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Development of Fins and Squamation in the Percichthyid Fish, *Lateolabrax japonicus*

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Abstract About 600 specimens of *Lateolabrax japonicus* reared under laboratory conditions were observed for the development of soft rays and squamation. The segmentation of fin rays was completed when fish attained 18 mm SL and branching of fin rays was completed at 40 mm SL. Squamation began immediately anterior to the caudal peduncle when the fish attained a size of about 19 mm SL. Squamation was completed for specimens as small as 35 mm SL.

Little is known about the early development of the Japanese sea bass, *Lateolabrax japonicus* (Cuvier). Mito (1957) described embryonic and larval development from wild-caught specimens. Some information about early squamation and formation of scale spines was provided from wild-caught fish by Kobayashi and Miwa (1964). Shirota (1978) described jaw development in larval and juvenile stages.

In this study, we documented squamation and sequence of fin formation during the early life stage of the Japanese sea bass.

Materials and methods

The specimens used in the study were obtained from laboratory-reared fish during the years 1978 and 1979. Rearing was conducted at the Hiroshima Prefectural Fisheries Experimental Station. The water temperature in the rearing tank ranged from 14.2° to 19.4°C in 1978, and from 13.6° to 19.5°C in 1979. Parent fish were caught by a set gill net during December and January. Newly hatched larvae were fed cultured rotifers, *Brachionus plicatilis*, wild plankton and minced meats. The rearing techniques were described by Fushimi (1979).

Specimens used for observations were randomly sampled from the tank and were preserved in 10% formalin (diluted with 30~31‰ seawater). Morphological observations were made five to eight months after fixation. Specimens were stained with alizarin red S to emphasize segmentation and branching of the soft rays of fins. The lengths of the fins and body were measured with a profile projector and calipers (precision of 0.1 mm). To evaluate squamation, we recorded the appearance of scales on the left side of the body and the extent of squamation. Specimens were inspected with a dissecting and a huge-power microscope. Six hundred and five specimens ranging from 3.6 to 58 mm SL were studied. Abnormally shaped specimens were discarded.

The criteria used for determining branching and segmentation were identical to those for the red sea bream, *Pagrus major*, by Fukuhara (1976).

Results

Standard length : total length relation. The relationship between standard length and total length for larval and juvenile sea bass is described by the equation:

$SL = 0.809\ TL + 0.592$ ($r = 0.998$; $N = 560$)

(Fig. 1).

Fin development. Segmentation of the soft rays of the unpaired fins was completed when the fish were about 12 mm SL (Fig. 2). Branching of the soft rays followed segmentation. The caudal, anal and dorsal fin rays began branching at 14, 21 and 26 mm SL, respectively. Branching for each of the three fins was completed at 23, 29 and 38 mm SL, respectively. The time required for branching was greater than that for segmentation.

Segmentation of the paired fins had not begun when the specimens were 12 mm SL. Completion of segmentation for the pectoral fins occurred when the fish were 18 mm SL as opposed to 16 mm SL for the pelvic fins. Initial branching of the pectoral fins contrasted with the pelvic fins. The branching of pectoral rays

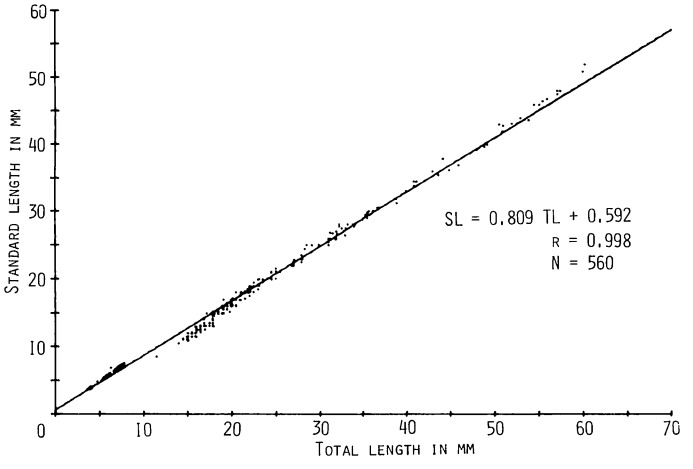

Fig. 1. Relationship between standard length and total length in larval and juvenile *Lateolabrax japonicus*.

was completed when the specimens were 40 mm SL, compared with 25 mm SL for the pelvic rays. Consequently, the segmentation of the paired and unpaired fins was completed by a size of about 18 mm SL indicating the formation of fundamental structure of the fins.

Lengths of the left pectoral and left pelvic fins plotted against standard lengths are shown in Fig. 3, and general remarks are shown photographically in Fig. 4.

Scale formation. The squamation sequence is shown in Fig. 5. The developmental stages of the scales were evaluated by two basic criteria: the number of rows of scales, and the extent of the body surface covered by the scales. Each stage was characterized as follows:

Stage A. Approximately 4 or 5 scales first appeared anterior to the caudal peduncle on the mid-lateral surface of the body. No scale spines were found on the exposed portion of the scales.

Stage B. The formation of scales extended anteroposteriorly. The anterior portion extended to the region just above the origin of the anal fin. The posterior portion extended to the anterior portion of the caudal peducle. A second row of scales began to develop.

Stage C. Posteriorly, the squamated area ended at the center of the caudal peduncle, where three scale rows formed. Anteriorly, the scaled area extended to the region above the anus.

Stage D. The squamated area extended dorsoventrally with an increase in the number of scale rows. The posterior portion was almost identical to that of Stage C, and the anterior almost reached the operculum. There were two or three scale rows in the anterior portion, and four or five in the posterior.

Stage E. There were five to nine scale rows. The anterior portion almost reached the operculum, and the posterior almost reached the base of the caudal fin. A few scales appeared at the posteroventral margin of the operculum.

Stage F. There were nine to eleven scale rows and approximately one-half of the body surface was squamated. In addition, two small patches of scales were formed along the posteroventral edge of the operculum.

Stage G. The caudal region was squamated with the exception of the base of the caudal fin. One-third of the trunk was squamated as was a small area anterior to the pelvic fin. The base of the dorsal fin remained naked.

Stage H. Except for the bases of the dorsal and pelvic fins, the body was mostly

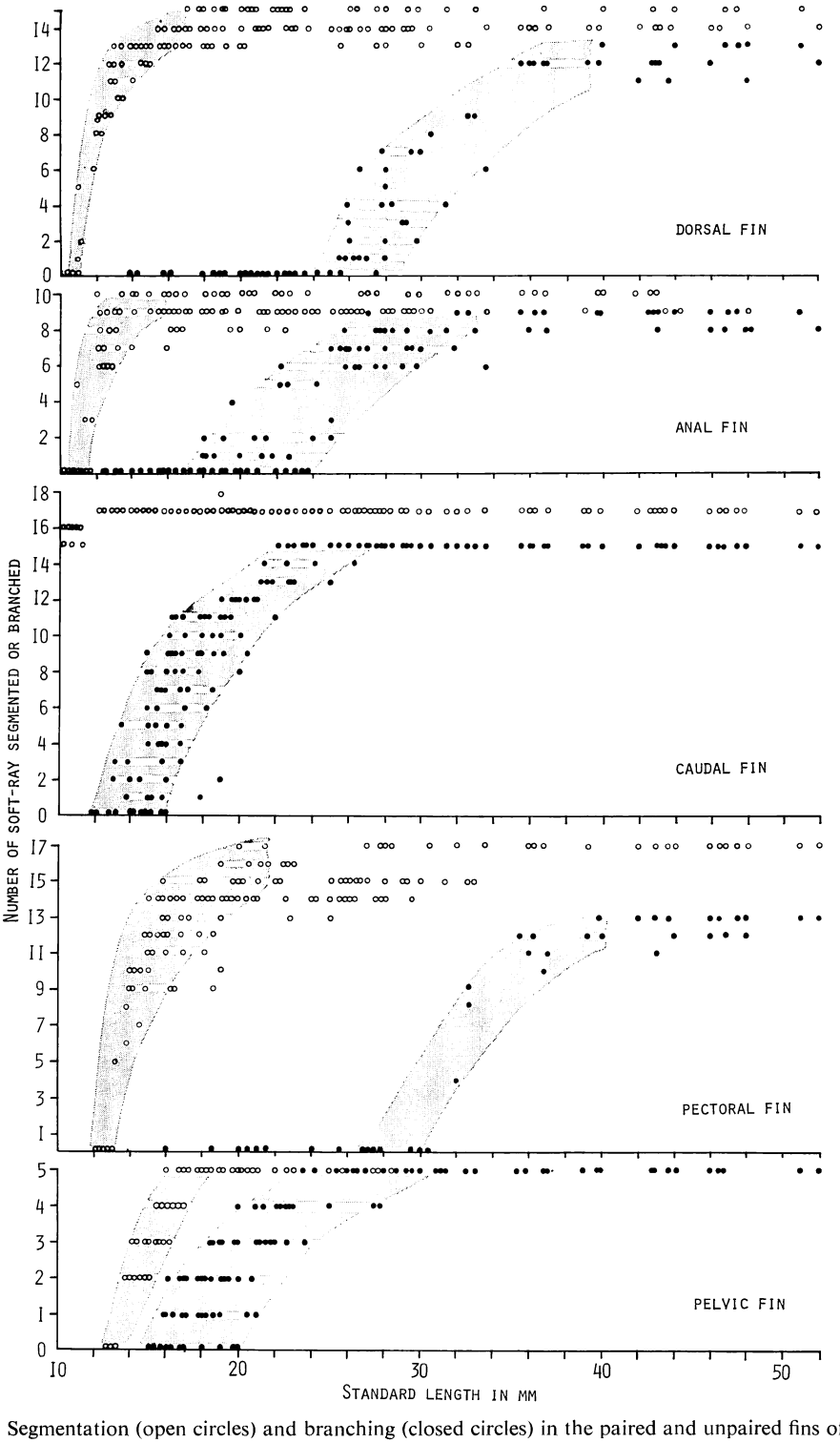

Fig. 2. Segmentation (open circles) and branching (closed circles) in the paired and unpaired fins of larval and juvenile *Lateolabrax japonicus*.

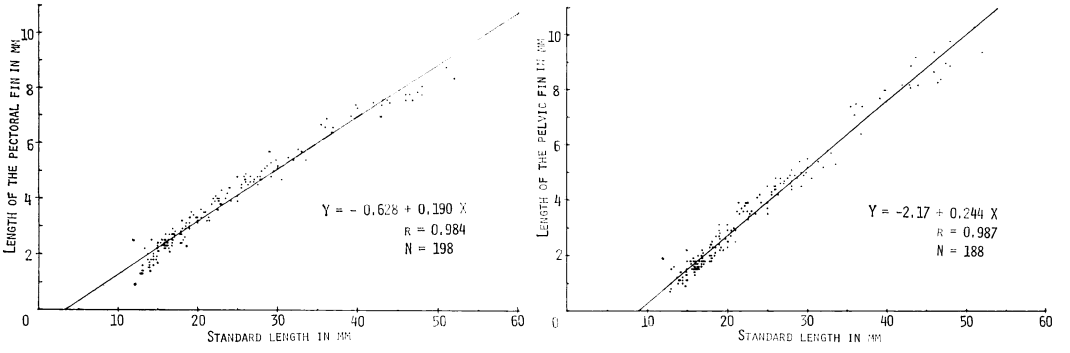

Fig. 3. Lengths of the pectoral and pelvic fins plotted against standard length in larval and juvenile *Lateolabrax japonicus*.

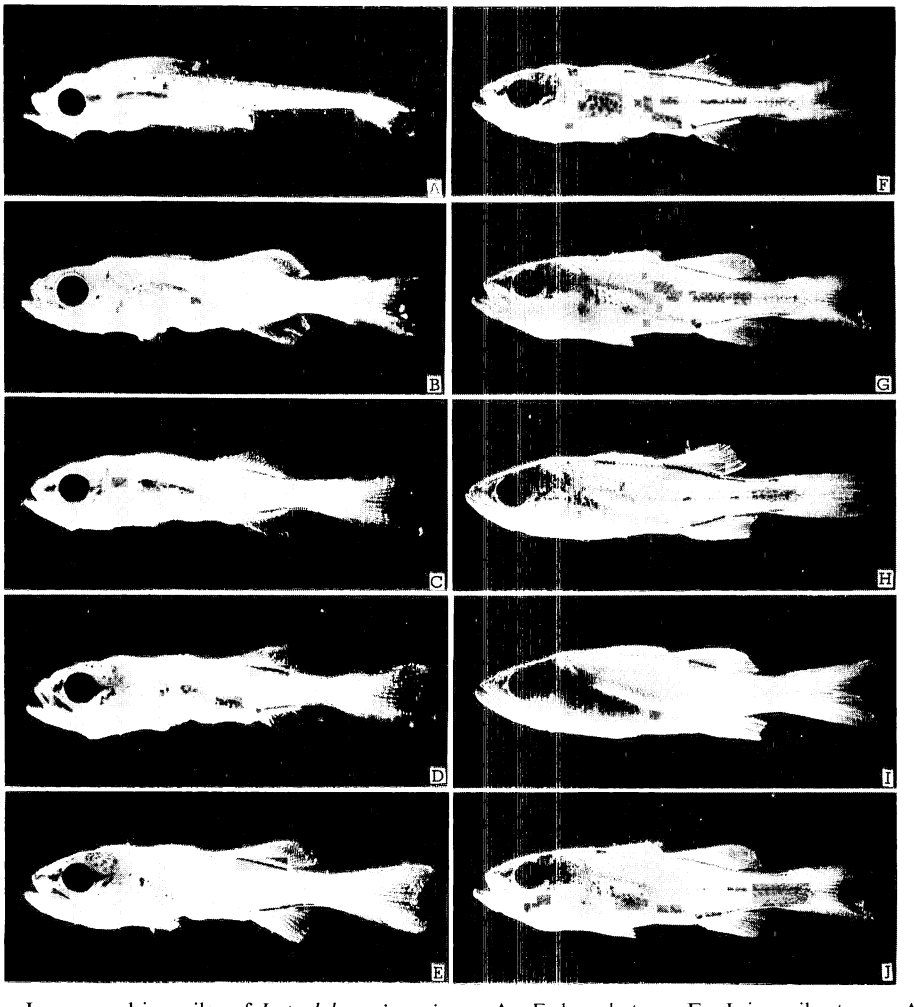

Fig. 4. Larvae and juveniles of *Lateolabrax japonicus*. A～E, larval stage; F～J, juvenile stage. A: 7.3 mm SL. B: 11.5 mm SL. C: 12.7 mm SL. D: 13.0 mm SL. E: 15.2 mm SL. F: 16.8 mm SL. G: 21.4 mm SL. H: 22.3 mm SL. I: 25.0 mm SL. J: 29.5 mm SL.

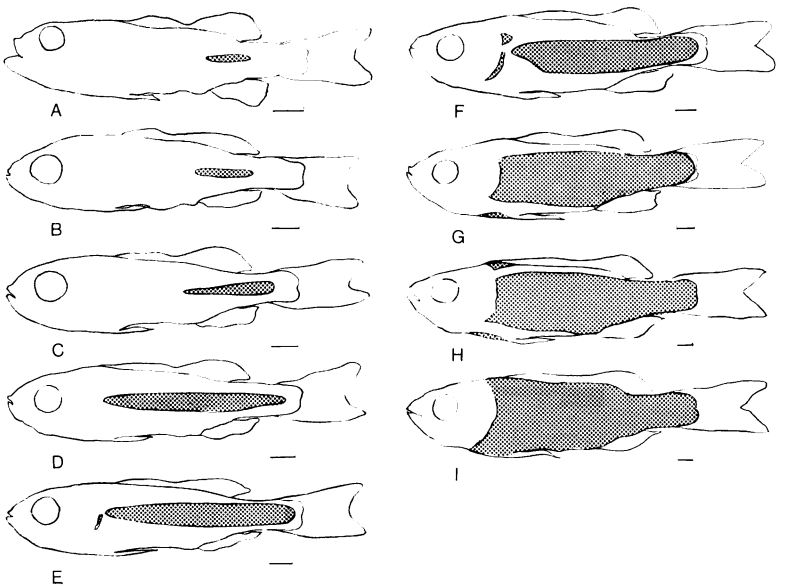

Fig. 5. Diagrammatic drawing of squamation in larval and juvenile *Lateolabrax japonicus*. Each stage was defined by the numbers of scale rows and the area of coverage. Refer to the text for details. Scales denote 2.0 mm.

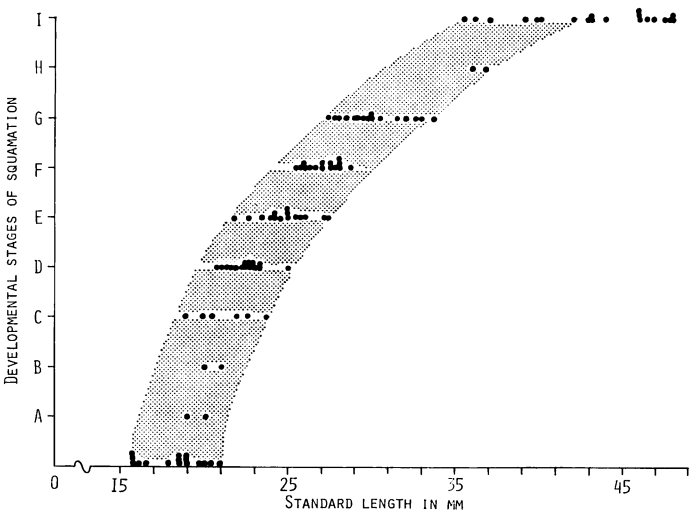

Fig. 6. Relationship between developmental stages of squamation and standard length in larval and juvenile *Lateolabrax japonicus*. Developmental stages are as designated in Fig. 5.

squamated. A small patch of scales appeared on the dorsal surface just anterior to the dorsal fin.

Stage I. The body surface was completely covered with scales.

Fig. 6 depicts the relationship between developmental stages of squamation and fish length. The largest specimen without scales was 21 mm SL, whereas the smallest larva with scales was 19 mm SL. Squamation progressed with an increase in fish length and was completed when specimens attained a length of about 35 mm SL. The largest larva to complete squamation was 43 mm SL.

Remarks

A full complement of fin elements was present in wild-caught specimens when they were about 15 mm SL (Mito, 1957) and from 15 to 17.6 mm SL (Saga Pref. Fish. Exp. Stn., 1975). In the laboratory-reared specimens, fin ray development was completed at about 16 mm SL. Therefore, transformation of larva to juvenile is assumed to occur at lengths of 16～18 mm SL for both wild and laboratory-reared specimens.

Kobayashi and Miwa (1964) described the squamation of Japanese sea bass based on wild-caught specimens. They observed that squamation began on fish 18 to 20 mm SL, and was completed at about 23 to 24 mm SL. Mito (1957) also observed that squamation began on a wild-caught specimen of Japanese sea bass of 21 mm SL.

Squamation begins at approximately the same length for both laboratory-reared and wild-caught specimens, but the length when squamation is completed differs. Wild specimens need to be studied in more detail.

Acknowledgments

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スズキの鰭および鱗の発達

福原　修・伏見　徹

スズキの幼期における外部形態，特に鰭の発達と鱗の形成を明らかにするため，人工飼育で得た標本をアリザリンで染色し観察した．鰭については各鰭の軟条の分節，分枝について調べた．各軟条の分節は 18 mm までに完了し，各鰭の基本的構造は完成する．そして分枝は体長 40 mm までに完了する．

鱗の発生は，体長 19 mm 頃に体側正中線上の尾柄直前付近から始まり，鱗域を各方向に拡げながら体長 35 mm 頃から体側全面を覆う個体が現われる．こうした外部形態の変化は，天然標本による観察結果と比較して鰭についてはほぼ同様であつたが，鱗については体側全面を覆う時期に差異が認められた．

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