魚類の細胞遺伝学的研究-3-カワハギStephanolepis cirrhiferにみられた複合性染色体

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CYTOGENETICAL STUDIES ON FISHES, III. MULTIPLE SEX CHROMOSOME MECHANISM IN THE FILEFISH, *STEPHANOLEPIS CIRRHIFER*[1)]

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The chromosome number of the female filefish, *Stephanolepis cirrhifer*, was thirty-four ($2n=34$), all of which were acrocentrics. In the males of this species, however, the number was thirty-three ($2n=33$), among which one large metacentric chromosome was always included. Haploid chromosome numbers in the secondary spermatocytes showed $n=16$ and $n=17$. In the former cells, one large metacentric chromosome found in the somatic and germ cells seemed to be a Y element. Thus, the sex chromosome mechanism in this species is inferred to be a multiple system, namely $X_1X_1X_2X_2$ in the female and X_1X_2Y in the male.

INTRODUCTION

In our previous study (Murofushi and Yosida 1979) the karyotypes of four species of filefishes including *Stephanolepis cirrhifer* have been reported. In that study the chromosome number of *S. cirrhifer* was $2n=34$, and all of the chromosome were acrocentric. The sex of the specimens at that time could not be identified because the specimens used were immature. Recently, matured female and male specimens could be obtained and their karyotypes were reexamined. This study found that the chromosome numbers of female specimens were different from the males and that the sex chromosome mechanism should be X_1X_2Y in the male. The present paper deals with the karyotypes of female and male specimens from somatic and germ cells in the filefish, *S. cirrhifer*.

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MATERIALS AND METHODS

Twenty-six mature specimens (♂11 and ♀15) of filefish, *Stephanolepis cirrhifer*, were used in the present study. They were obtained between May, 1978 and September, 1979, from the west coast of Izu Peninsula, Shizuoka Prefecture, and off the coast of Shimonoseki and Yanai, Yamaguchi Prefecture. The chromosome observations were carried out following our technique described previously (Murofushi and Yosida 1979).

RESULTS AND DISCUSSION

The diploid chromosome number in all females was 34 (Table 1), being characterized by all acrocentrics as already described (Murofushi and Yosida 1979). The modal diploid chromosome number in all males, however, was 33, and among them one large metacentric chromosome was always found in the karyotypes (Fig. 1). The metacentric element which was found in only male specimens seemed to be the Y element. If the species were characterized by the usual XY mechanism, the chromosome numbers in female and male would be the same. However, the odd chromosome number ($2n=33$) was usually found in the male, and one chromosome was always less in the male than in the female specimens. These chromosome complements strongly suggest that the males in this species have the X_1X_2Y sex determination mechanism. To confirm the above finding, the secondary spermatocytes during meiosis were observed. The chromo-

Table 1. Distributions of the diploid chromosome numbers in each specimen of the filefish, *Stephanolepis cirrhifer*

Females	$2n$						Total
Specimen No.	30	31	32	33	34	35	
1	3	2	2	7	39	1	54
2				3	33		36
3			1	2	31	1	35
4			1	5	54	4	64
5-15				6	104		110
Total	3	2	4	21	261	6	299
Males	$2n$						Total
Specimen No.	30	31	32	33	34	35	
1	1	5	11	59	2		78
2	2	2	11	66	2		83
3		5	15	22	1		43
4		1	3	54			58
5-11			2	68			70
Total	3	13	42	269	5		332

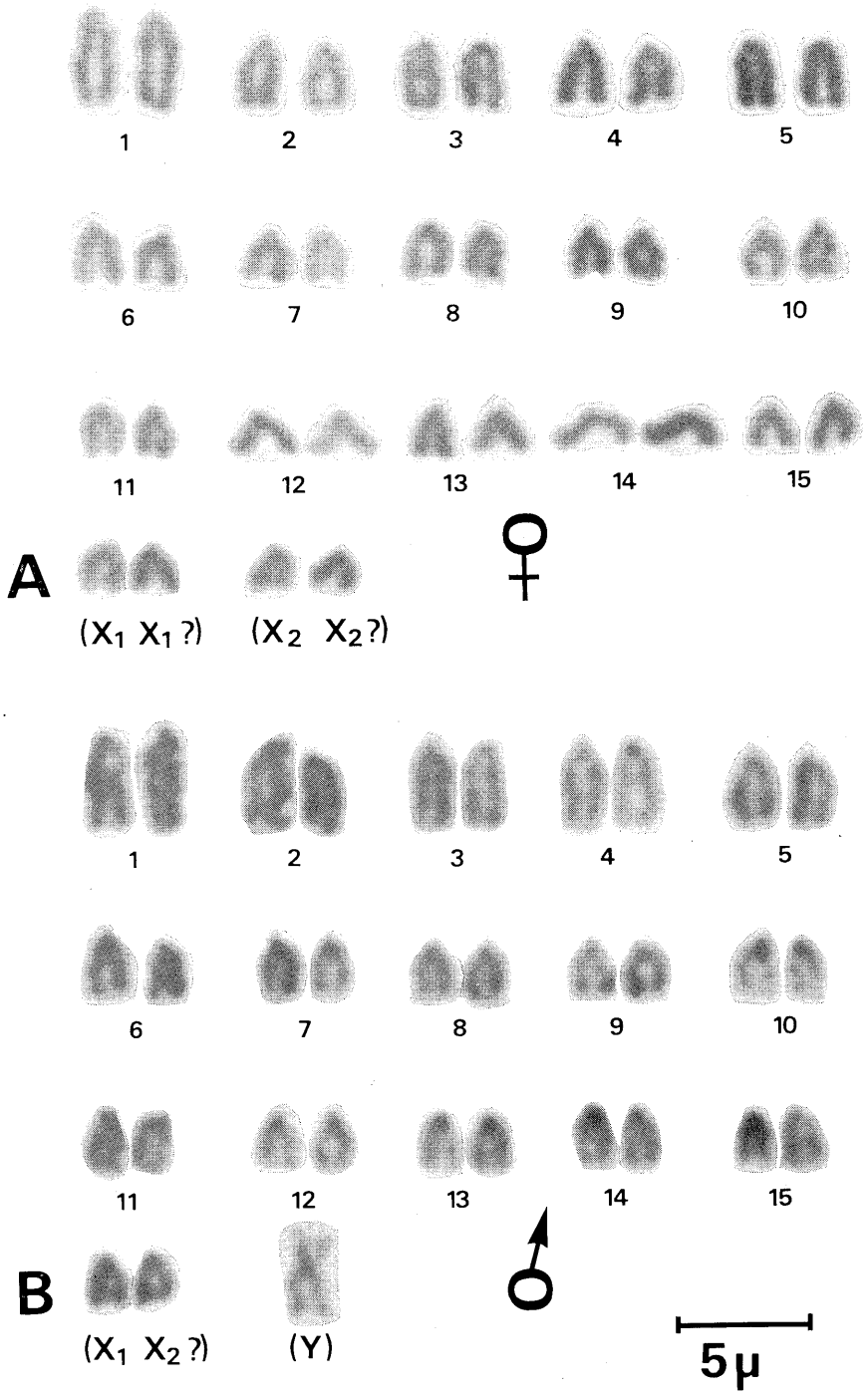

Fig. 1. Karyotypes of the filefish *Stephanolepis cirrhifer*. A, female, $2n=34$. B, male, $2n=33$.

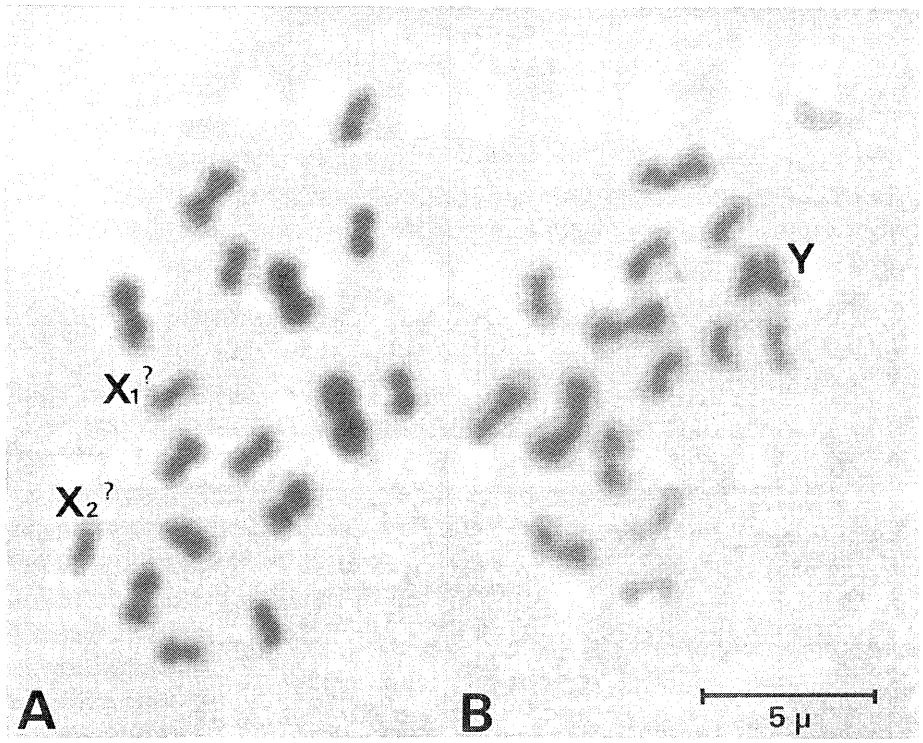

Fig. 2. Meiotic metaphases of the secondary spermatocyte in the filefish, *Stephanolepis cirrhifer*. A, $n=17$. B, $n=16$.

Table 2. Diploid and haploid chromosome numbers and the sex chromosome mechanism in the filefish, *Stephanolepis cirrhifer*

Sex	Diploid			Haploid		
	$2n$	Chromosome arms	Sex mechanism	n	Sex chromosome	No. of cells counted
Female	34	34	$X_1X_1X_2X_2$	17 (?)	X_1X_2 (?)	—
Male	33	34	X_1X_2Y	17 16	X_1X_2 Y	18 21

some numbers in the secondary spermatocytes were found to be of two types, $n=16$ and $n=17$ (Table 2). In metaphase II with 16 chromosomes, one metacentric was conspicuous (Fig. 2B), while in the cells with 17 chromosomes the metacentric was never observed (Fig. 2A). It seemed probable that the sex chromosome mechanism in *S. cirrhifer* is the male heterozygosity type having X_1X_2Y. The number of chromosome arms in the female and male specimens in this species was the same, i.e., thirty-four (Table 2). These results suggested that the metacentric Y chromosome has been derived from a Robertsonian fusion between an ordinarily acrocentric Y and one member of an acrocentric autosome pair, and that the remaining one became the X_2 element. Thus, this species has X_1X_2Y in the male and $X_1X_1X_2X_2$ in the female. As

we unfortunately could not discriminate the X chromosomes from the autosomes, the identification of the X_1 and X_2 shown in Figs. 1 and 2 is tentative.

Sex chromosomes of fishes have already been reported in some species. The first observation was described by Chen and Ebeling (1968) for one mosquitofish species. Later on, twenty-three species were reported by Chen (1969), Chen and Reisman (1970), Ebeling and Chen (1970), Yosida and Hayashi (1971), Uyeno and Miller (1971), Thorgaard (1977) and Park (1978). The sex chromosome mechanism in these cases was mainly XX-XY, but XX-XO, $X_1X_1X_2X_2$-X_1X_2Y as the male heterozygote and also ZW-ZZ as the female heterozygote were rarely reported. The X_1X_2Y mechanism found in the present material has been already reported in Mexican cyprinodontid fish by Uyeno and Miller (1971). On the origin of the multiple sex chromosome, they suggested to be derived from the fusion of sex chromosome and autosome. In the present materials (*S. cirrhifer*) it is also shown to be derived from the Robertsonian fusion of the X chromosome and the autosome. Generally speaking, the sex chromosome in the fishes is not morphologically differentiated, but the multiple sex chromosome is easily identified from the autosomes. Thus, the finding of the multiple sex chromosome mechanisms seems to be very available for the study on differentiation and evolution of sex chromosomes in the fishes.

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