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by

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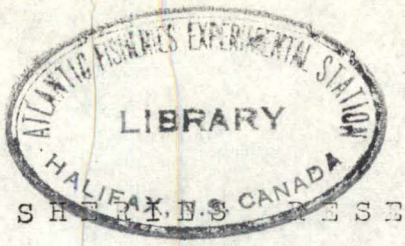

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REPORT ON THE DEVELOPMENT AND SCALES FROM THE INTEGUMENT IN CUTTHROAT AND STEELHEAD TROUT.

Author

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Report on the Development of Scales from the Integument in Cutthroat and Steelhead Trout

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Since the discovery of lenses; scale structure, the interpretation of scale structure, and the development of scales, have in certain fields, been subjects of scientific investigation. To present a history of such studies here is impossible, but it is necessary to mention the names of some of the workers in the field--particularly those responsible for most of our knowledge of the histogenesis of scale structure. Some of the first investigators were: Mandl, Williamson (1851), Baudelot (1873), Hofer (1889), Klaatsch (1890-94), and Ussow (1900). J. Stuart Thomson (1904), has presented an excellent review of the work of these men. Since that time Tims (1906), Hase (1907), Taylor (1916), Padget (1920), and Creaser (1926) have done further research on the structure and growth of fish scales in relation to the interpretation of their life-history. The investigations of Klaatsch and Padget were done on trout material and seem to be the most detailed, especially with reference to the earliest stages of scale development.

I am indebted to Dr. W.A. Clemens and to Dr. C. McC. Mottley for the Cutthroat and Steelhead trout material used in my work. These samples of liver-fed fry from the Cowichan Fish Hatchery, were taken at intervals of one week during the months of April, May, June, July and August during 1932; preserved in 4% formalin and sent to the Pacific Biological Station.

This paper reviews the appearance or distribution of the scales and the beginning of development of scale papillae and scales in the fry of Steelhead and Cutthroat trout.

To determine the distribution of the scale papillae over the body, the skin was removed, stained in Delafield's haematoxylin for 5-6 minutes and observed low magnification.

The first appearance of scale papillae seemed, with a few exceptions, to depend upon the length rather than the age of the fry. Most of the exceptions occurred in the earlier stages of development, when unusually long fry (Steelhead 3 cm.) showed no sign of scale papillae while those of the same length but older by a week, had 2-3 rows of papillae. No examples were encountered in which small fry showed equal development of papillae with those of the same age but of greater length.

The first papillae make their appearance in Steelhead fry about 2.6 centimetres in length, and in cutthroat of 2.8 to 3 centimetres in length. The papillae appear as a single row of circular plates along the lateral line extending almost from the pectoral fin to the adipose fin (Steelhead 2.6 cm., Fig. 1 and 11). One larger specimen (Steelhead 3 cm., Fig. III and IV), there are two or three rows of papillae along the lateral line from just behind the operculum to the caudal region, and 5-6 rows in the region of the dorsal fin. Development proceeds more rapidly in the ventral direction (Fig. VIII and IX). The papillae are arranged two to each myotome in rows which cut directly across the mycommata (Fig. IX).

Due to the fact that the papillae change in position to allow the scales to overlap, they become more difficult to distinguish as development proceeds; a characteristic more noticeable in the heavy-skinned Cutthroat.

The development of the scale papillae was determined from longitudinal and transverse sections of Steelhead fry, stained with haematoxylin.

Fry 2.5 centimetres long (Fig. XI and XII) show an epidermis four to five

thick. The epidermis envelops the entire fry including the dorsal fin, and is deeply invaginated in the region of the lateral line. There is, at this stage, no indication of scale papillae, but it is interesting to note that the developing caudal fin rays show a very similar appearance to that of the scales which appear later. The fin rays appear in cross section (Fig. II) as a strip of refractive substance, just beneath the epidermis and surrounded by cells, which stain more deeply than the surrounding tissue; as do the scleroblasts which later envelop the scales.

When the scale papillae begin to develop at the 2.6 cm. stage, in the Steelhead, the skin shows a thin epidermis and relatively fine loose dermis. An aggregate of deeply staining cells appears in the dermis. This cell mass spreads itself out horizontally and the cells become arranged in two circular plates--Steelhead, 2.8-3 cm. Between these two plates a layer of highly refractive substance appears. This is the first appearance of the scale substance.

When first observable this strip does not extend throughout the entire length of the papillae; it is thickest at the centre and thins out towards its border. On further development the scale substance spreads itself throughout the entire length and width of the papillae. Meanwhile the papillae grow out in a horizontal direction. In this way a circular plate, lying parallel to the upper surface of the fish, originates immediately beneath the epidermis.

At first the scales lie entirely in the dermis and parallel with the surface of the body (Fig. XIII and XIV). At this stage the scleroblasts on the upper surface of the scale are longer and closer together than on the lower surface. But before the scales are large enough to crowd each other, they pass from the original horizontal position, into a position oblique to the upper surface--Steelhead, 3.y cm., (Fig. XVIII and XIX).

Contemporaneously with this change of position all the layers of the skin have grown in thickness. The epidermis consists of 8-10 layers of cells, and the cells of the dermis have undergone proliferation so that the scale papillae lie in a layer of louse tissue. The posterior end (that turned toward the tail of the animal) raises itself gradually, while the anterior end becomes sunk in the deeper layers of the dermis. The change in position of the scale appears to come about through a proliferation of epidermal cells beneath the posterior end of the scale and development of connective tissue between the epidermis and the anterior end of the scale.

Number of Rows of Papillae in Regions 1, 2, 3. 4. A above, B below the lateral line.

Steelhead

Region	1		2		3		4	
Length & Date Taken	A	B	A	B	A	B	A	B
2.5 cm.	-	-	-	-	-	-	-	-
2.8 cm. June 6, 1931	1	-	1	-	1	-	1	-
" 13, "	1	-	1	-	1	-	1	-
" 20, "	1	-	1	-	1	-	1	-
" 27, "	1	-	1	-	1	-	1	-
3.0 cm. June 6, 1931	-	-	1	-	1	1	-	-
" 20, "	1	1	2	3	2-3	4-5	2	1-2
" 27, "	1	1	2	3	3	3-4	1-2	2
July 4, "	1	1	2	3	2-3	3-5	1-2	2
3.2 cm. July 27, 1931	2-3	2-3	5-6	5-6	5-7	4-6	4	4-5
3.4 cm. July 4, "	3-4	3-4	6-7	5-6	6-7	8-11	5-6	5-6
3.7 cm. July 4, "	5-6	4-5	10	15	10	14	10-12	8-9
" 4, "	5-6	4-5	7	7-8	8	12	5-6	5-6

Steelhead hatched April 25, 1931.
a Exceptions.

Number of Rows of Papillae in Regions 1, 2, 3, 4. A above, B below the lateral line.

Cutthroat

Region	1		2		3		4	
Length & Date taken.	A	B	A	B	A	B	A	B
2.5 cm.	-	-	-	-	-	-	-	-
2.8 cm. June 6, 1931	-	-	-	-	-	-	-	-
" 13, "	-	-	-	-	-	-	-	-
" 20, "	-	-	-	-	-	-	-	-
" 27, "	-	-	-	-	-	-	-	-
July 4, "	-	-	-	-	-	-	-	-
" 11, "	-	-	-	-	-	-	-	-
3.0 cm. June 20, 1931	-	-	-	-	-	-	-	-
" 27, "	-	-	1	-	1	-	-	-
July 4, "	-	-	1	-	1	-	-	-
" 11, "	1	-	1	-	1	-	-	-
3.2 cm. June 20, 1931	1	-	1	-	1	-	-	-
" 27, "	1	-	1	-	1	-	-	-
July 4, "	1	-	1-2	1	1	-	-	-
" 11, "	1	-	1	-	1	-	-	-
3.4 cm. June 27, 1931	1	-	1	-	1	-	-	-
July 4, "	2-3	2	2-3	5-7	2-3	3-4	2-3	2-3
" 11, "	2-3	2-3	2-3	3-5	4-5	5-6	2-3	2-3
3.6 cm. July 11, 1931	2-3		2-3	2-3	1-3	1-3	2-3	3-5

Exceptions
Length from nose to caudal fin.
Cutthroat hatched May 2, 1931.