

**Tetraploid Origin of the Karyotype
of the Asian Sucker,
*Myxocyprinus asiaticus***

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It is thought that the family Catostomidae evolved from a cyprinid-like ancestor in Asia (Miller, 1959). However, most of the members of this family, which comprises about 60 species, are now limited to North America and only two species are endemic to Continental Eurasia, including *Catostomus catostomus rostratus* (a subspecies of the North American *C. c. catostomus*; both fishes are sometimes classified as a single subspecies, *C. c. catostomus*) in eastern Siberia and *Myxocyprinus asiaticus* in China. Tetraploidy in North American suckers has already been verified (Beamish and Tsuyuki, 1971; Uyeno and Smith, 1972). Examination of the karyotype of *M. asiaticus*, therefore, would determine whether the entire family Catostomidae were tetraploid. It would also reveal influential data useful for clarifying whether the tetraploidization occurred in Asia or after the spreading of the animals to North America from Asia by crossing the Bering Straits land bridge which once existed in glacial times (Schultz, 1980).

Materials and methods

Five juvenile *M. asiaticus* individuals (3.0–5.5 cm in body size; sex not determined) were obtained from an aquarium fish dealer in Osaka. Prior to preparation of chromosome slides, injections of carp plasma were given twice into the dorsal musculature of each test fish (2% of body weight each time). The second injection was given 3 days after the first and the fish were then subjected to slide preparation the following day (this treatment was performed on the basis of descriptions given by Wallin and Gustavsson, 1969, and Ojima and Kurishita, 1980). The treatment was given in order to activate cell division in kidney tissue, by initiating an antigen-antibody reaction against heterologous proteins. Tissue samples were then taken from the kidney. The slide preparations

were made using an air-drying method after colchicine treatment, the test fish being given an intraperitoneal injection of colcemid at a dose of 1 $\mu\text{g/g}$ body weight 3 h prior to sacrifice. Air-dried slides were then subjected to Giemsa staining and silver staining for the nucleolus organizer regions (Howell and Black, 1980).

Results and discussion

Chromosome counts obtained from five *M. asiaticus* individuals using a total of 50 well-spread metaphase plates were: <95 (6 cells), 96–99 (10), 100 (27), 101–104 (4) and >105 (3). The sharp modal count of $2n=100$ indicated that this is the normal diploid number for this species (Fig. 1A). These chromosomes were classified into 6 metacentric, 8 submetacentric and 86 subtelocentric chromosomes according to their centromeric positions (Levan et al., 1964) (Fig. 2) and fundamental chromosome number (assigning a value of one to subtelocentric and acrocentric chromosomes and a value of two to metacentric and submetacentric chromosomes) was estimated to be 114. Morphological comparison of these chromosomes indicated that some of them were arranged into groups of two homologs. This possibility was also strongly supported by the images obtained by differential staining technique (Fig. 1B).

The karyotype of *M. asiaticus* already been revealed by Chinese workers (Li et al., 1983). In comparison with that report, the chromosome number revealed here coincided with them, while there are a little differences on the chromosomal complements.

Beamish and Tsuyuki (1971) have reported that two species of North American suckers (*Catostomus catostomus* and *C. commersoni*) have $2n=98$ chromosomes and, because of this high chromosome number, indicated the possibility that the ancestors of these fish once underwent duplication of their chromosomal complement. More accurate data indicating that North American suckers are tetraploid have been reported by Uyeno and Smith (1972). According to their report, 14 species of 8 genera in this family have $2n=96-100$ chromosomes and the DNA content of *C. commersoni* is almost twice that of a cyprinid fish, (*Clinostomus elongatus*). The



Fig. 1. Mitotic chromosomes of *Myxocyprinus asiaticus*. A: Metaphase spread showing a diploid number of 100. B: Silver staining metaphase. Two chromosomes (arrows) of a homologous pair showing dark staining nucleolus organizer regions.

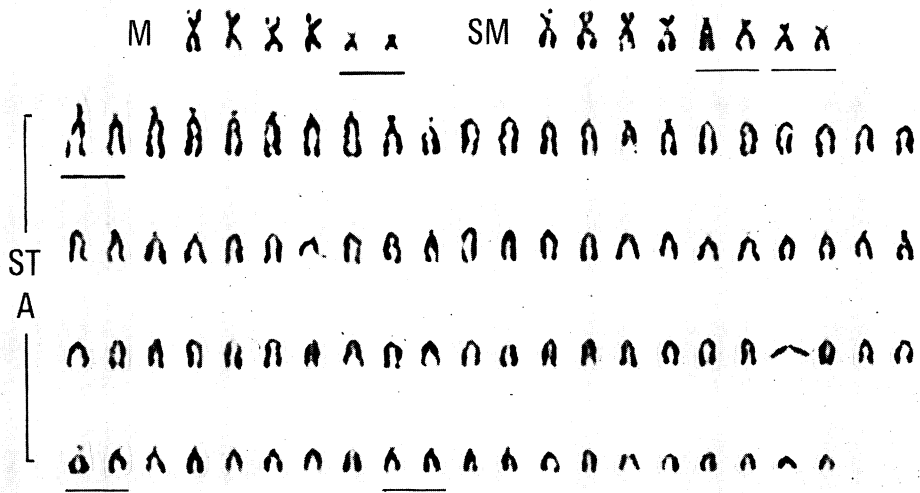


Fig. 2. Ideogram from Fig. 1A showing pairs of correct (thickly underlined) and probable (thinly underlined) homologous chromosomes.

results of the present study on a species of the Catostomidae, *M. asiaticus*, which has been preserved in Asia, confirmed that the entire family is of tetraploid origin. It is thought that Cycleptinae with two genera, *Cycleptus* and *Myxocyprinus*, is

most primitive amongst the subfamilies of the Catostomidae (Miller, 1959), so the study also suggested that the tetraploidization of this family occurred not in North America but in Asia, having a close relation to its rise.

Regarding the karyotypic differentiation after tetraploidization, two types occur in fish; conservative and progressive. Karyotypes of the sturgeon (Ohno et al., 1969) and paddle-fish (Dingerkus and Howell, 1976) (Acipenseriformes) belong to the former type and these maintain a state of homotetraploidy. Karyotypes of trout and salmon (Salmonidae), on the other hand, belong to the latter type, which progress toward diploidization containing two homologous sets of chromosomes (Ohno, 1970). The karyotype of *M. asiaticus* obviously belongs to the latter type from its complement.

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アジアのサッカー *Myxocyprinus asiaticus* にみられた 4 倍体起源の核型

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アジアのサッカー *Myxocyprinus asiaticus* の核型は、 $2n=100$ 、6つの中部着糸型、8つの次中部着糸型、および86の次端部・端部着糸型(2つの大形次端部着糸型は仁形成部を備える)染色体で成り立っていた。この結果は、本種が北米産サッカー科魚類と同様に4倍体起源の魚であり、サッカー科の4倍体化は本科全体に及ぶことを示した。サッカー科はアジアに進化起源の中心をもつとされており、また *M. asiaticus* は本科の内で原始的な種に属すると考えられている。したがってこの分析結果は、サッカー科の4倍体化がアジアにおいて生じたことを示唆するものといえる。*M. asiaticus* の核型には2つずつ対をなす相同染色体が認められたが、この点は本種の核型が2倍体化に向けての分化途上にあることをうかがわせた。

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