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REGENERATION OF THE CAUDAL FIN IN THE INDIAN OIL SARDINE, *SARDINELLA LONGICEPS* VALENCIENNES*

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INSTANCES of regeneration recorded among Indian fish species are limited to the observations made by Deraniyagala (1932), Hora (1936), Menon (1951) and Jones and Menon (1952). Hence the present communication on the regeneration of fins in the Indian oil sardine, *Sardinella longiceps*, may be of interest. The few specimens having their caudal fins in various stages of regeneration were collected while studying the size-composition of the commercial catches at Cannanore (south-west coast of India) during August to November, 1964. They were caught by the boat-seine units, *arakolli-vala*.

Normally the caudal fin in *S. longiceps* (Fig. 1) is forked and heterocercal, the lower caudal lobe being a little longer than the upper. Laterally the fin on each side is provided with three triangular fleshy lobes, two arranged one above the other on upper caudal lobe and only one on the lower lobe. Certain enlarged scales called alar scales are present at the fin base on each side. The fin is supported by 26 to 28 dermal rays which have a segmented structure. The rays along the dorsal and ventral extremities of the fin base are unbranched while those of the rest are branched. The fin-rays are arranged in a diverging manner from the base and follow a straight course.

PATTERN OF REGENERATION

The pattern of regeneration of the caudal fin in *S. longiceps*, obviously after truncation or some injury, appears to depend upon the region and the intensity of the injury. Two different types have been observed in the present collections.

1. *Involving the lower caudal lobe :* This is the common pattern met with and affects only the lower caudal lobe. Different types have been observed depending upon the intensity of truncation and the stage of regeneration. Thus in one case (Fig. 2) the lower caudal lobe is reduced in its distal half. Here regeneration is in its initial stage and perhaps the injury is of a recent origin. In another specimen (Fig. 3) the whole of the lower caudal lobe appears to have regenerated from a severe injury. Still, in a third sardine (Fig. 4) the injury appears to have been only slight, involving one or more of the caudal rays; here regeneration is completed.

2. *Involving the upper caudal lobe :* This is the less frequent condition in which the upper caudal lobe is involved. Only two specimens have been obtained

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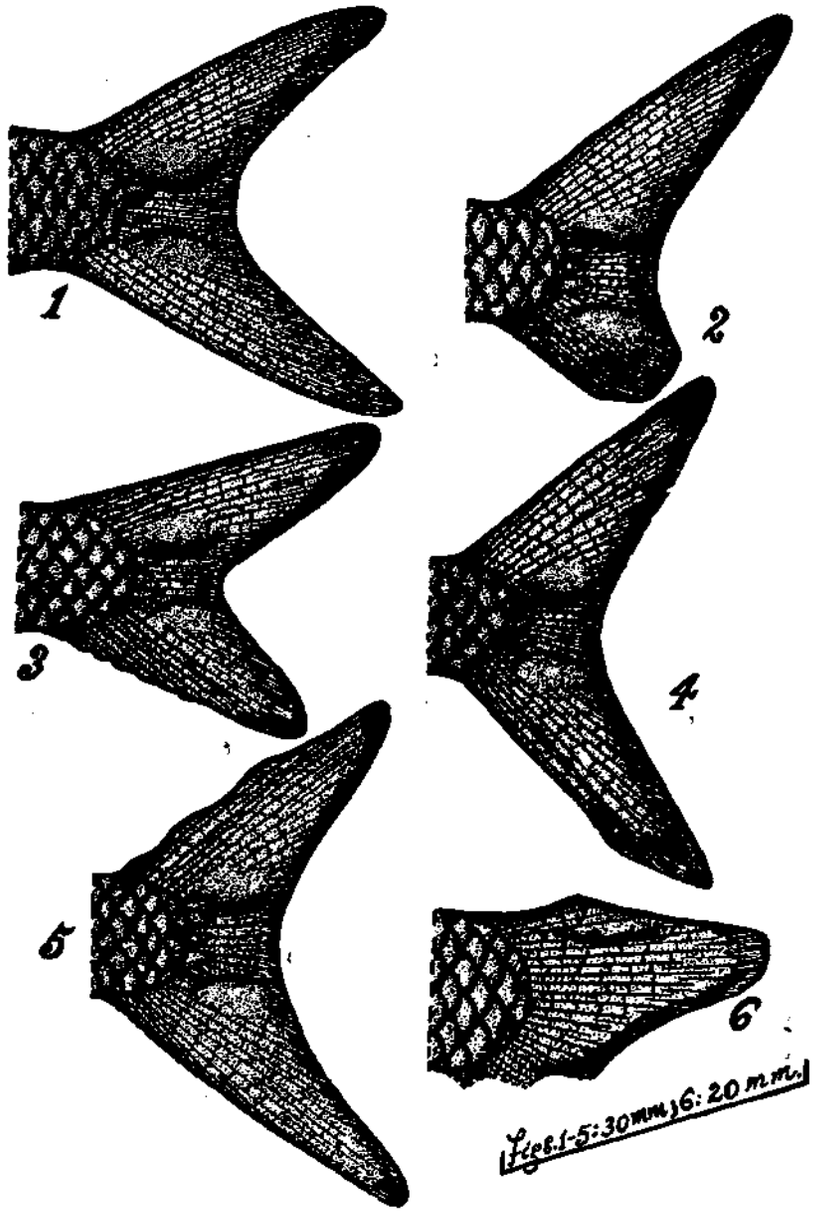
representing two extreme types. In one case (Fig. 5) only a few of the upper caudal rays are affected, while in the second specimen (Fig. 6) the injury appears severe involving three-fourth of the upper caudal lobe.



FIGS. 1-6. Left-side views of the caudal fins of *S. longiceps*. 1. normal fin of a specimen of 170 mm. total length; 2-6 regenerating/regenerated fins of specimens 185, 184, 183, 186 and 170 mm. total length respectively.

Stages in Regeneration

Five distinct stages in the regeneration of the caudal fin in *S. longiceps* have been collected.

Stage I (Fig. 7) : Regenerating caudal fin of a specimen measuring 175 mm. in total length.* This is a very early stage in which the wound or injury has been closed but the epidermis has not covered it fully and the future dermal rays are not indicated. There are trails of pigments roughly marking the positions of the rays to be regenerated.

Stage II (Fig. 8) : Specimen of 182 mm. total length. In this stage the epidermis along with pigmentation has spread to the major part of the regenerating area. The condensation of the dermis to give rise to the rays has commenced. These zones of dermal condensation mark the areas of regeneration.

Stage III (Fig. 9) : Specimen of 183 mm. total length. Regeneration is in progress at this stage and about 3 to 4 segments of the future rays are indicated.

Stage IV (Fig. 10) : Specimen of 175 mm. total length. The process of regeneration is almost completed in this stage with well differentiated bony rays ; but the division of the tip of the rays into fine filaments is not indicated.

Stage V (Fig. 11). Specimen of 179 mm. total length. In this stage the division of the tip of the regenerated rays into fine filaments is completed.

Differences Between Regenerated and Normal Caudal Fins

Apart from the differences in the size and shape of the regenerated portion of the caudal fin, it can be distinguished from a normal fin by the difference in the disposition between the original and the regenerated components of the fin-rays. The latter have always a different course from that of the original components (Fig. 12). Besides, the number of branches of a regenerated ray is generally more than that of a normal ray.

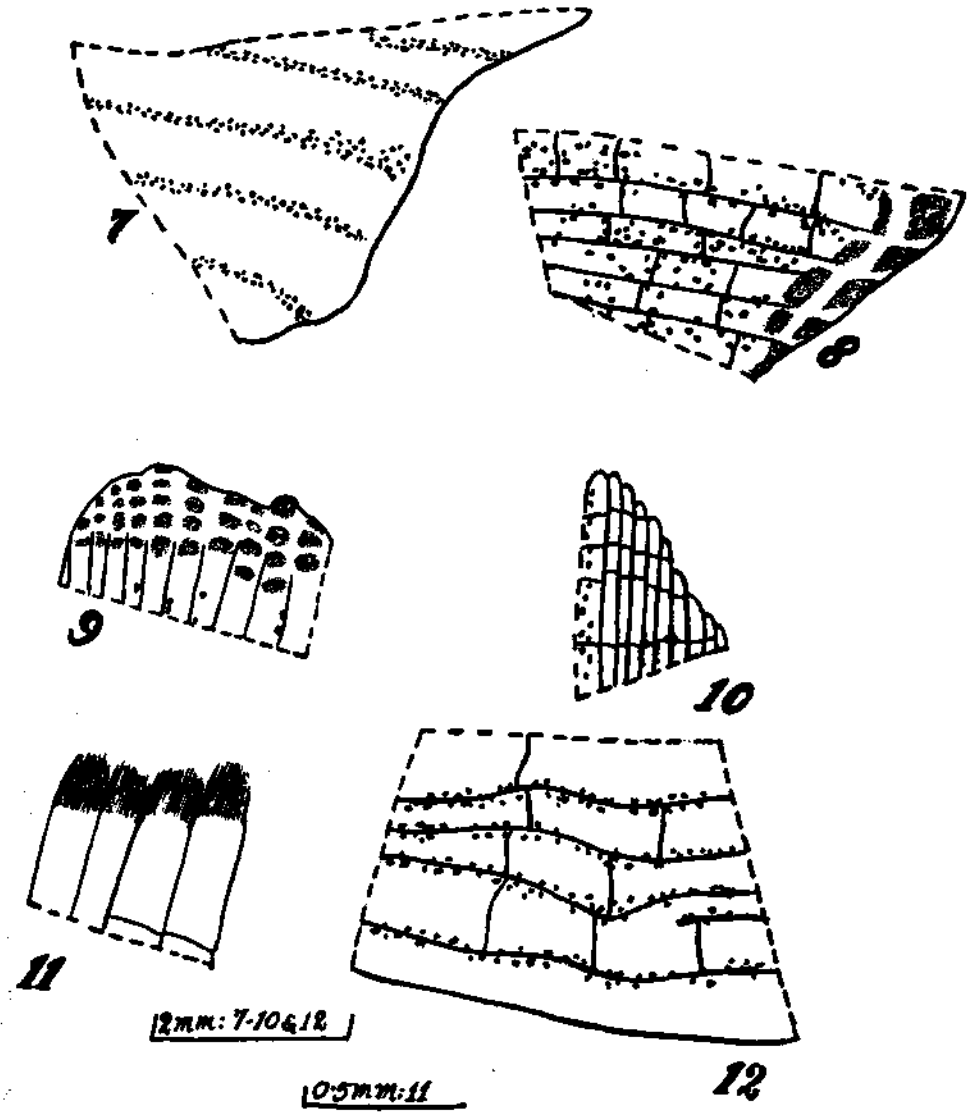
The zone of truncation or injury can be determined as the level from which the regenerated components take the different course. This region presents a twisted appearance (Figs. 4, 5 and 6) and is diagnostic of regenerated fins.

Regeneration in Relation to Size and Maturity

Of about 8000 specimens of *S. longiceps* ranging in total length from 50 mm. to 202 mm. studied for four years (1961 to 1964), this is the first time that specimens with regenerated caudal fins have been observed. Except for a single immature specimen of 126 mm. total length collected on 11-11-1964, all the specimens ranged between 167 mm. to 189 mm. On 9-9-1964, 48% of the specimens from a sample had regenerated caudal fins while on 19-9-1964 only 20%. All these sardines

*Total length is measured from the tip of the lower jaw to the end of the longest upper caudal ray.

ranged in sexual maturity from partly spent (VI b.) to recovered condition. Another fact noted is that 96% of the specimens had only the lower caudal lobe affected.



FIGS. 7-12. *Camera-lucida* sketches of the regenerating and regenerated regions of the caudal fins of *S. longiceps*. 7-11 stages I, II, III, IV and V in regeneration from specimens of 175, 182, 183, 175 and 179 mm. total length respectively; 12 showing the twisted condition of the rays at the zone of truncation, from a specimen 180 mm. total length.

Regeneration of mostly the lower caudal lobe, obviously after some injury or truncation, observed mostly in the spawning stock and at the close of the spawning season is significant, as this may point out to some interesting behaviour of the fish during spawning.

General Remarks

Information relating to aspects of regeneration in economically valuable fishes is essential to determine the most suited part of the body which regenerates the wounds caused in tagging studies. Experimental work on this aspect has not been attempted in our country. This is due to the lack of facilities for keeping the fish alive in the aquarium under natural conditions. Nevertheless this phenomenon appears to have well developed in Indian forms. Some of the abnormal specimens of the Indian mackerel (*Rastrelliger kanagurta*) described by Jones and Silas (1964) appear to be specimens having undergone regeneration. George *et al.* (1959), however, had suspected a different factor as the cause of asymmetrical caudal fins in the mackerel specimens collected by them.

Hallock *et al.* (1952) have observed variations in the regenerative capacities even between allied species. Thus *Oncorhynchus kisutch* showed much a less power than *O. tschawytscha*. These authors have also reported differences in the regenerative powers between parts of the body of the same species. Thus the dorsal fins of *O. tschawytscha* regenerated fully but the ventral fins showed much less regeneration. Jones and Menon (1952) while remarking on regeneration of the caudal fin in *Coilia*, also a Clupeiform genus from India, state that the more anterior the truncation the larger the number of regenerated rays. These authors have pointed out the probability that certain little known species of *Coilia* may be specimens with regenerated caudal fins and hence their dissimilarity from the normal condition. Although mistaking of abnormal specimens as new species and even genera are known among Chondrichthyes (see Gill, 1896 ; Bigelow and Shroeder, 1953) such cases among Osteichthyes are rare. Perhaps the only other instance from India was by Hamilton (1822) who has regarded an abnormal specimen of *Clarias batrachus* as a new species namely *C. jagur*, as has been elucidated by Hora (1936).

Regeneration of the caudal fin in *S. longiceps* reported in the present paper has involved only a portion of the caudal fin and the truncation or injury appears in most cases not to have extended up to the basal region. From the available data it appears that the process involves a healing up of the wound and regeneration from the zone of injury. Nusbaum (1903 ; 1907) has claimed that regeneration in the trout involves even the somites ; but this has been challenged by Okada (1943). Jones and Menon (1952) have observed in *Coilia* that regeneration is confined to the truncated region only.

Acknowledgement

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Summary

Five stages in the regeneration of the caudal fin in *S. longiceps* are described and some of the forms acquired on regeneration noted. The process involves healing up of the wound and regrowth from the region of injury. The regenerated component can be distinguished from the original mainly by the difference in the disposition of its rays from the latter. The occurrence of regeneration of mostly the lower caudal lobe in spawning *S. longiceps*, obviously after some injury, may point out to some behaviour of the shoals during spawning.

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