NOTES ON MORPHOLOGICAL DIFFERENCES BETWEEN THE JUVENILES OF CHUM AND PINK SALMON IN SHORE WATERS

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Artificial propagation of chum salmon, *Oncorhynchus keta* (WALBAUM) has long been carried out in the Yurappu River, one of the largest rivers flowing into Uchiura Bay, southwestern Hokkaido. In addition to chum salmon, artificial propagation of pink samlon, *O. gorbuscha* (WALBAUM) was also carried out in 1969 for fishery expansion in this bay; about 410 million chum salmon fries were released into the river from March 20 till May 23 and about 188 million pink salmon fries from February 18 till May 20, by the Hokkaido Salmon Hatchery. They seemed to descend the river and to enter the shore waters of the bay, one after another in a comparatively short time.

Relatively numerous knowledges have been accumulated on fresh water life of the fry stage. But little is known on the life of juvenile salmon in shore waters, there being only some general comments given by Sano (1953), Mihara (1958), etc.

Early last summer, the present authors could collect in the shore waters of the bay, a number of chum and pink salmon juveniles which seemed to originate from the fries released into the Yurappu River. As a contribution for the study on early life of salmon in sea water, this paper presents the results of observation on some morphological differences between the juveniles of chum and pink salmon simultaneously caught there.

Materials and Method

One hundred and eighty-two juveniles of both chum and pink salmon in total were caught by a trap set-net for sandlances fishery in shore waters near the location of Mori town (Text-fig. 1) on June 16, 17 and 18, all being submitted for observation. A number of the trap set-nets were arranged along the coast of Mori. One of them employed by the authors was settled 200 m away from the shore, in 20 m depth, its mesh size being 10 mm in stretched measure at its end.

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As a reference material, one hundred fries of chum and pink salmon were taken from fry-rearing ponds of the Yakumo Salmon Hatchery situated at about 20 km above the mouth of the Yurappu River, on May 7, 1969 by courtesy of the Hokkaido Salmon Hatchery.

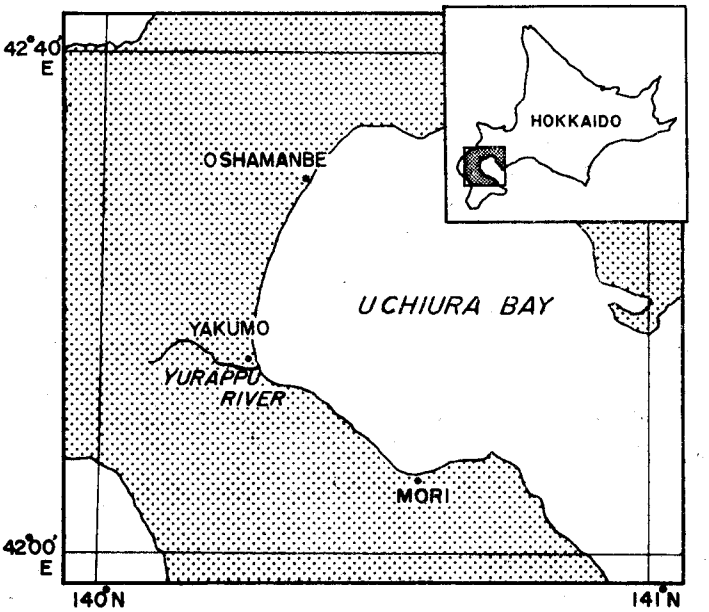

Fig. 1. Locations of the sampling of fries and juveniles of chum and pink salmon

Observations were made on the shape and color of the body, parr marks as well as gill rakers in both fresh and formaldehyde-preserved materials. The fork length was measured as to decide the sizes of the two species. The development of the scales was also examined under a binocular microscope.

Results of observation

1. External appearance

The identification of chum and pink salmon fries in fresh water life is very easy when one refers to the detailed descriptions given by Foerster & Pritchard (1934). It has been shown that chum salmon fry reveals clear parr marks on the body sides, chiefly above the lateral line, which are rather elliptical in shape and vary from 8 to 12 in number, while pink salmon fry has no parr marks on its body sides. This difference was obviously found between the two species obtained from the hatchery on May 7 (Plate I, fig. 1).

The parr marks of chum salmon fry begin to fade out after entering into sea, though the time of disappearance remains unconfirmed in the present study.

Perhaps after several days, the juvenile of chum salmon becomes difficult to be separated from that of pink salmon, owing to the disapearance of parr marks. Though Foerster & Pritchard (1934) stated that the juveniles of the two species even in such condition could be readily identified by counting the number of scales on the lateral line, the scale counting in a small individual such as a fry or early juvenile seemed to be very cumbersome work. Thus, the authors' attention was paid to find available characteristics for identification.

Examining on the juveniles of June 16–18, ranging from 55 to 84 mm in fork length, distinguishing characters are enumerated as follows; (1) a silvery color on the sides extends toward the dorsal part of the body in chum salmon, while a blue black color appears strongly on the dorsal part, showing a distinct deep blue border along the dorsal edge in pink salmon (Plate I, fig. 2). This difference is most distinct in fresh specimens, but maintained within 24 hours in formaldehyde-preserved materials. Then the feature becomes quite obscure after 48 hours due to the fading of the silvery color. (2) The body shape of similar size is slightly slender in pink salmon than in chum salmon. Myotomes under the skin are visible superficially in pink salmon, whereas they are invisible in chum salmon, the skin being mostly covered with silvery scales. (3) Scales are obviously visible on the skin in chum salmon, while they are scarce or invisible on the skin surface in pink salmon.

2. *Size in fork length*

The fork length was measured on all individuals of fries of May 7 and of juveniles of June 16～18. Measured data are arranged as shown in Table 1 and 2.

In Table 1, the fork length of chum salmon fries is slightly larger than that of pink salmon fries, the mean value showing 45.8 and 45.0 mm respectively, but this difference between the two means is not significant according to a statistical test.

In Table 2, the juveniles of chum salmon are evidently larger than those of pink salmon, the mean value showing 68.4 and 63.8 mm respectively. In this case, the difference between the two means is highly statistically significant. It seems also that larger individuals occurred in comparatively great number among the juveniles of chum salmon, while smaller individuals were found among those of pink salmon.

The largest individual among the juveniles of June 16～18 was 84 mm in fork length in chum salmon and 79 mm in pink salmon. Sano & Kobayashi (1952) described that the juveniles of chum salmon were found in the shore waters of Ishikari Bay, western Hokkaido, from the middle of May until the end of June and that they seemed to disappear from the waters when attaining 71～94 mm in body length. By the report of Pearson (1966), the largest size of pink salmon from

Table 1. Frequency distribution of fork length in fries of chum and pink salmon obtained from the Yakumo Salmon Hatchery salmon (May 7, 1969)

Fork length (mm)	Number of individuals	
	Chum	Pink
32.1~34.0	2	
34.1~36.0	2	1
36.1~38.0	1	3
38.1~40.0	2	5
40.1~42.0	7	7
42.1~44.0	13	19
44.1~46.0	21	27
46.1~48.0	23	16
48.1~50.0	19	17
50.1~52.0	4	5
52.1~54.0	4	
54.1~56.0	2	
Total number	100	100
Mean value	45.8	45.0
Minimum value	34	35
Maximum value	55	51
Stand. Dev.	4.17	5.13

Table 2. Frequency distribution of fork length in juveniles of chum and pink salmon caught in shore waters off Mori (June 16~18, 1969)

Fork length (mm)	Number of individuals	
	Chum	Pink
42.1~44.0		1
44.1~46.0		
46.1~48.0		
48.1~50.0		2
50.1~52.0		
52.1~54.0		
54.1~56.0	2	8
56.1~58.0	1	6
58.1~60.0	3	9
60.1~62.0	9	12
62.1~64.0	7	11
64.1~66.0	10	9
66.1~68.0	14	6
68.1~70.0	11	5
70.1~72.0	14	11
72.1~74.0	4	4
74.1~76.0	6	2
76.1~78.0	5	2
78.1~80.0	1	2
80.1~82.0	3	
82.1~84.0	2	
Total number	92	90
Mean value	68.4	63.8
Minimum value	55	43
Maximum value	84	79
Stand. Dev.	6.13	7.16

Puget Sound on June 23, 1964 was 82 mm in fork length and no juvenile could be located there after that time. Also in our observation, no juvenile was found there after the beginning of July. These facts probably suggest the size of the body at the time when juveniles leave the shore waters and start for the open sea.

3. *Number of gill rakers*

Taking out carefully the first gill arch on the left side by means of a pointed pincette, the number of gill rakers on the arch was counted under a binocular microscope after staining in an aqueous solution of alizarin red. For the present purpose, the fries of May 7 and juveniles of June 16～18 were almost submitted. Counted data are arranged as shown in Table 3 and 4.

Table 3. Frequency distribution of number of gill rakers in fries of chum and pink salmon obtained from the Yakumo Salmon Hatchery (May 7, 1969)

Number of gill rakers	Number of individuals	
	Chum	Pink
15	1	
16	8	
17	21	
18	33	
19	26	
20	8	
21	3	2
22		3
23		11
24		29
25		27
26		20
27		6
28		2
Total number	100	100
Mean value	18.1	24.7
Minimum value	15	21
Maximum value	21	28
Stand. Dev.	1.21	1.37

In the fries, of May 7, the number of rakers was 18.1 in mean value, ranging from 15 to 21 in chum salmon and 24.7, from 21 to 28 in pink salmon (Table 3). In the juveniles of June 16～18, the number increased to 21.4 in mean value, ranging from 18 to 24 in chum salmon and 28.1, from 26 to 32 in pink salmon (Table 4). It was noticed in the present observation that several rakers near both ends of a gill arch remained undeveloped, just as small swellings in form. If the authors missed seeing these undeveloped rakers, the number of rakers would be rather underestimated than the value mentioned above.

Table 4. Frequency distribution of number of gill rakers in juveniles of chum and pink salmon caught in shore waters off Mori (June 16~18, 1969)

Number of gill rakers	Number of individuals	
	Chum	Pink
18	1	
19	5	
20	19	
21	24	
22	24	
23	10	
24	9	
25		
26		12
27		17
28		23
29		22
30		11
31		1
32		1
Total number	92	87
Mean value	21.4	28.1
Minimum value	18	26
Maximum value	24	32
Stand. Dev.	1.39	1.34

As the number of gill rakers in adult chum and pink salmon, Matsubara (1957) has given 22~24 and 26~32 respectively, Clemens & Wilby (1961), 19~26 and 24~35, Hikita (1962), 19~27 and 26~36. From these numerical values, it is very obvious that gill rakers in the chum and pink salmon fries of May 7 did not yet attain full number in adult, even for the largest individual. Afterward, with the advance of body growth, they increased approximately to full number in the juveniles of June 16~18. Increases of the number of rakers from May 5 till June 16~18 in both chum and pink salmon are illustrated in Text-fig. 2.

Therefore, if the two species in earlier stages are sorted only by counting the number of gill rakers, there may be a risk to mistake a pink salmon for a chum salmon. Even in such a case, the two species can be comparatively easily distinguished by the external appearance of rakers on the gill arch, which is stout and shorter in chum salmon, slender and elongate in pink salmon (Plate I, fig. 3). Besides, as Robinson (1969) pointed out, the pigment spots regularly arranged one by one on the spaces between rakers standing side by side are also reliable for the identification of pink salmon, as they appear only as traces in chum salmon.

4. Number of scale circuli

A scale examination was made on some juveniles of chum and pink salmon of June 16~18. The samples of scales were removed from the part of the body

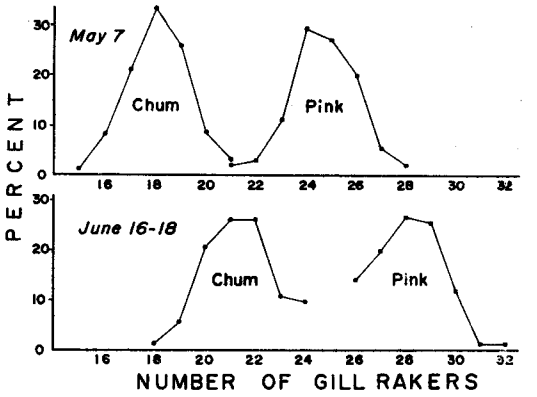

Fig. 2. Increases of the number of gill rakers from May 7 till June 16–18 in both chum and pink salmon

which was put between two perpendiculars drawn down from the posterior end of the dorsal fin and the anterior end of the adipose fin. The number of circuli on a scale was counted under a binocular microscope.

As shown in Table 5, the scales of most juveniles in chum salmon are provided with circuli from 6 to 8, the mean value showing 7, while, about 1.1 circuli in mean value ranging from 0 to 3 are found upon the scales of pink salmon, as seen in Table 6. It is noticed in the latter Table that there are six individuals having no scales on the body. From these data, it is apparent that scale formation in pink salmon began at the time when individuals grew more than about 55 mm in fork length at least, and that the circulus number of pink salmon was less, about five, than that of chum salmon of the same size.

In the study of scale development of chum salmon, Kochi (1933) reported that no scale was recognized on individuals measuring less than 34 mm long, while scales appeared at first on the caudal peduncle of individuals measuring 35～36 mm long. Examining the number of scale circuli in pink salmon, Pearson (1966)

Table 5. Number of scale circuli in juveniles of chum salmon taken from shore waters off Mori (June 16～18, 1969)

No. of circuli	No. of individuals	Range of fork length (mm)
5	3	66～70
6	7	64～80
7	11	68～83
8	7	70～71
12	1	74
Mean 7.0	Total 29	

Table 6. Number of scale circuli in juveniles of pink salmon caught in shore waters off Mori (June 16～18, 1969)

No. of circuli	No. of individuals	Range of fork length (mm)
No scale	6	56～57
0	14	55～70
1	2	57～65
2	8	58～72
3	5	68～74
Mean 1.1	Total 35	

described that two juveniles, 60 and 63 mm long, had scales without a circulus and forty-nine other specimens ranging from 65 to 82 mm in size had scales with one, two or three circuli. These data indicate that the formation of scales begins earlier in chum salmon than in pink salmon, starting at the time when one individual grew about 35 mm long in the former species and at least 55 mm long in the latter. The authors' data seem to agree with the observations mentioned above.

Summary

1. Ninety-two chum salmon and ninety pink salmon juveniles were caught by a trap set-net for sand-lances fishery in shore waters off Mori Town, situated along the coast of Uchiura Bay (Text-fig. 1) on June 16～18, 1969.

2. The juveniles of the two species can be easily identified by the following characteristics in external appearance (Plate I, fig. 2): (1) A silvery color on the sides extends towards the dorsal part of the body in chum salmon, while a distinct deep blue border remains along the dorsal edge in pink salmon. This feature is most distinct in fresh specimens, becoming obscure after 24 hours of preservation in formalin due to the fading of the silvery color. (2) The body shape of similar size is slightly slender in pink salmon than in chum salmon (3) Myotomes under the skin are superficially visible in pink salmon, whereas they are invisible because the skin is mostly covered with silvery scales in chum salmon.

3. The juveniles of chum salmon are evidently larger than those of pink salmon, the mean value showing 68.4 mm in the former, 63.8 mm in the latter (Table 2). Larger individuals occurred in a comparatively great number among the juveniles of chum salmon, while smaller individuals were found among those of pink salmon.

4. Gill rakers in both species attain approximately full number in adults, acquiring 21.4 in mean value in chum salmon, 28.1 in pink salmon (Table 4). One must be careful enough to identify the two species only by counting the number of

gill rakers, because the number of rakers at earlier stages are considerably less than the full number in adult form (Table 3).

5. Scales in chum salmon are provided with 7 circuli in mean value (Table 5), while in pink salmon only 1.1, there being included some individuals having no scales on their bodies (Table 6). Obviously the development of scales begins considerably earlier in chum salmon than in pink salmon.

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Explanation of Plate I

Fig. 1. Fries of chum salmon (above), 48 mm and pink salmon (below), 50 mm in fork length, obtained from the Yakumo Salmon Hatchery on May 7, 1969

Fig. 2. Juveniles of chum salmon (above), and pink salmon (below), 71 mm in fork length respectively, caught in shore waters off Mori on June 18, 1969

Fig. 3. The first gill of the left side, showing rakers on the gill arch of juvenile chum (left) and pink salmon (right), 68 mm in fork length respectively, caught in shore waters off Mori on June 17, 1969 Ca. $\times 7$

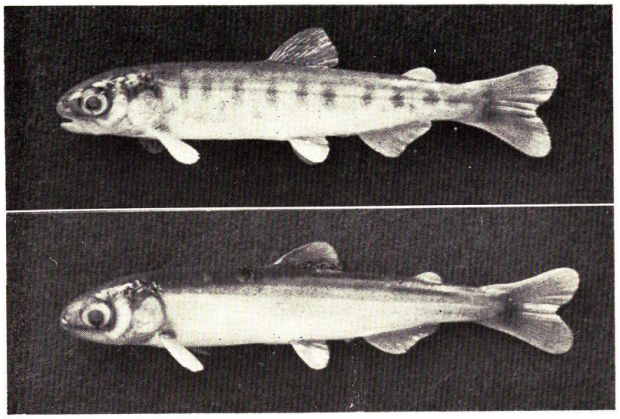

Fig. 1.

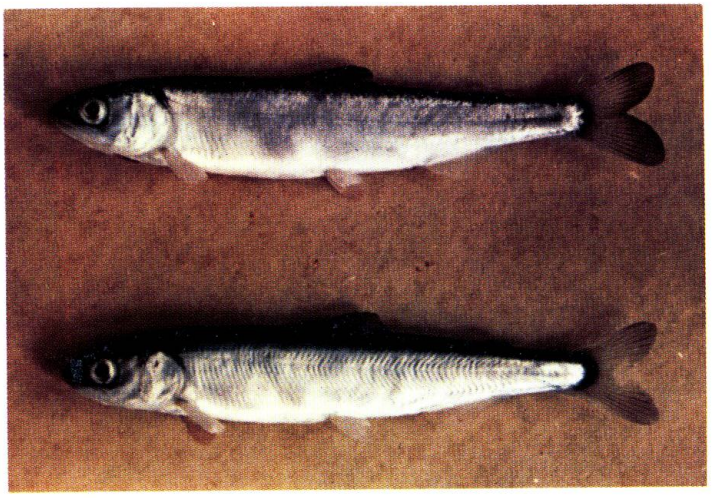

Fig. 2.

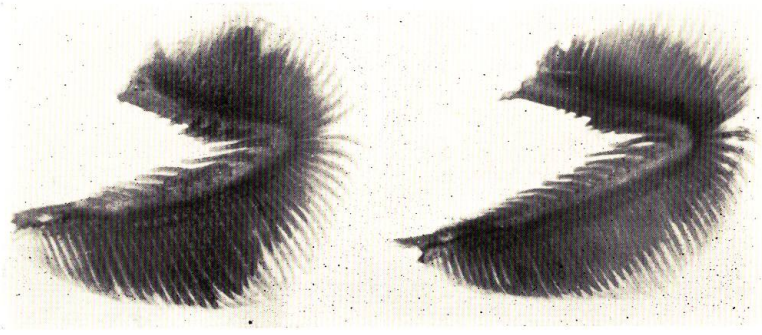

Fig. 3.

S. OKADA & T. NISHIYAMA : Juvenile chum and pink salmon