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The Chromosomes of a Catfish *Parasilurus aristotelis* from Greece

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Abstract The karyotype of the catfish, *Parasilurus aristotelis*, from Lake Trichonis, Greece, shows that the species has a diploid chromosome number of 2n=58. Comparison with published data on the karyotypes of other species belonging to *Parasilurus* shows the same chromosome number but different arm numbers. Reported karyological data of the European populations of *Silurus* indicate that they have a diploid number of 2n=60. A reduction in chromosome number is assumed to be connected with speciation and, therefore, *Parasilurus* probably forms a separate group from that of *Silurus*.

Parasilurus aristotelis (Agassiz, 1856) and *Silurus glanis Linnaeus*, 1758 are the only catfishes found in the freshwaters of Greece (Berg, 1949; Ladiges and Vogt, 1965). The status of *Parasilurus* is problematic. Haig (1950), in her review of the family Siluridae, regarded *Parasilurus* as a junior synonym of *Silurus*. Her revision was provisional and her conclusions was tentative, but Chen (1977) and Kobayakawa (1989) supported her revision based on studies of the external and anatomical characteristics of several catfishes. Some other authors simply reported *Parasilurus* as *Silurus* with no explanation at all. *Parasilurus aristotelis*, which is endemic to western central Greece, is the only known member of the genus *Parasilurus* reported to be found in Greece (see Economidis, 1972–73) and has not been studied karyologically. Five other members of the genus *Parasilurus* are found in Asia (Berg, 1949) and have been studied karyologically.

None of the species of Greek fish fauna has been examined karyologically. This study describes the chromosomes and karyotype of *Parasilurus aristotelis* from Lake Trichonis, Greece and compares them with the Asian species of the same genus.

Materials and methods

All specimens were caught during the spring of 1987 in fish traps as used by the local fishermen from Lake Trichonis, Greece and transported back to the laboratory alive. They had not reached full adult size and varied from 14 to 20 cm in total length. There were 8 females and 2 males.

The chromosome preparations were made using the method of Kang and Park (1973) and Ojima (1982). Karyograms were made from photographs of 7 very good metaphases and measurements made of the chromosome arm lengths using calipers to determine the centromeric positions as described by Levan et al. (1964). Thus, the chromosomes were designated as having one or two arms: those chromosomes with median or submedian centromeres in this paper called as biarmed and those with centromeres in terminal point as uniarmed. The short arms on subterminal chromosomes were included in counting the chromosome arm number.

The name *Silurus soldatovi meridionalis*, as mentioned by Hong and Zhou (1983), was used according to the classification of Chinese Siluridae by Chen (1977) who describes *Silurus meridionalis* as a subspecies of *Silurus soldatovi*. But Kobayakawa (1989) reports that the difference in the skull shape between these two forms is so great that they are believed to represent two distinct species. And the fact that *S. meridionalis*, as described by Chen (1977) and Kobayakawa (1989), like other *Parasilurus* species, has one pair of mandibular barbels, which is one of the diagnostic characters separating *Parasilurus* from *Silurus* having two pairs, shows the possibility of *Silurus meridionalis* being *Parasilurus meridionalis*.

Results

Chromosome number counts from 149 cells from the 10 individual fish varied from 50 to 62. The

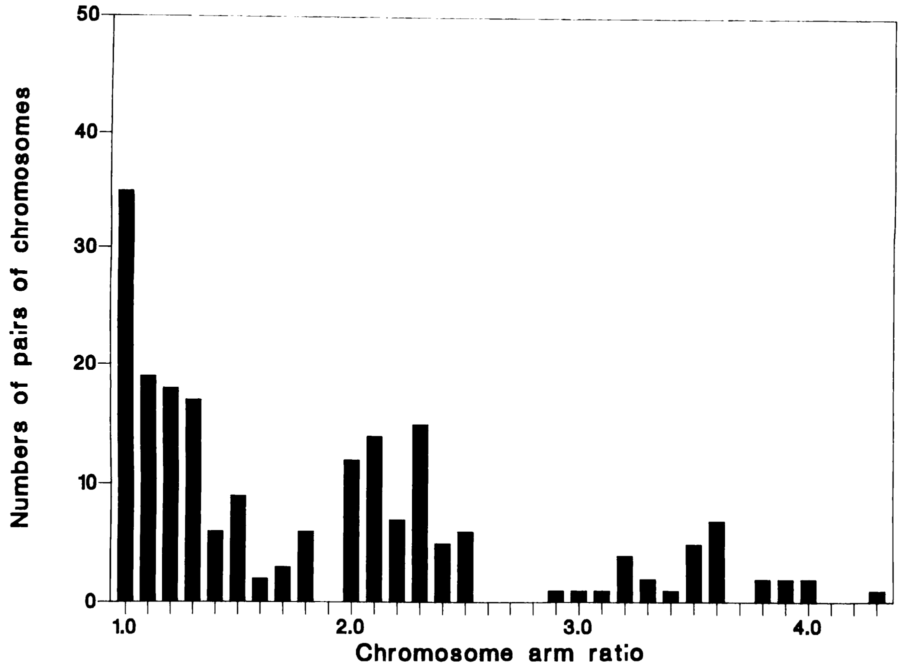

Fig. 1. Histogram of chromosome arm ratios plotted against total number of pairs of chromosomes from 7 karyograms of *Parasilurus aristotelis*.

modal value of 2n = 58 was seen in 55 percent of the cells examined. There was no evidence of polymorphism, including aneuploidy. Cells not showing modal counts were probably caused by loss during preparation or by chromosomes being obscured by surrounding cell nuclei. The number of cells with 2n > 58 was 8 percent and can probably be accounted for by chromosome breakage or additions from other nearby cells.

The measurements taken from 7 karyograms were used to calculate the ratios of the long arm: short arm and the mean and standard deviation for each pair of chromosomes. The mean ranges from 1.02 to 3.80 and the standard deviation ranges from 0.04 to 0.36. All the arm ratios from each pair of chromosomes from the 7 karyograms were plotted in a histogram (Fig. 1). The chromosomes were grouped into 3 categories: group A consisted of 15 pairs of chromosomes, each of which was characterized by a median centromere. Ten pairs of chromosomes forming group B were submedian in nature. The 4 pairs of chromosomes forming group C carry subterminal centromeres. Thus, all the chromosomes were scored as biarmed and the arm number (NF) was 116. Chromosomes pairs of each group were arranged according to size. It was not possible to further subdivide the groups of chromosomes as they showed a gradual decrease in size (Fig. 2).

The chromosomes ranged in size from 1.5 to 3.0 μm. Large secondary constrictions were observed on one of the first pair of metacentric chromosomes (Fig. 2), in 28 percent of the cells examined, which had 2n = 58 and which came from the 10 individual fish. This area is the site of the nucleolus organizer and is mainly apparent in less contracted metaphases (Goessens et al., 1987). There was no evidence of sexual dimorphism of the chromosomes.

Discussion

All available karyological data of the 6 species of the genus *Parasilurus* are summarised in Table 1, which shows that three different diploid chromosome numbers, 28, 58 and 60, have been observed. The most commonly reported diploid number for species in the genus *Parasilurus* is 58, as is shown in this study in *P. aristotelis*. *P. asotus*, *P. biwaensis*, *P. lithophilus* and *Silurus soldatovi meridionalis* from locations in Japan, Korea and China (Muramoto, 1969; Arai and Katsuyama, 1974; Kim et al., 1982; Hong and Zhou, 1983) also have a diploid number of 2n = 58, but *Parasilurus microdorsalis* is reported to

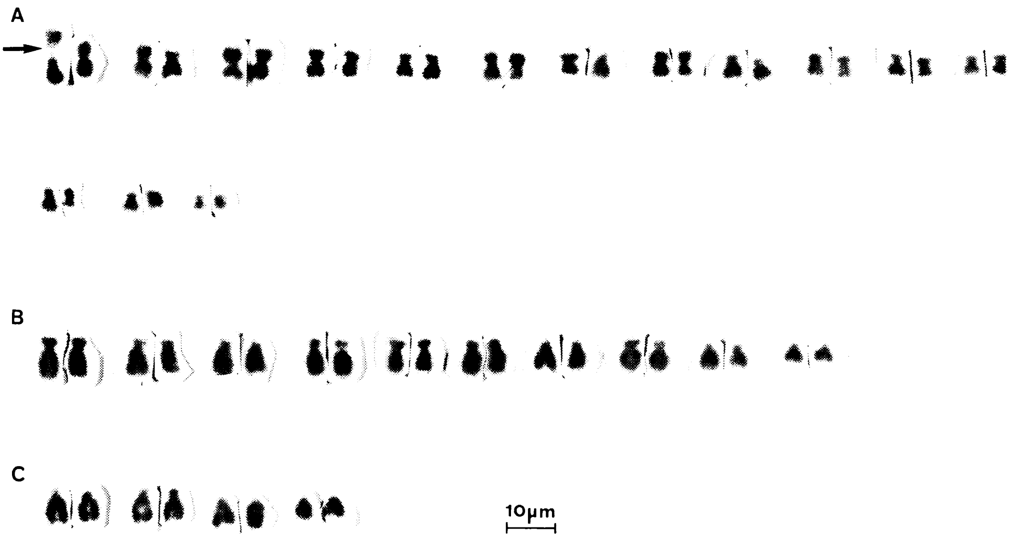

Fig. 2. Karyogram of *Parasilurus aristotelis.* Three groups (A–C) are recognized. Arrow indicates secondary constriction.

have a diploid number of 2n = 60 (Kim et al., 1982). Lee et al. (1983) reported 2n = 60 for *P. asotus* without any other notes and 2n = 28 for *P. microdorsalis* found only from 6 cells, but their data may not be accurate.

Parasilurus microdorsalis, having 2n = 60, differs from the other 5 species having 2 microchromosomes in its karyotype. Microchromosomes have not been observed in the karyotype of *P. aristotelis*.

The fact that the 5 other species of *Parasilurus* have the same diploid chromosome number 2n = 58, with similar chromosome sizes, but different karyotype suggests that chromosomal changes involved in, or associated with, speciation in these fishes probably did not include rearrangements in chromosome number, but include other rearrangements (e. g. centromeric shifts) which might have occurred in their separate evolutionary histories.

Table 1. Reported karyological data in the genus *Parasilurus* and *Silurus.* NF_1, ST as two-arm; NF_2, ST as one-arm.

Species	No. of individuals	No. of metaphases	2n	Arm number (NF_1)	(NF_2)	Chromosome type M	SM	ST	T	Micro	Author
Parasilurus asotus	3	35	58	—	102	—44—		—14—			Arai and Katsuyama (1974)
Silurus asotus	5	100	58	112	102	20	24	10	4		Hong and Zhou (1983)
P. asotus	10	>110	58	106	106	24	24		10		Kim et al. (1982)
	5	92	60	—	—	—	—	—	—		Lee et al. (1983)
	—	35	58	104	96	—38—		8	12		Muramoto (1969)
P. biawaensis	2	23	58	—	102	—44—		—14—			Arai and Katsuyama (1974)
P. lithophilus	1	43	58	—	102	—44—		—14—			Arai and Katsuyama (1974)
S. soldatovi meridionalis (*S. meridionalis*)	5	100	58	112	98	20	20	14	4		Hong and Zhou (1983)
P. aristotelis	10	149	58	116	108	30	20	8			present study
P. microdorsalis	4	>110	60	106	106	22	24		12	2	Kim et al. (1982)
	1	6	28	56	54	12	14	2			Lee et al. (1983)
S. glanis	—	100	60	100	100	18	22		20		Krasznai and Marian (1978)
	12	300	60	120	114	28	26	6			Rab (1981)
	4	50	60	—	98	—38—		—22—			Sofradzija (1982)
	3	—	60	108	94	16	18	14	12		Vujosevic et al. (1983)

Parasilurus asotus, *P. biwaensis*, *P. lithophilus* and *Silurus soldatovi meridionalis* demonstrated morphological homogeneity with respect to their general karyological characteristics, i. e. there are many biarmed and many monoarmed chromosomes. However, they are quite different in detail. Thus, *Parasilurus asotus*, which is the most studied species in the genus, may differ karyotypically from the other three species, but it also shows variations in the karyotype from different localities. The population found in China (Hong and Zhou, 1983) has a different karyotype from that of the 2 populations from Korea (Kim et al., 1982; Lee et al., 1983) and that of one of the 2 populations from Japan (Muramoto, 1969; Arai and Katsuyama, 1974). There are three different chromosome arm numbers varying between 104 and 112. This means variation by artificial factor or that there are 3 different morphological descriptions of the chromosome set for *P. asotus* (Table 1). The difference between these distinct populations may be due to incipient chromosomal evolution with the different environments being selective agents.

Similar karyotypic differences are seen amongst populations with the same diploid number of $2n=60$ of *Silurus glanis* from Czechoslovakia (Rab, 1981), Yugoslavia (Sofradzija, 1982; Vujosevic et al., 1983) and Hungary (Krasznai and Marian, 1978) (Table 1). These differences, according to Rab (1981), may reflect either the true geographical variability or some inaccuracy of chromosome class determination.

According to Kirpichnikov (1973), the karyotypic peculiarities of the most thoroughly studied groups of Teleostei (Salmonoidei, Cypriniformes, Cyprinodontiformes and Perciformes) bear out the relationship between the level of specialization and evolution of the fish genome. In some families of the order Cypriniformes, there is an evident, although not quite clear, tendency to reduction of chromosome number which can be observed for instance in some catfishes (suborder Siluroidei). It is assumed that in such cases the decrease in the number of chromosomes is connected with specialization (Kirpichnikov, 1973). Thus, we can hypothesize that the *Parasilurus* group, which have a diploid chromosome number of $2n=58$, forms a separate group from that of *Silurus* with $2n=60$ and is probably a new branch of the latter. This, however, leaves a questionmark concerning the position of *Parasilurus microdorsalis* with a diploid number of $2n=60$.

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ギリシア特産のナマズ科魚類 *Parasilurus aristotelis* の核型

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ギリシア特産のナマズ科魚類 *Parasilurus aristotelis* の核型は 2n＝58 で，中部着糸染色体 30，次中部着糸染色体 20，次端部着糸染色体 8 であった．本種とアジア産 *Parasilurus* 属 6 種の核型を比較し，*Silurus* 属 (2n＝60) と *Parasilurus* 属 (2n＝58) のちがいを核型から検討した．