MEAN FORK LENGTH AND NUMBER OF SCALE CIRCULI OF CHUM SALMON GROUPS IN THE GULF OF ANADYR AND ADJACENT HIGH SEAS IN LATE JULY 1966*

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In late July in 1966, exploratory fishings were carried out on chum salmon in the Gulf of Anadyr and on high seas extending from southern waters off Cape Navarin to the vicinity of St. Lawrence Island by the *Oshoro Maru*, a fisheries training ship of Hokkaido University. Some biological data obtained in her cruise revealed that chum salmon caught in the above sea areas were composed of three different fish groups in both three- and four-year-old fish: the first group was a mature in the Gulf of Anadyr, the second an immature one beyond the Gulf of Anadyr and the third an immature one in the water off Cape Navarin (Nishiyama et al. 1968).

In this report, we made an observation on scale circuli of the respective chum salmon groups that were found in the above northern Bering Sea.

Materials and Methods

From July 19 to 31 in 1966, twelve exploratory fishings with drift gillnet sets were conducted in the Gulf of Anadyr, beyond the Gulf of Anadyr and in far southern waters off Cape Navarin. Cited here are the results of seven fishing locations where catches of salmon were considerably large. The data and position of our fishings are represented in Table 1. Specimens of chum salmon were sampled at random from the catch taken by five mesh sizes, i.e. 90, 115, 121, 130 and 136 mm stretched measure. The scale sampling was done on the eight rows above and below the lateral line encircled by the end of the base of the dorsal fin and the origin of the base of the adipose fin. The surface feature of scale was magnified fifty times by a projector for observation, and the outer edges of all circuli were contoured on recording paper along the longest axis from the center of scale to the margin. Then the number of scale circuli in each annulus was counted. The

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Table 1. Date, position, catch and number of samples of chum salmon at the seven fishing locations taken by the *Oshoro Maru* in the Gulf of Anadyr and in the northwestern waters of the Bering Sea, late July, 1966

No. of fishing*	Date at net hauled	Position of net set		No. of catch**	No. of samples
		Latitude	Longitude		
F 21	July 21	58°49′N	178°24′W	332	218
F 26	26	64°17′	174°45′	190	164
F 27	27	64°37′	179°00′	468	58
F 28	28	64°00′	179°41′	228	220
F 29	29	63°00′	178°54′	292	226
F 30	30	62°29′	176°00′	649	283
F 31	31	61°31′	176°51′	784	200

* The number assigns each fishing location occupied by the present cruise
** Amount of salmon gillnet used was 102 tan in all the operation

number of scale circuli in the first or last half of scale in the first year band was not taken into account in the present examination.

At the seven fishing locations, the samples of chum salmon belonged to one of four age groups from three- to six-year-old fish. However, both three- and four-year-old fish retained a large part of the samples, whereas five- and six-year-old fish were very few in number. Therefore, two dominant age groups are discussed here. Variations in numerical values for fork length and number of scale circuli due to sex are liable, so that the fish belonging to the same age are further subdivided into male and female groups. Maturity of both sexes are also provided for the check of the values. Thus chum salmon are classified into eight groups according to age (three- or four-age), sex (female or male) and maturity (mature or immature). The value of gonad weight limiting mature from immature specimens was placed on the point of 25 g in case of female and 1 g in case of male. At the locations F 21, F 30 and F 31, the fish groups were mostly formed by immature individuals, while at F 26 to F 29 the groups consisted of mature fishes. In this report, mature fishes at F 21, F 30 and F 31, and immature fishes at F 26 to F 29 were excluded because of the small number of samples.

Results

1. Mean fork length

As to examine bias due to sex, the mean fork length was firstly calculated according to female and male groups at the seven fishing locations (Table 2). In the three- and four-age groups, it is apparently seen that the mean fork length of male groups was larger than that of the female groups except in two cases. As seen in Table 3, the difference of the mean fork length by sex is not statistically significant in most cases, but for the three-age groups at F 21 and F 29.

Based on the results that in general there was no statistical significance in

Table 2. Mean fork length (cm) of chum salmon groups according to age and sex in the Gulf of Anadyr and in the northwestern waters of the Bering Sea, late July, 1966. The figures in parenthesis represent 95% confidence limit

Location		Female		Male	
		N	$\bar{x}$	N	$\bar{x}$
			3-age group		
Immature group	F 21	68	46.6 (46.05–47.15)	69	47.7 (47.10–48.30)
	F 30	27	49.6 (48.12–51.08)	51	50.5 (49.50–51.50)
	F 31	30	48.6 (47.35–49.85)	27	50.0 (48.77–51.23)
Mature group	F 26	44	57.0 (56.02–57.98)	27	57.8 (56.85–58.75)
	F 27	22	57.4 (56.69–58.11)	12	57.1 (55.91–58.29)
	F 28	78	56.7 (56.11–57.29)	57	57.4 (56.53–58.27)
	F 29	95	56.2 (55.75–56.65)	52	57.5 (56.76–58.24)
			4-age group		
Immature group	F 21	30	52.0 (50.76–53.24)	23	53.1 (52.03–54.17)
	F 30	50	54.9 (54.05–55.75)	58	55.7 (55.00–56.40)
	F 31	48	53.8 (52.86–54.74)	22	54.5 (53.46–55.54)
Mature group	F 26	41	60.6 (59.54–61.66)	16	59.3 (57.65–60.95)
	F 27	14	60.5 (59.17–61.83)	3	61.7
	F 28	45	60.3 (59.19–61.41)	20	61.7 (60.17–63.23)
	F 29	31	59.8 (58.86–60.74)	6	61.5 (59.33–63.67)

Table 3. Test of difference of mean fork length between female and male chum salmon groups at the seven fishing locations

Location	*F*-test	*t*- or *z*-test
	F_0 $F_{.05}$	t_0 or z_0 $t_{.05}$ or $z_{.05}$
	3-age group	
F 21	$1.224 < 1.48$	$2.668 > 1.96$
F 30	$1.796 < 1.82$	$1.048 < 1.99$
F 31	$1.146 < 1.91$	$1.616 < 2.00$
F 26	$1.838 < 1.84$	$1.110 < 1.99$
F 27	$1.349 < 2.64$	$0.491 < 2.04$
F 28	$1.544 > 1.51$	$1.327 < 1.96$
F 29	$1.451 < 1.51$	$2.982 > 1.96$
	4-age group	
F 21	$1.796 < 1.98$	$1.306 < 2.00$
F 30	$1.246 > 1.56$	$1.459 < 1.96$
F 31	$1.901 < 1.91$	$0.908 < 1.99$
F 26	$1.182 < 2.16$	$0.424 < 2.00$
F 27		
F 28	$1.295 < 2.01$	$1.455 < 2.00$
F 29	$1.403 < 4.50$	$1.515 < 2.03$

the mean fork length between female and male groups, the mean for both sexes is given in Table 4. From this table, it is fairly suggested that the mean fork length of both ages can be separated into three groups. Each of them shows similar numerical values: the first groups is at F 21, the second at F 30 and F 31, and the third at F 26 to F 29. According to statistical tests (Table 5), it is ascertained that in both age groups the mean fork length at F 21 differs completely from that at F 30 and F 31, where the difference is not seen between F 30 and F 31 in the

Table 4. Mean fork length (cm) of chum salmon groups (both females and males combined) in the Gulf of Anadyr and in the northwestern waters of the Bering Sea, late July, 1966. The figures in parenthesis represent 95% confidence limit

Location		N	$\bar{x}$
		3-age group	
Immature group	F 21	137	47.2(46.76-47.64)
	F 30	77	50.2(49.38-51.02)
	F 31	58	49.3(48.43-50.17)
Mature group	F 26	70	57.3(56.60-58.00)
	F 27	34	57.3(56.31-58.29)
	F 28	135	57.0(56.50-57.50)
	F 29	134	56.6(56.19-57.01)
		4-age group	
Immature group	F 21	51	52.5(51.65-53.35)
	F 30	104	55.3(54.75-55.85)
	F 31	70	54.0(53.29-54.71)
Mature group	F 26	59	59.7(58.85-60.55)
	F 27	17	60.4(59.19-61.61)
	F 28	65	60.7(59.81-61.59)
	F 29	39	60.9(59.82-61.58)

Table 5. Test of difference of mean fork length of chum salmon groups among the seven fishing locations

Locations	*3-age group*		*4-age group*	
	F-test	*t*- or *z*-test	*F*-test	*t*- or *z*-test
	F_0 $F_{.05}$	t_0 or z_0 $t_{.05}$ or $z_{.05}$	F_0 $F_{.05}$	t_0 or z_0 $t_{.05}$ or $z_{.05}$
F 21-F 30	2.086>1.32	6.547>1.96	1.117<1.48	5.545>1.96
F 21-F 31	1.731>1.48	4.379>1.96	1.010<1.53	2.734>1.96
F 30-F 31	1.208<1.52	1.612<1.96	1.106<1.46	2.893>1.96
F 26-F 27	1.086<1.70	0 <1.96	1.562<2.12	0.914<1.99
F 26-F 28	1.015<1.40	0.230<1.96	1.196<1.54	1.624<1.96
F 26-F 29	1.487<1.40	1.701<1.96	1.466<1.65	1.644<1.96
F 27-F 28	1.070<1.63	0.548<1.96	1.868<2.11	0.387<1.99
F 27-F 29	1.370<1.54	1.322<1.96	1.066<2.14	0.144<2.01
F 28-F 29	1.465>1.34	1.217<1.96	1.753>1.64	0 <1.96

three-age groups. Difference was significant in the mean between F 30 and F 31 in the four-age groups. Further, there was highly statistical significance between immature and mature groups in the three- and four-age groups. No difference was found in the means among the four locations from F 26 to F 29.

In consequence, it is considered that the difference of the mean fork length in the above three fish groups of both ages was attributed either to racial difference or to different growth rate of fish at the respective fishing locations.

2. Mean number of scale circuli

Mean number of scale circuli from the first to the successive year bands in each group is given in Table 6. The number of scale circuli in the third year band in the three-age groups and the fourth year band in the four-age groups is not

Table 6. Mean number of scale circuli of chum salmon groups according to age and sex in the Gulf of Anadyr and in the northwestern waters of the Bering Sea, late July, 1966. The figures in parenthesis represent 95% confidence limit

Location		*Female*		*Male*	
		N	$\bar{x}$	N	$\bar{x}$
			3-age group		
1 st year band	F 21	62	25.0 (24.39-25.61)	64	25.3 (24.81-25.79)
	F 30	26	24.4 (23.51-25.29)	51	24.6 (24.01-25.19)
	F 31	29	26.0 (24.91-27.09)	25	25.4 (24.49-26.23)
	F 26	44	24.3 (23.36-25.24)	26	23.7 (22.72-24.68)
	F 27	17	23.7 (22.84-24.56)	9	23.8 (22.51-25.09)
	F 28	78	23.5 (22.98-24.02)	54	23.4 (22.90-23.90)
	F 29	94	23.7 (23.26-24.14)	50	23.8 (23.26-24.34)
2nd year band	F 21	62	17.1 (16.52-17.68)	64	17.8 (17.34-18.26)
	F 30	26	16.3 (15.18-17.42)	49	17.1 (16.23-17.97)
	F 31	29	17.5 (16.66-18.34)	27	17.8 (16.62-18.98)
	F 26	44	18.4 (17.71-19.09)	26	19.6 (18.66-20.54)
	F 27	17	18.1 (17.34-18.86)	9	18.0 (16.53-19.47)
	F 28	78	18.5 (17.98-19.02)	54	18.8 (18.22-19.38)
	F 29	94	18.5 (17.99-19.01)	50	19.2 (18.47-19.93)
3rd year band	F 21	62	7.5 (7.16- 7.84)	64	7.6 (7.32- 7.88)
	F 30	26	8.3 (7.96- 8.64)	49	8.6 (7.99- 9.21)
	F 31	29	8.8 (8.24- 9.56)	27	8.5 (7.81- 9.19)
	F 26	44	10.6 (9.92-11.19)	26	10.6 (10.01-11.19)
	F 27	17	10.1 (9.46-10.74)	9	11.3 (9.99-12.61)
	F 28	78	10.8 (10.27-11.33)	54	11.0 (10.38-11.62)
	F 29	94	10.4 (10.03-10.77)	48	10.4 (9.92-10.88)
			4-age group		
1 st year band	F 21	25	25.7 (24.90-26.50)	22	25.5 (24.63-26.37)
	F 30	50	25.0 (24.26-25.74)	51	24.9 (24.29-25.61)
	F 31	48	24.8 (2.364-25.96)	21	25.6 (24.48-26.72)
	F 26	40	23.3 (22.36-24.24)	16	23.6 (21.84-25.36)
	F 27	12	22.2 (21.43-22.97)		
	F 28	45	23.2 (22.22-24.18)	19	24.4 (22.88-25.92)
	F 29	28	24.1 (22.81-25.39)	6	23.3 (21.16-25.44)
2nd year band	F 21	25	16.1 (15.25-16.95)	22	15.4 (14.64-16.16)
	F 30	50	15.8 (15.23-16.37)	51	16.0 (15.47-16.51)
	F 31	48	14.9 (14.08-15.72)	21	15.1 (14.20-16.00)
	F 26	40	17.0 (16.30-17.70)	16	16.3 (14.81-17.79)
	F 27	12	17.0 (15.81-18.19)		
	F 28	45	17.4 (16.69-18.11)	19	16.5 (15.49-17.51)
	F 29	28	16.5 (15.47-17.53)	6	17.3 (14.96-19.64)
3rd year band	F 21	25	11.3 (10.64-11.96)	22	11.7 (10.53-12.87)
	F 30	50	12.5 (11.86-13.14)	51	12.5 (11.79-13.21)
	F 31	48	11.7 (11.24-12.16)	21	12.3 (10.94-13.66)
	F 26	40	12.7 (12.00-13.00)	16	13.1 (11.34-14.86)
	F 27	12	12.9 (11.11-14.69)		
	F 28	45	13.0 (12.27-13.73)	19	12.6 (11.64-13.56)
	F 29	28	12.4 (11.56-13.24)	6	13.8 (11.86-15.74)
4th year band	F 21	25	5.1 (4.54- 5.66)	22	5.6 (4.89- 6.31)
	F 30	50	5.6 (5.03- 6.17)	51	5.4 (5.02- 5.78)
	F 31	48	5.5 (4.96- 6.04)	21	5.4 (4.82- 5.98)
	F 26	40	7.4 (6.53- 8.27)	16	6.6 (5.89- 7.31)
	F 27	12	6.8 (5.93- 7.67)		
	F 28	45	7.3 (6.78- 7.82)	19	7.4 (6.73- 8.07)
	F 29	28	7.7 (7.03- 8.37)	6	6.5 (5.11- 7.89)

the count of circuli in which the growth of scale was completed in the respective year, but only the count of the last year when the fish were caught on high seas.

As represented in Table 7 and 8, tests of differences of the means assure no statistical significance between female and male groups in all the year bands of both age groups, except the second year band of the three-age groups at F 26 and the third year band of the three-age groups at F 27.

In Table 6, it is obviously seen that in the three-age groups the mean number of scale circuli in the first year band is larger in immature groups than in mature ones. Instead, the means in the second and the third year bands tend to increase more in mature groups than in immature ones. These phenomena are also true for the four-age groups. On the basis of the observation that there was no statistical significance in difference of the mean fork length among mature groups from F 26 to F 29, the fish samples are wholly combined to each other. The mean number of scale circuli which was pooled from the data on female and male groups is shown in Table 9. The comparison of differences of the means among the fish groups in the four fishing sea areas is made as seen in Table 10. In the three-age groups, the difference of the mean number of scale circuli is not found in the first year band between two immature groups at F 21, and F 30 and F 31. It is evident that the number of scale circuli in the first year band in mature groups of three-

Table 7. Test of difference of mean number of scale circuli in the first to the third year band of the three-age female and male chum salmon groups

Location	*F*-test	*t*- or *z*-test
	F_0 $F_{.05}$	t_0 or z_0 $t_{.05}$ or $z_{.05}$
	First year band	
F 21	1.509<1.52	0.775<1.96
F 30	1.088<1.74	0.094<1.99
F 31	1.829<1.96	1.067<2.00
F 26	1.210<1.86	0.787<2.00
F 27	1.019<3.20	0.147<2.06
F 28	1.597>1.51	0.279<1.96
F 29	1.272<1.52	0.286<1.96
	Second year band	
F 21	1.549>1.52	1.941<1.96
F 30	1.226<1.85	0.272<1.99
F 31	1.131<1.88	0.131<2.00
F 26	1.051<1.76	2.129>2.00
F 27	1.620<2.59	0.150<2.06
F 28	1.193<1.51	0.769<1.96
F 29	1.051<1.53	1.571<1.96
	Third year band	
F 21	1.013<1.52	0.447<1.96
F 30	1.734<1.85	0.152<1.99
F 31	1.003<1.94	0.230<2.00
F 26	2.376>1.86	0.000<2.00
F 27	1.809<2.59	2.096>2.06
F 28	1.076<1.51	0.493<1.96
F 29	1.166<1.54	0 <1.96

Table 8. Test of difference of mean number of scale circuli in the first to the fourth year band of the four-age female and male chum salmon groups

Location	F-test	t- or z-test
	F_0 $F_{.05}$	t_0 or z_0 $t_{.05}$ or $z_{.05}$
	First year band	
F 21	1.022<2.02	1.615<2.00
F 30	1.040<1.61	0.196<1.98
F 31	1.149<1.79	1.183<1.99
F 26	1.250<1.93	0.667<2.01
F 27		
F 28	1.069<2.06	1.359<2.00
F 29	3.070<4.52	0.571<2.04
	Second year band	
F 21	1.450<2.05	1.273<2.00
F 30	1.217<1.61	0.272<1.98
F 31	2.026>1.97	0.296<1.99
F 26	1.624<1.93	1.004<2.01
F 27		
F 28	1.293<2.06	1.432<2.00
F 29	1.639<4.52	0.699<2.04
	Third year band	
F 21	2.728>2.02	0.622<2.00
F 30	1.302<1.61	0 <1.98
F 31	3.546>1.79	1.096<1.99
F 26	1.368<2.21	0.639<2.01
F 27		
F 28	1.526<2.06	0.634<2.00
F 29	1.597<4.52	0.471<2.04
	Fourth year band	
F 21	1.383<2.02	1.177<2.00
F 30	1.064<1.61	0.516<1.98
F 31	2.061>1.97	0.225<1.99
F 26	4.272>2.21	0.991<2.01
F 27		
F 28	1.545<2.06	0.225<2.00
F 29	1.980<4.52	0.512<2.04

age at F 26 to F 29 is different from those in immature groups. Furthermore, the number of scale circuli in the successive year bands from F 26 to F 29 was distinguished from those of F 21, F 30 and F 31; the number of scale circuli in the four-age groups from F 26 to F 29 was almost dissimilar from those found at F 21, F 30 and F 31, except the third year band in which the mean was overlapped with that of F 30. The number of scale circuli in the fourth year band was not different in F 21, F 30 and F 31.

Despite the fact that the mean fork length suggests three fish groups in both ages, we can identify only two groups in the sea areas occupied by the mean number of scale circuli. In addition, no statistical significance is derived from the test of difference of the means in number of scale circuli in the first year band between the three- and four-age groups in all the fishing locations (Table 11).

Table 9. Mean number of scale circuli of chum salmon groups (both females and males combined) in the Gulf of Anadyr and in the northwestern waters of the Bering Sea. The figures in parenthesis represent 95% confidence limit

Location		N	$\bar{x}$
		3-age group	
1 st year band	F 21	126	25.1 (24.72-25.48)
	F 30	77	24.8 (24.32-25.28)
	F 31	54	25.7 (25.01-26.39)
	F 26-29	374	23.6 (23.35-23.85)
2 nd year band	F 21	126	17.4 (17.03-17.77)
	F 30	75	17.0 (16.42-17.58)
	F 31	56	17.6 (16.99-18.21)
	F 26-29	373	18.7 (18.42-18.99)
3 rd year band	F 21	126	7.6 (7.38- 7.82)
	F 30	74	8.4 (8.00- 8.80)
	F 31	55	8.4 (7.93- 8.87)
	F 26-29	369	10.7 (10.51-10.89)
		4-age group	
1 st year band	F 21	47	25.6 (25.04-26.16)
	F 30	107	25.1 (24.61-25.59)
	F 31	70	25.0 (24.38-25.62)
	F 26-29	167	23.5 (23.04-23.96)
2 nd year band	F 21	47	15.7 (15.06-16.34)
	F 30	106	16.1 (15.74-16.46)
	F 31	69	15.1 (14.53-15.67)
	F 26-29	167	16.9 (16.55-17.25)
3 rd year band	F 21	46	11.3 (10.59-12.01)
	F 30	106	12.4 (11.98-12.82)
	F 31	69	11.7 (11.29-12.11)
	F 26-29	167	12.8 (12.46-13.14)
4 th year band	F 21	47	5.3 (4.85- 5.75)
	F 30	108	5.5 (5.26- 5.74)
	F 31	69	5.4 (5.10- 5.70)
	F 26-29	166	7.3 (7.01- 7.59)

Table 10. Test of difference of mean number of scale circuli of chum salmon groups among the four representative fishing locations

Locations		*3-age group*		*4-age group*	
		F-test	t- or z-test	F-test	t- or z-test
		F_0 $F_{.05}$	t_0 or z_0 $t_{.05}$ or $z_{.05}$	F_0 $F_{.05}$	t_0 or z_0 $t_{.05}$ or $z_{.05}$
1 st year band	F 21-F 30	1.053<1.43	1.033<1.96	1.776>1.54	1.336<1.96
	F 21-F 31	1.362<1.51	0.750<1.96	1.051<1.42	1.559<1.98
	F 21-F 26-29	1.272<1.29	6.124>1.96	2.500>1.46	5.612>1.96
	F 30-F 31	1.434<1.56	1.414<1.96	1.021<1.47	0.303<1.96
	F 30-F 26-29	1.339<1.39	4.479>1.96	1.409>1.35	4.330>1.96
	F 31-F 26-29	1.072<1.46	4.811>1.96	1.373<1.43	3.875>1.96
2 nd year band	F 21-F 30	1.476<1.45	1.155<1.96	1.387>1.48	0.905<1.96
	F 21-F 31	1.181<1.49	0.590<1.96	1.187<1.54	1.710<1.98
	F 21-F 26-29	1.671>1.26	5.814>1.96	1.090<1.53	3.220>1.96
	F 30-F 31	1.654>1.56	1.566<1.96	1.648>1.45	2.860>1.96
	F 30-F 26-29	1.339<1.39	3.775>1.96	1.512>1.35	3.266>1.96
	F 31-F 26-29	1.236<1.46	6.523>1.96	1.090<1.37	5.384>1.96

Table 10. Continued

3rd year band	F21-F30	1.931>1.38	2.186>1.96	1.161<1.48	0.549<1.96
	F21-F31	1.950>1.44	3.266>1.96	1.924>1.56	1.000<1.98
	F21-F26-29	2.366>1.29	21.921>1.96	1.125<1.46	4.001>1.96
	F30-F31	1.010<1.48	0.033<1.96	1.658>1.46	1.524<1.96
	F30-F26-29	1.225<1.39	10.215>1.96	1.032<1.35	1.524<1.96
	F31-F26-29	1.214<1.45	9.044>1.96	1.710>1.43	4.328<1.96
4th year band	F21-F30			1.439>3.47	0.549<1.96
	F21-F31			1.579>1.51	0.378<1.98
	F21-F26-29			1.556>1.53	7.559>1.96
	F30-F31			1.097<1.45	0.676<1.96
	F30-F26-29			2.239>1.35	9.326>1.96
	F31-F26-29			2.456>1.43	12.324>1.96

Table 11. Test of difference of mean number of scale circuli in the first year band between the three- and four-age groups at the four representative fishing locations

Location	F-test		t- or z-test	
	F_0	$F_{.05}$	t_0 or z_0	$t_{.05}$ or $z_{.05}$
F21	1.285<1.53		0.657<1.96	
F30	1.460>1.43		0.866<1.96	
F31	1.040<1.53		1.509<1.96	
F26-29	1.531>1.30		0.354<1.96	

Discussion

Recently, certain knowledge has been accumulated by Japanese research vessels on the extent of the distribution of chum salmon in the northernmost of the Bering Sea. From late July to early August in 1966, the *Etsuzan Maru* participated in the research cruise on the continental shelf of the Bering Sea where immature chum salmon were reported to be widespread (Yonemori, 1967). The *Tairin Maru* also explored salmon distribution in late summer of 1966 in the North Bering Sea as far as the north of the Chukchi Sea, where chum salmon were found to be relatively abundant (Yonemori and Takahashi, 1967). Yet investigation of the distribution of chum salmon is further necessary in the northern part of the Bering Sea where a potentiality of maintaining a considerable yield of chum salmon is suggested.

Since 1964, the *Oshoro Maru* has carried out research cruises on the distribution of chum salmon in the northern part of the Bering Sea covering the Gulf of Anadyr, the Norton Sound and the vicinity of St. Lawrence Island. In her 1966's cruise, it was found that mature chum salmon predominated in the Gulf of Anadyr, whereas immature chum salmon appeared densely in the sea area beyond the Gulf of Anadyr and off Cape Navarin. Comparing fork length, body weight and other biological characteristics, immature chum salmon were subdivided into two populations. Namely one population, which was mostly composed of the three-year-old fishes, was found in the waters off Cape Navarian and the other, in which

the four-year-old fishes occurred dominantly was recognized in the sea area off the Gulf of Anadyr (Nishiyama et al. 1968).

In the early studies on scale of chum salmon, the main efforts were spent on the detection of indicators to identify the origin of chum salmon distributed on high seas in the northern part of the North Pacific Ocean. Particularly, a large amount of task for scale was made in request for dividing the limit of distribution of chum salmon gathered from both Asian and American origins. Along this line, the number, width or pattern of scale circuli as well as the proportion of width of scale to the number of circuli have been investigated on the samples collected from shores or on high seas by previous authors (Sato, Bilton and Shepard, 1958; Bilton, Shepard and Jenkinson, 1958; Bilton and Shepard, 1959; Sato, 1959; Бивен, 1961; Kobayashi. 1961). Available information hitherto published shows that measurement of growth of scale in the first year band is appropriate to discriminate geographical origin of descendants from eastern and western continents. At present, it is concordantly known that there is a tendency the more northern the origin is, the less the number in the first year scale circuli become, being irrespective of continental difference. It is also revealed that the difference of the number of scale circuli in the second year band takes place among the Asian and American origins; apparently the number is greater in the eastern than in the western origin.

In the present observation, our special attention is paid to discriminate chum salmon groups which were found in the three adjacent waters in the northern part of the Bering Sea.

At the locations F 21 and F 29, it was found that the mean fork length of three-age was larger in the male group than in the female one, whereas at other locations, it was indifferent between both sex groups according to statistical tests. Although secondary sexual character accompanying morphological difference of maturing fish should be minded, the surpassingness of the male over the female in fork length seems to be usual. For example, this is explained even in the immature groups at F 21 in which the male groups exceeded the female ones, though secondary sexual character had not yet been obviously disclosed. In accordance with the case of fork length, the mean body weight, not only including but also excluding the gonad weight, has been mostly found to larger in the male groups than in the female ones (Nishiyama et al. 1968). These results may indicate that the surpassingness of the male over the female both in fork length and body weight is derived from a fundamental phenomenon which reflects different growth rate by sex regardless of maturity. In spite of the difference of the mean fork length in the four-age groups between F 30 and F 31, the difference in number of scale circuli was negligible. In considering the similar number of scale circuli, it seems probable that the discrepancy in fork length was not attributed to the racial difference but to the difference of growth between the two fishing locations.

The analysis of the mean fork length for salmon groups caught in the three sea areas shows clearly that the chum salmon were divided into two immature groups and one mature groups. Nevertheless, the analysis of the mean number of scale circuli in the first year band resulted in the presence of only two groups, i.e. one immature and one mature group. On the basis of the assumption that the number of scale circuli makes it available to discriminate the origin of chum salmon, it may be admitted that the mature chum salmon in the Gulf of Anadyr was essentially distinctive in population from the immature groups which were obtained off the Gulf of Anadyr and off Cape Navarin. On this point, however, other characteristics of scale such as width, proportion of width to number of circuli and others should be studied.

The number of scale circuli in the first and second year band is very alike in the two immature groups in the two sea areas, off the Gulf of Anadyr and off Cape Navarin. The results bring about an interpretation that the two immature groups were not different but common in origin and might be regarded as the same population, though the mean fork length differed entirely from each other. If accepted, it is very likely that the immature chum salmon off Cape Navarin moved eastwardly to the sea area beyond the Gulf of Anadyr on the continental shelf. It is also probable that the different fork length between two immature groups was caused by the increment of growth during a period of ten or eleven days when fish moved. Stronger evidence, however, should be afforded on the assumption that the growth of the immature fish group was taken place in fork length during such a short term. Argumentation concerning whether or not the origin is the same in both immature groups will be proceeded in comparison with measurement of growth in the younger stage of respective fish groups.

Sato et al. (1958) describe that when chum salmon have common origin the number of scale circuli in the first year band does not differ among the fish groups even in different brooding years. It has been confirmed by the following studies (Bilton et al. 1958; Бивен, 1961; Kobayashi, 1961). If we accept this genetical participation, it appears that the similar number of scale circuli in the first year band between the three- and four-age groups, as found in the present observation, has the similar origin in both age groups. In other words, even though the brooding year is different, the fish groups which descended from a common origin inhabit the same water on high seas.

When comparing the count of scale circuli described by the previous authors (Sato et al. 1958; Bilton et al. 1958; Bilton et al. 1959; Bilton and Shepard, 1959; Kobayashi, 1961) with the number observed by the present examination, it seems probable that the immature chum salmon population found in the northern part of the Bering Sea has originated in more southern Asian regions than the fish population in the Gulf of Anadyr, judging from the small number of scale

circuli in the first year band. The determination of origin of both fish populations, however, is still suspended until the scales gathered from both continents in 1966 and consecutive years are observed. As reported previously (Nishiyama et al. 1968), it is considered that because of the geographical relation of fishing grounds to the condition of maturity of fish chum salmon in the Gulf of Anadyr were the spawners bound for the Anadyr River or its neighbouring streams. From the present observation, it becomes obvious that the scales of chum salmon collected in the Gulf of Anadyr in 1966 were characterized as being smaller in number in the first year band and rather larger in number in the second year band than those of the fish population off the Gulf of Anadyr and off Cape Navarin.

Summary

Fork length and number of scale circuli of three- and four-year-old fish of chum salmon which were captured in the Gulf of Anadyr, off the Gulf of Anadyr and off Cape Navarin during late July in 1966 were analyzed in relation to distribution of fish population in the northern part of the Bering Sea. Three peculiar values were obtained in mean fork length that corresponded to the respective sea areas, whereas the mean number of scale circuli designated two groups in the above sea areas. Similarity of the mean number of scale circuli implies that the fish groups in the waters off the Gulf of Anadyr and the fish groups off Cape Navarin derives from a same population. The fish groups in the Gulf of Anadyr differed from the above fish groups in both mean fork length and number of scale circuli, and were regarded as coming from a different population than the other groups.

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