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Some results of studying chum salmon in Ilyushin and Sernovodka rivers on the Kunashir Island (Kuril Islands)

by

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ABSTRACT

Data on the abundance of anadromous chum salmon and their fry migrating downstream the Ilyushin River, and those on size and age structure of chum salmon and their females fecundity from Ilyushin and Sernovodka rivers (Kunashir Island) are given in this paper. Differences in age, body sizes and fecundity between chum salmon migrating for spawning to the river (Ilyushin River) or lake-river (Sernovodka River) systems are shown. A tendency in condition improvement for chum salmon growth in the ocean after a period of long depression is supposed to be outlined.

INTRODUCTION

Chum salmon is a second by abundance species among Pacific salmon inhabiting the Kunashir Island waters. Despite the ancient history of its fishery, regular observations for the chum salmon reproduction have been started only in the 1990s. By this time period, chum salmon inhabiting the Kuril Islands waters was known to be of two ecological types. Chum salmon having a high stage of maturity and external breeding color changes spawn in small and shallow rivers typical for islands. At the same time, chum salmon migrating for spawning to the lake-river systems is widely presented on Kuril Islands. By the episodic observations, it differs both by the lesser stage of maturity and expression of external breeding color changes when entering fresh waters, and the larger body sizes (Ivankov, 1985), greater fecundity (Ivankov, Bronevsky, 1974), and larger body height relative to its length (Kaev et al., 1996). These two fish groups form different ecological types: a lake type and that of small rivers. Chum salmon of the lake ecological type is supposed to be at the stage of forming the lake race (Ivankov, 1984). In this connection, chum salmon has been studied in two rivers of the Kunashir Island ocean coast.

Both abundance and biological indices of adult fish and juvenile downstream migrants have been annually studied in the Ilyushin River. This is a typical island river (a main course is 9.3 km long), where common chum salmon spawning grounds make up 4 thousand m^2 (Kaev, Strukov, 1999). Biological indices of adult chum salmon have been studied in the Sernovodka River too. This river is a channel of about 4 km in length, along which chum salmon migrate from sea waters to the Peschanoye Lake where spawn, mainly, in a littoral zone of the lake and partly in small tributaries-brooks (Kaev, Ardavichus, 1984). Thus, the data collected during these years let us to characterize the interannual changes of some parameters of chum salmon reproduction as well as to show for the first time the peculiarities of forming a size-age structure and fecundity for chum salmon from different ecological types (river and lake) based on the long-term collections.

Abundance of spawning chum salmon in the Ilyushin River was determined by a total count of live and dead fish during the foot walk along the river in late October. The counted number of fish was multiplied by 1.5, compensating by this the undercount due to depredation and probable fish entries to the river during November. Sex, stage of maturity, fork length, body weight, and fecundity were studied in fish sampled from research river catches by means of beach seines (Ilyushin River) or gill nets with a full overlapping a channel (Sernovodka River). Age was determined by scales collected according to the accepted method (McLellan, 1987). Condition factor (CF) was calculated by the formula $CF = 100W/L^3$, where W is a total body weight (g), L is a length from tip of snout to a line joining tips of tail (cm). Fry migrants were captured with a fingerling seine; a total number of downstream migrants was determined by the method of sampling captures (Volovik, 1967). The collected data are given in the corresponding tables, where the following symbols are used: Mean is a mean value, S.D. is a standard deviation, R is a coefficient of correlation, Lim is extreme values of a character considered, ? is a level of a confident probability, and N is a sample size.

RESULTS AND DISCUSSION

Chum salmon spawning run to rivers is going formally over two months, because individual fish appear in rivers as early as the second half of September, and the last specimens continue to enter even in December. Nevertheless, the run of the major fish continues not more than one month; the mid-run occurs in the second half of October. Fish caught in October from the Ilyushin River (further – river chum salmon) and from the Sernovodka River (further – lake chum salmon) differed by stages of their gonad maturity. Thus, on average, during the years of observations the major male river chum salmon have entered the river with gonads at IV-V stages of maturity, and the lake ones at IV stage of maturity (Table 1). There are no such clear distinctions by stages of maturity between females, but when comparing age 0.3 fish at IV stage of maturity, one can see that the fast readiness for spawning at female river chum salmon results in the larger size of their eggs (236 ? 3.9 mg) compared to those at female lake chum salmon (178 ? 4.5 mg). On average, lake chum salmon were larger, especially males. Differences in body weights between river and lake fish were more significant, that is seen from the higher values of condition factor of the lake chum salmon (Table 2) due to their high-body constitution (Kaev et al., 1996). These data correspond to the previously obtained notion of differences between river and lake chum salmon. Nevertheless, a fecundity of female lake chum salmon was lesser, on average (Table 2), even in years when lake chum salmon were significantly larger than river specimens.

Indices given in Table 2 to a great extent were determined by their estimates for different-age fish and by the ratio between age groups in returns in different years. For the years of observation, fish from five age groups have been caught (Table 3). Among them fish at age 0.3 and 0.4 were the most abundant. A total proportion of age 0.2 and 0.5 fish rarely approached to 10 %, and age 0.1 fish were represented by one male captured from the Ilyushin River in 1999 (Kaev, 2002). In general, changes in age composition were similar. In one and the same years the increase in proportion of one of the dominating age groups: 0.3 (1994, 1997–1998, 2000–2002) or 0.4 (1995, 1999) occurred among river and lake chum salmon. But these increases were equal by their sizes not in all the years, that is

evidently associated with the interannual changes in chum salmon abundance in Ilyushin and Sernovodka rivers, but not with differences in dates of sampling. A coincidence of chum salmon age composition in such single-type rivers as Severyanka (episodic sampling) and Ilyushin in 1994-1995, 1997, where similar interannual changes in fish abundance have been noted (Kaev, Strukov, 1999), speaks in favor of such hypothesis.

Due to the absence of data on the factual chum salmon annual entering the Sernovodka River, we used a mean value of research catches per a night in individual years as an index of their abundance. For easy comparison, the mean estimates of annual chum salmon catches from the Sernovodka River and numbers of chum salmon entering the Ilyushin River are expressed in percentage to the corresponding average long-term estimates (Fig. 1). In 1993, chum salmon were not counted in the Ilyushin River. Table 3 did not illustrate the data on the relative abundance of chum salmon in 1994, because their high abundance in this year could be caused by the early cessation of fishery resulted from the catastrophic earthquake. Judging by the data (Fig. 1), the increase in numbers of chum salmon entries and their further decline occurred in Sernovodka River with one year in advance. Along with that, a high portion of fourth-year fish, reflecting the appearance of a brood year more abundant compared to previous one, was observed in the initial stage of growth in chum salmon returns. A one-year difference in development of these processes could be caused by differences in fry ecology: formation of juvenile “river” chum salmon abundance occurs in sea coastal waters, and that of “lake” ones in freshwaters of lakes, where they intensively feed, grow, and migrate to a sea later than chum salmon from rivers (Ivankov, Bronevsky, 1974; Kaev et al., 1996).

When comparing fish of identical age, the differences in body length and fecundity are clearly seen also for a general aggregate of species (Table 1): almost in all cases the “lake” chum salmon were larger, on average, than the “river” ones, but along with that during all years of observations a fecundity of lake chum salmon was lesser (Table 4). Perhaps, this peculiarity is also associated with the ecological peculiarities of fry from different ecological types, as far as significant differences in both fish length (Kaev, 1998) and fecundity (Ivankov, 2001) are laid at the early stages of ontogenesis.

By the results of counted captures of chum fry migrants from Ilyushin River, chum salmon downstream migration is determined to continue not less than two months. It begins in the second half of April and usually finishes in the first half of July. During this period changes in downstream migration intensity have not a single expressed peak like for pink salmon, because the dynamics of chum salmon downstream migration has a wavy character. These great migratory “waves” (without taking into account a small-periodical interdaily variability) in all cases occurred in the periods between full moons. During the period of a full moon, the intensity of downstream migration naturally decreased, that is the full moons served like boundaries between the passings of separate waves (Kaev, Romacenko, 2002). During the years of observations, from 1.2 to 4.1 million of chum downstream migrants have migrated from the Ilyushin River, that shows a comparatively high spawning efficiency of fish-parents (from 3.9 to 26.4 thousand) entering the river in these years (Table 5). The change in survival at the freshwater stage of reproduction (Fig. 2a) as well as in body length of the downstream migrating juveniles (Fig. 2b) was connected with the age of parents. Like for the Iturup Island chum salmon (Kaev, 2000), the increase in these indices has been noted for brood years from the older parents’ spawning (Fig. 2 illustrates the ageing of a spawning part of population as the increase in proportion of age 0.4 and older fish in the total chum salmon return). At the same time, a relationship between the considered parameters is closer for the Kunashir Island chum salmon, that can be associated with the lesser environmental “pressure” on the process of chum salmon reproduction in the rivers of Kunashir Island due to its softer climate.

In conclusion we can note that a process of deceleration in chum salmon growing in the ocean observed since the early 1980s (Kaev, 1994, 1999; Helle, Hoffman, 1995; Bigler et al., 1996; Kaeriyama, 1996) has not avoided the Kunashir Island chum salmon either. Thus, in 1980 the fourth-year chum salmon captured from the Sernovodka River were from 64 to 85 cm, averaged 73.1 ? 0.80 cm (49 ind.), and fifth-year fish from 73 to 89 cm, averaged 81.7 ? 0.77 cm (31 ind.). That is the chum salmon sizes were much larger compared to the last 10 years (Table 4). In this connection we need to note the occurrence of larger and much fertile fish in the recent-year returns, especially evident in the Ilyushin

River (Fig. 3). In addition, the age composition of chum salmon in returns has stabilized in the recent years in comparison with its great variability at the end of XX century (Kaev, 1999). Should these changes mean the approach of the new period in chum salmon reproduction associated with the improvement of feeding conditions in the eastern part of North Pacific?

Thus, the data obtained when studying the Kunashir Island chum salmon (1) have shown differences both in fish age and size structural formation, and in female chum salmon fecundity for different ecological types – river and lake; (2) have proved the earlier shown dependence (Kaev, 2000) of the abundance formation and body sizes of progeny (at the stage of fry downstream migrants) on the age structure of parents; (3) have given the arguments to assume that after the period of long depression, a trend of improvement in chum salmon growth in the ocean has appeared.

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Table 1. A percentage correlation of fish at different stages of maturity from chum salmon catches in Ilyushin (upper values) and Sernovodka (lower values) rivers, Kunashir Island, on average for 1994-1995, 1997-2002

Sex	Stage of maturity				N
	Ⅲ-Ⅳ	Ⅳ	Ⅳ-Ⅴ	Ⅴ	
Males	0.2	31.7	61.0	7.1	1123
	0.5	89.0	10.1	1.4	355
Females	0.2	81.2	9.7	8.9	913
	1.2	95.3	2.0	1.5	409

Table 2. Fork length (FL) and body weight, condition factor (CF) and absolute fecundity (AF) of chum salmon from catches in Ilyushin and Sernovodka rivers, Kunashir Island, on average for 1994-1995, 1997-2002

Indices	Sex	Ilyushin river		Sernovodka river	
		Mean	Lim	Mean	Lim
FL, cm	Males	65.8	62.7 – 68.8	68.2	64.1 – 71.5
	Females	64.6	61.3 – 66.9	66.4	62.9 – 69.2
Weight, g	Males	3264	2666 – 3631	3878	3144 – 4343
	Females	3157	2544 – 3408	3334	2761 – 3885
CF	Males	1.39	1.31 – 1.44	1.49	1.45 – 1.59
	Females	1.42	1.33 – 1.47	1.45	1.35 – 1.51
AF, eggs	Females	2346	1968 – 2580	2105	1807 – 2323

Note: ? ean – average long-term value, Lim – extreme average annual values

Table 3. Age composition of chum salmon from catches in Ilyushin and Sernovodka rivers, Kunashir Island, in different years

Year	River	Proportion (%) of fish at age				N
		0.2	0.3	0.4	0.5	
1993	Ilyushin	6.7	82.0	9.0	2.3	89
1994	Ilyushin	1.3	75.8	22.9	0	153
	Sernovodka	5.9	58.8	35.3	0	17
1995	Ilyushin	1.2	38.7	58.4	1.7	238
	Sernovodka	2.4	36.9	58.3	2.4	84
1996	Ilyushin	1.0	42.0	42.0	15.0	100
1997	Ilyushin	11.0	68.3	20.3	0.4	246
	Sernovodka	5.3	77.4	17.3	0	150
1998	Ilyushin	4.7	83.3	11.7	0.3	300
	Sernovodka	7.0	63.0	30.0	0	100
1999	Ilyushin	2.0	38.0	59.4	0.3	300*
	Sernovodka	0	25.0	71.7	3.3	120
2000	Ilyushin	7.0	53.0	37.5	2.5	200
	Sernovodka	6.0	73.0	19.0	2.0	100
2001	Ilyushin	7.7	58.0	34.0	0.3	300
	Sernovodka	5.5	69.9	24.6	0	73
2002	Ilyushin	2.0	76.7	20.3	1.0	300
	Sernovodka	0.8	70.0	29.2	0	120

* 0.3 % of fish (1 ind.) at age 0.1

Table 4. Fork length (FL) and fecundity of fourth-year and fifth-year female chum salmon from catches in Ilyushin and Sernovodka rivers, Kunashir Island, in different years

Year	Age	River	FL, cm			Fecundity, eggs		
			Mean	S.D.	N	Mean	S.D.	N
1994	0.3	Ilyushin	61.0	4.39	116	1811	422	24
		Sernovodka	63.1	4.33	10	2022	—	2
	0.4	Ilyushin	66.6	3.88	35	2594	481	6
		Sernovodka	65.3	2.67	6	1663	—	3
1995	0.3	Ilyushin	63.2	3.98	92	2165	390	19
		Sernovodka	66.4	4.26	31	2102	301	8
	0.4	Ilyushin	66.5	3.65	139	2183	421	45
		Sernovodka	71.5	4.40	49	2148	348	12
1996	0.3	Ilyushin	63.5	3.81	42	2122	300	11
	0.4	Ilyushin	66.2	3.98	42	2244	392	19
1997	0.3	Ilyushin	63.9	3.75	168	2201	413	64
		Sernovodka	65.1	4.08	116	—	—	0
	0.4	Ilyushin	68.2	4.51	50	2345	673	27
		Sernovodka	69.5	4.21	26	—	—	0
1998	0.3	Ilyushin	62.9	2.64	250	2278	356	93
		Sernovodka	64.7	4.41	63	1964	347	38
	0.4	Ilyushin	67.2	2.77	35	2273	489	17
		Sernovodka	67.8	4.11	30	2003	567	16
1999	0.3	Ilyushin	65.8	4.11	114	2470	429	34
		Sernovodka	68.2	3.45	30	2324	411	11
	0.4	Ilyushin	69.2	3.39	178	2529	367	76
		Sernovodka	71.0	3.43	86	2318	361	44
2000	0.3	Ilyushin	65.2	3.78	106	2349	444	45
		Sernovodka	64.0	4.81	73	1949	394	46
	0.4	Ilyushin	70.9	4.06	75	2616	502	35
		Sernovodka	71.3	3.38	19	2366	259	10
2001	0.3	Ilyushin	64.8	3.99	174	2576	401	74
		Sernovodka	65.1	5.45	51	2084	465	24
	0.4	Ilyushin	67.7	3.65	102	2633	493	52
		Sernovodka	70.0	4.69	18	2350	472	11
2002	0.3	Ilyushin	67.0	3.79	230	2581	469	86
		Sernovodka	65.8	3.61	84	2204	519	51
	0.4	Ilyushin	70.8	4.49	61	2595	411	25
		Sernovodka	71.2	4.65	35	2508	542	23

Table 5. Ratio between the numbers of chum salmon entering the Ilyushin River and numbers of fry downstream migrants

Numbers of chum salmon entering the river		Numbers of fry downstream migrants		
Year	Thousand ind.	Year	Thousand ind.	DMC, %
1990	26.4	1991	2214	6.7
1991	10.5	1992	1483	11.4
1994	10.0	1995	3933	39.1
1995	5.1	1996	4077	73.4
1996	4.3	1997	1744	37.1
1997	4.4	1998	1219	24.8
1998	5.0	1999	1211	23.7
1999	6.5	2000	3625	44.7
2000	4.2	2001	1640	31.7
2001	3.9	2002	1063	21.2

Note: A coefficient of downstream migration (DMC) was determined from a ratio of number of fry migrants to the total female chum salmon fecundity (nos. of females x average individual fecundity) in the Ilyushin River

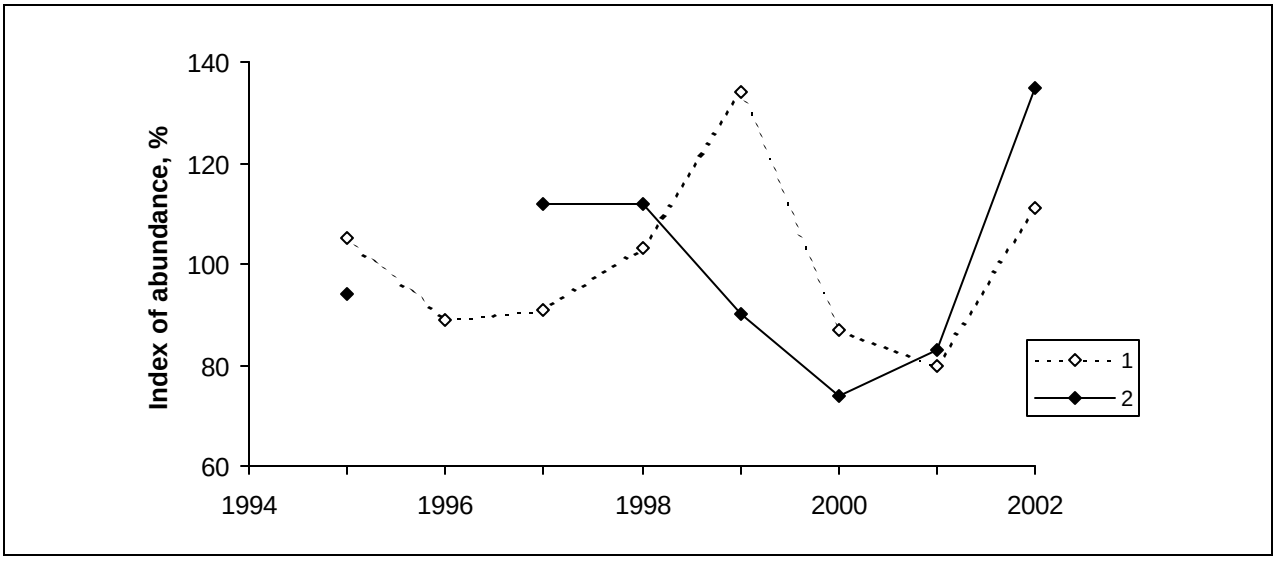

Fig. 1. Dynamics of indices of chum salmon abundance in Ilyushin (1) and Sernovodka (2) rivers, Kunashir Island

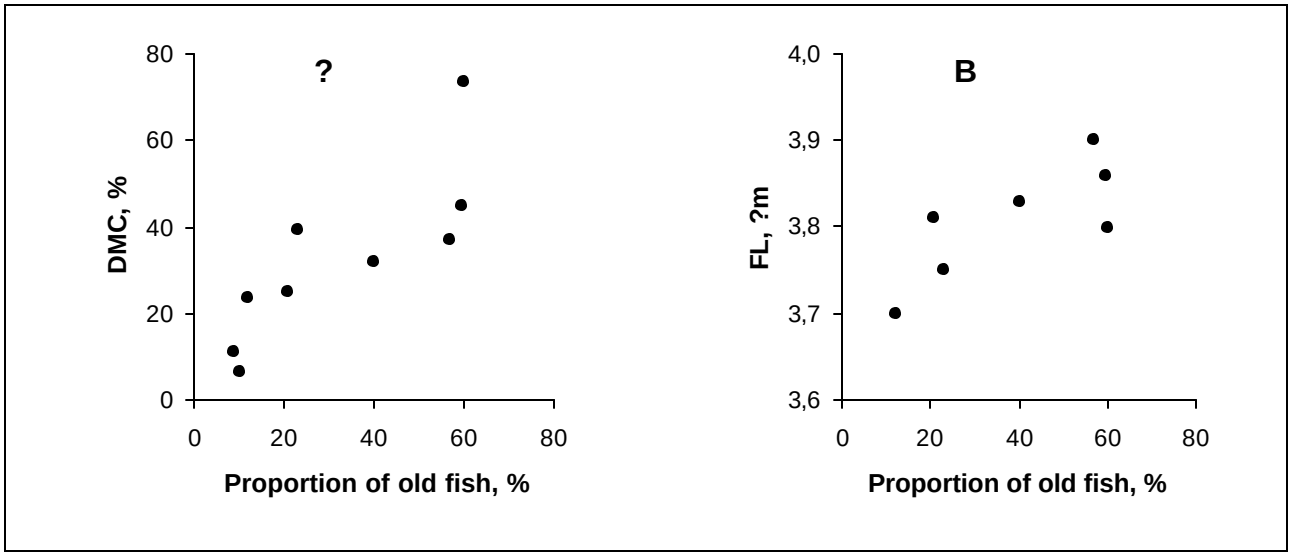

Fig. 2. Relationship between chum salmon spawning efficiency (A) and length of their fry (?) and the age of their parents in 1990-1991,1994-2000 in the Ilyushin River, Kunashir Island.

?: r = 0.82; P <0.01; n = 9. ?: r = 0.78; P <0.05; n = 7

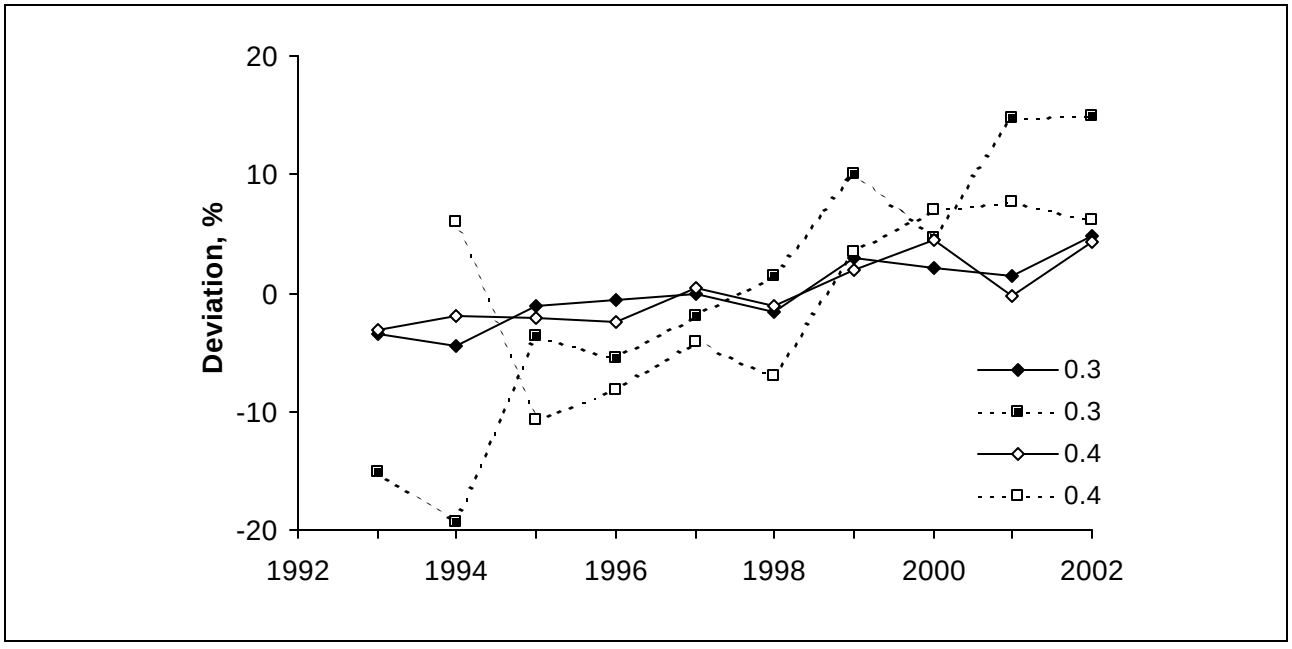

Fig. 3. Changes in mean values of fish body length (full line) and female fecundity (dotted line) for age 0.3 and 0.4 chum salmon from Ilyushin River in 1993-2002 in percentage deviations from the corresponding average long-term values