Bull. Fac. Fish. Hokkaido Univ.
38(1), 34-37. 1987.

Chromosomes of the Hybrids between Masu Salmon and Chinook Salmon

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Abstract

Chromosome preparations were made in order to describe the cytogenetic characteristics of the hybrids between masu salmon *Oncorhynchus masou* and chinook salmon *O. tshawytscha*. The diploid chromosome numbers were 66 for the masu salmon and 68 for the chinook salmon. Their hybrids showed the just intermediate karyotype equal to an exact sum of the haploid set from each parent species.

Artificial hybridization between masu salmon *Oncorhynchus masou* and chinook salmon *O. tshawytscha* led to successful fertilization rates and satisfactory high viability of the resultant hybrid embryos.[1] The F_1 hybrids of two year old age presented a hybrid vigor in their growth and surval potential and also showed an intermediate nature of numerical characters such as numbers of pyloric caecum and gill rakers.[1] These facts suggest an intermediate nature of cytogenetic constitution of the hybrids. The present study was carried out to descride exact number and morphology of the chromosomes in the viable hybrids between the masu salmon and the chinook salmon.

Materials and Methods

Hybrid specimens were the descendants from experimental crosses between masu salmon and chinook salmon in October, 1978. Parental masu salmon and chinook salmon were obtained from the Chitose Branch of Hokkaido Fish Hatchery as the control of the hybridization. Specimens for the chromosome preparations were from 7.0 cm to 11.7 cm in fork length and sampled at July, 1979.

The specimens were intramuscularly injected with a dose of 10 μg/g body weight colchicine. After 12-20 hours, they were killed and dissected to take their head kidneys. The tissue samples were treated for 50-60 minutes with hypotonic 0.075 M KCl solution and then fixed with Carnoy's fixative containing three parts of methyl-alcohol and one part of acetic acid for one hour or more. Chromosome preparations were made by the routine air-drying method and the chopping method[2]. Then the prepared slides were stained with Giemsa solution diluted to 30

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times by a phosphate buffer (pH 6.8). Karyological analyses were made according to the standard proposed by Levan et al.[3]

Results

As shown in Table 1, the modal number of chromosomes in masu salmon was 66 for all three specimens examined. Karyotype analysis revealed that the diploid complement consisted of 17 pairs of meta- or submetacentric, 12 pairs of subtelocentric and 4 pairs of acrocentric chromosomes (Fig. 1A and Fig. 2A).

The modal chromosome number of the chinook salmon was obtained as 68 in four specimens examined (Table 1). Karyotype analysis proved that the diploid complement consisted of 16 pairs of meta- or submetacentric, 14 pairs of subtelocentric and 4 pairs of acrocentric chromosomes (Fig. 1B and Fig. 2B).

Hybrids from masu salmon ♀ × chinook salmon ♂ and those from reciprocal chinook salmon ♀ × masu salmon ♂ had the modal frequency of 67 chromosomes (Table 1). The karyotype of these hybrids consisted of 33 meta-or submetacentric,

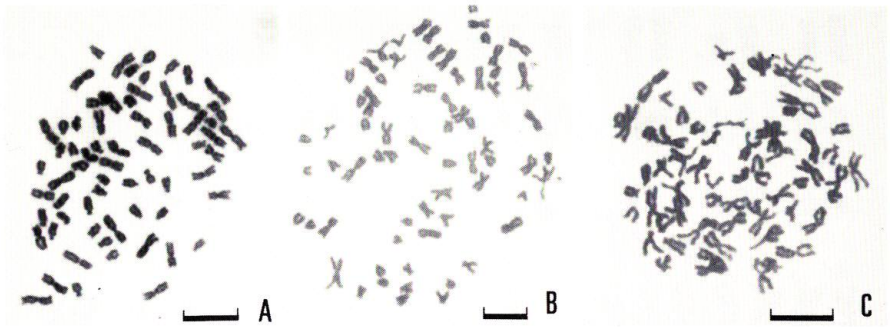

Fig. 1. Chromosome spreads of the masu salmon (A), the chinook salmon (B) and the hybrid between female chinook salmon and male masu salmon (C). Each scale indicates 10 μm.

Table 1. Ferquency distribution of chromosome numbers on the masu salmon, the chinook salmon and their bybrids.

Species	No.	Fork length (cm)	Sex	Chromosome numbers																	Total
				54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	
masu salmon	1	7.0	?						1						1	5			1			8
	2	11.5	?													1						1
	3	11.7	♂													2						2
chinook salmon	1	11.7	♂														3	6				9
	2	10.4	♂													2	2	9				13
	3	9.0	?				1					1			2			7				11
	4	8.2	♀									1					1	2				4
masu ♀ ×chinook ♂	1	7.5	?			1					1			1	1		3	1				8
	2	7.5	?								1	1	1	1	1	2	9					16
chinook ♀ ×masu ♂	1	10.2	♀	3	2				2		1	2	4	2	5	3	65				1	90
	2	10.5	♀						1				1		1		18					21

Fig. 2. Karyotypes of the masu salmon (A), the chinook salmon (B) and the hybrid between female chinook salmon and male masu salmon (C). Karyograms based on each spread in Fig. 1. m, sm, st and a denote meta- or submetacentric, subtelocentric and acrocentric chromosomes, respectively. Each scale indicates 10 μm.

26 subtelocentric and 8 acrocentric chromosomes (Fig. 1C and Fig. 2C). It was clear that the hybrid karyotype showed an exact sum of the haploid set from each parent species.

Discussion

The present results proved that the hybrids between the masu salmon and the chinook salmon had just an intermediate cytogenetic nature. Such an intermediate karyotype was generally recognized in other viable hybrids among salmonids[4,5]. The evidence of successful karyogamy between maternal and paternal genetic materials may give a reasonable interpretation both on the intermediate nature in the numerical characters and on the satisfactory high viability previously observed in one or two years old hybrids[1]. The present data, however, was limited to only masu × chinook hybrids which showed good survival and growth while the cytogenetics of individuals which died during the early embryogenesis was still unknown. It was reported that the aneuploidy was one of the cause responsible for the inviability in some interspecific hybrids[5]. The possibility of chromosome aberration in the masu salmon × chinook salmon individual which could not develop beyond the embryonic stages can not be excluded. Therefore, further detailed study including analysis of embryonic cells are requested to confirm the conclusive cytogenetic character of the masu salmon × chinook salmon hybrids.

It was reported that the masu salmon × chinook salmon F_1 hybrids showed a sign of maturation both in female and male individuals, but their gonadal development was less satisfactory regarding the number of mature gamates than those of the parental species[1].

Complete "gonadal sterility"[6] may be abscent in the masu salmon × chinook salmon hybrids, while a slight difference in the chromosome complement between masu salmon and chinook salmon may give rise to a failure of meiosis followed by the resultant "gametic" or "zygotic sterility"[6]. The cytogenetic mechanisms underlying the probable sterility of the hybrids is additional interesting problems in terms of the application of reproductive traits of the hybrids on aquaculture. Further effort to prove such a problem should be done in recent future.

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