossochilu latius diplochilus* are as follows:

1) **Age 1.**

\[
1 = \frac{72 \times 1.4}{2.7} = 37.3 \text{ mms (for one year only)}
\]

calculated 1 for \(1 + = 37.3 + 5.4 = 42.7\) mms.

observed 1 for \(1 + = 44.0\) mms

Therefore the error in \(1 = 44.0 - 42.7 = 1.3\) mms.

ii) **Age 2.**

\[
1 = \frac{72 \times 2.0}{2.7} = 53.3 \text{ mms (for two years only)}
\]

calculated for \(2 + = 53.3 + 5.4 = 58.7\) mms.

observed 1 for \(2 + = 65.0\) mms

Therefore the error in \(1 = 65.0 - 58.7 = 6.3\) mms.

iii) **Age 3.**

\[
1 = \frac{72 \times 2.5}{2.7} = 66.6 \text{ mms (for three years only)}
\]

calculated 1 for \(3 + = 66.6 + 5.4 = 72.0\) mms.

observed 1 for \(3 + = 72.0\) mms.

Therefore the error in \(1 = 72.0 - 72.0 = 0.0\) mms.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Length of the fish</th>
<th>Character of annuli formation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total mm</td>
<td>Standard mm</td>
</tr>
<tr>
<td>1.</td>
<td>50.0</td>
<td>44.0</td>
</tr>
<tr>
<td>2.</td>
<td>73.0</td>
<td>65.0</td>
</tr>
<tr>
<td>3.</td>
<td>77.0</td>
<td>72.0</td>
</tr>
</tbody>
</table>
Table XIX.
To show the error between lengths recorded and lengths calculated.

<table>
<thead>
<tr>
<th>Age</th>
<th>observed standard length</th>
<th>Calculated 1 for exact age.</th>
<th>Calculated 1 added to the + index.</th>
<th>Error.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 + 44.0 mms.</td>
<td>37.3 mms</td>
<td>42.7 mms</td>
<td>1.3 mms</td>
<td></td>
</tr>
<tr>
<td>2 + 65.0 mms.</td>
<td>53.3 mms</td>
<td>58.7 mms</td>
<td>6.3 mms</td>
<td></td>
</tr>
<tr>
<td>3 + 72.0 mms.</td>
<td>66.6 mms</td>
<td>72.0 mms</td>
<td>0.0 mms</td>
<td></td>
</tr>
</tbody>
</table>