

*THE REGENERATED SCALES OF *FUNDULUS HETEROCLITUS* LINNE'
WITH A PRELIMINARY NOTE ON THEIR FORMATION.

BY WILL SCOTT.

The work of Hoffbauer, '99, on the scales of the carp established the fact that, up to the third year, the age of this fish could be determined by the sculpture of the scales. Johnston '05-'08-'10 has shown that not only can the age of the salmon be determined by the sculpture of the scale, but the emigration of the young salmon (parr) from river to sea and each return to spawn of the sexually mature leave an indelible mark upon the scale. These marks have been rendered perfectly intelligible by the work of Johnston and that of his associates on the Scottish fisheries board.

Hutton, '10, in working on the scales of the Wye River salmon observed, occasionally, scales quite different from the normal ones and suggested that these scales might be the result of regeneration. If this suggestion be true then it would be possible, by scale examination, to determine the wounds received by and, in a general way, the hazards encountered by any individual. To add this additional index to the life history of a fish these experiments concerning the regenerated scale were performed.

The Killifish, *Fundulus heteroclitus* Linne, was selected for the experiment because of its abundance and its well known hardiness. Many fish of this species, at this season of the year (Aug.), were infected with a sporozoan parasite. This infection proved fatal in most cases, consequently great care had to be exercised in selecting material. The operation consisted in the removal of about six rows of scales from the left side between the posterior end of the dorsal fin and the anal fin. The fish were covered with clean cheese cloth which was kept wet with sea water; only a small area was exposed at any one time. The scales were lifted from their pockets with a scalpel, care being taken not to injure the inner wall of the pocket. If the circulatory system was injured in any noticeable degree sporozoan infection occurred.

¹ The work was done while acting as scientific assistant in the laboratory of the U. S. Fish Com. at Woods Hole, Mass., and is published with the permission of the Hon. Geo. M. Bowers, Commissioner of Fisheries.

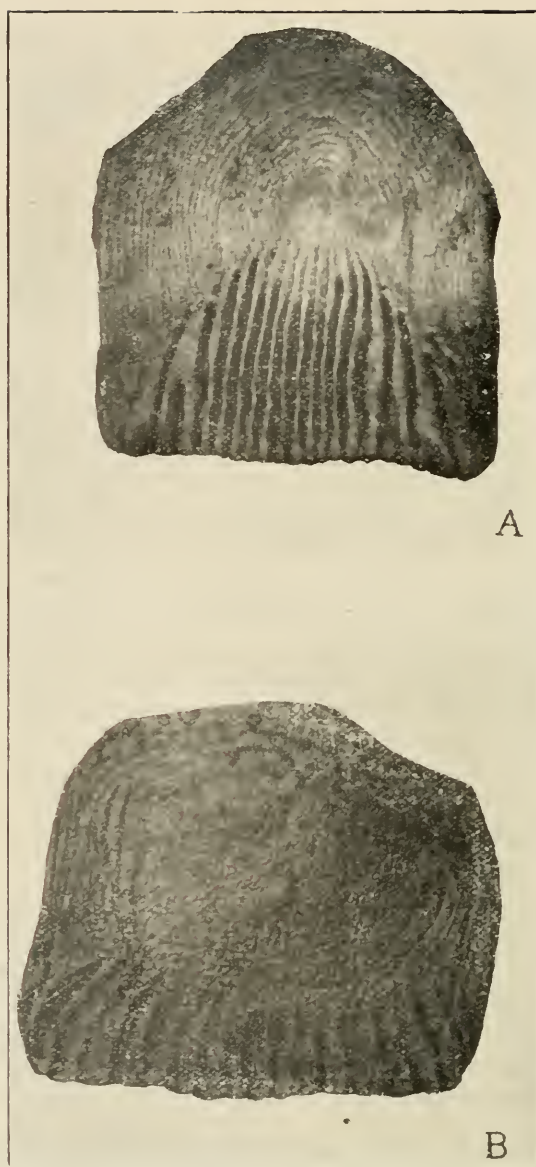


Plate 1. Comparing (A) normal and (B) regenerated scale

Series A. On August 3, twenty-one fish varying from 91 m.m. to 114 m.m. were operated on and placed in tank A, in running sea water. The scales shown in plate II were all taken from this series. No fish from this series were lost during the experiment.

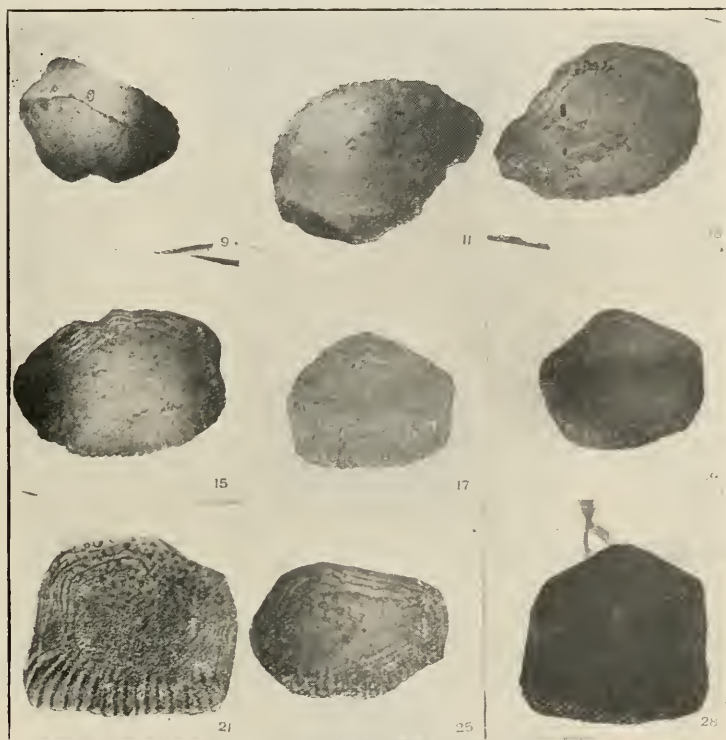


Plate II. Showing the process of differentiation in regenerating scales. All operations were performed on Aug. 3. Numbers in lower right hand corner indicate the day of the month on which the fish were killed.

Series B. August 3, twelve fish varying from 72 m.m. to 86 m.m. were operated on and placed in tank B. In this series two individuals were lost, one by sporozoan infection and one by being accidentally caught in the outlet of the tank.

Series C. On August 4, five fish were totally denuded of scales except a few accidentally left around the base of the fins. It was very



Plate III. Indicating that age and degree of injury do not influence differentiation in the regeneration of fish scales. (A) from the largest fish, 114 m.m. (B) from the smallest, 72 m.m. (C) from one of the fish in series C which were entirely denuded of scales.

difficult to remove so many scales without injuring the skin. Two fish suffered slight punctures in the operation and died of sporozoan infection two days later. The other three lived until the close of the experiment.

The scales regenerated to almost their normal size in twenty-five days. The rate will probably be found to vary in different species of fish. I was unable to dissect out the scales before the sixth day after the operation. On this date the scales were very thin and fragile; the cycloid sculpture was developed to the extent of three irregular yet fairly distinct lines which surrounded a relatively large unsculptured area.

The radiate sculpture which the normal scales of this fish have on their inner ends could not be detected on the sixth day. Faint traces of it appeared on the eighth and tenth days and by the twelfth it was very evident. From the twelfth day the sculpture developed as it does on the periphery of a normal scale except that the lines of the cycloid sculpture were slightly farther apart.

Scales from the largest of series A, 114 m.m., the smallest in series B, 72 m.m., and one of the fish that had all its scales removed are figured in plate III. These show no marked difference in the differentiation, indicating that age and degree of injury do not influence the process to any great extent, if at all.

It may be noted that no fatalities occurred which were referable to the osmotic pressure of the sea water. This fact is in direct opposition to the findings of Garrey, '05, but corroborates in part those of Sumner, '06, who repeated and extended the work of Garrey. The results may be harmonized by assuming that sporozoan infection occurred in Garrey's experiments of which he took no account. The histological study of this process has not yet been completed.

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