

Karyology of the Marine Catfish *Bagre marinus* (Ariidae) with an Analysis of Chromosome Numbers among Siluriform Fishes

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Abstract *Bagre marinus* has a diploid complement of 54 chromosomes composed of 12 metacentrics, 8 submetacentrics, and the remainder with terminal or near-terminal centromeres. Karyotypes for three species of ariid catfishes (*Arius dussumieri*, *A. felis*, and *Bagre marinus*) indicate the same diploid number, but each species has a different arm number. Data for 132 species in 14 families of catfishes show a predominance of 56 ± 2 chromosomes in the diploid set. This range in diploid number is most common in the Ariidae, Bagridae, Ictaluridae, and Pimelodidae, which, together with the Doradidae (no karyotypes available), have been suggested, from osteology, as forming a group close to ancestral stock from which living catfishes evolved.

This report describes the chromosome complement for the gafftopsail catfish, *Bagre marinus*, a common inhabitant of inshore marine and brackish waters of the Gulf of Mexico, Caribbean Sea, and western Atlantic Ocean (Massachusetts to Cuba). The karyotype of *B. marinus* is compared with those for two other family members, *Arius felis* from the Gulf of Mexico (LeGrande, 1980) and *A. dussumieri* from the Indian Ocean (Rishi et al., 1983); data for ariids are, in turn, contrasted with information available for 129 species in 13 families of marine and freshwater catfishes.

Materials and methods

Live catfish were collected from the northern Gulf of Mexico in the vicinity of Grand Isle, Louisiana, on 15–17 September 1983 and 10–11 October 1985. The preparation of chromosome microslides followed procedures described by LeGrande and Fitzsimons (1976); counts and designation of chromosome types followed Uyeno et al. (1983). For selected spreads, calculations of arm ratios (long arm/short arm) and the percent each chromosome contributed to the total length of the complement (%TCL) was aided by the use of modified CHROMPAC software (Green et al., 1980) on an IBM Personal Computer and Sonic Accessories Corporation GP6-40 sonic digitizer. Other spreads were scored from camera lucida drawings and projections of photographic negatives. Fish used in this study were preserved as voucher specimens in the collection of fishes at the

Louisiana State University Museum of Zoology. Karyotypic data for siluriform fishes are summarized from LeGrande, unpublished, "Bibliography and Checklist of Chromosome Formulae in Fishes," a computerized information database including about 1,100 publications on fish karyology. Interpretations of chromosome data are based on the assumption that broadly distributed character states are plesiomorphic.

Results and discussion

Karyotype of *Bagre marinus*. Examination of 77 metaphase spreads from nine catfish indicated a diploid complement of 54 chromosomes (Fig. 1, Table 1). The single count above 54 probably represents two chromosomes recruited from a nearby spread during slide preparation or an atypical cell. Hypomodal counts are probably due to a loss of chromosomes during slide preparation. For most cells, an arm number of 74 (20 strongly biarmed chromosomes and 34 uniarmed elements) was recorded. Deviations from modal numbers of chromosome arms and types may indicate atypical cells but, more likely, are attributable to our inability to pinpoint centromere positions in contracted chromosomes. Modal numbers of biarmed chromosomes included 12 metacentric and 8 submetacentric chromosomes. Metacentrics were usually slightly smaller than submetacentrics. Contraction of chromosomes during slide preparation made it difficult to distinguish between chromosomes with terminal vs.



Fig. 1. Diploid chromosome complement of *Bagre marinus*. Bar represents 5 μ m. m, metacentric; sm, submetacentric; stt, subtelo-telocentric.

near-terminal centromeres; counts for these chromosomes were included in the single class subtelo-telocentric-telocentric. No sexual differences in chromosome numbers or configuration were noted. Differences in sizes (%TCL) and arm ratios between chromosomes in a graded series were too slight to allow accurate identification of homologues.

Ariid karyotypes. *Bagre marinus* has the same diploid chromosome number as *Arius felis* and *A. dussumieri*, but the three species differ from one

another in arm number (Table 2). Biarmed chromosomes form more than half the set for *A. dussumieri*, about half for *A. felis*, and somewhat less for *B. marinus*, but chromosome illustrations for the three species indicate that they have certain similarities in metacentric chromosomes. *Arius dussumieri* and *B. marinus* each have 12 metacentrics, and *A. felis* has 14. In the latter two species, these chromosomes are about half the size of the largest submetacentrics, and, in *A. dussumieri*, four pairs are small, one pair is large, and another pair is intermediate. The gradation from large to small chromosomes within karyotypes of these fishes indicates that a combination of fusion and non-fusion events has likely contributed to the evolution of their chromosome morphology. Large metacentric-submetacentric chromosomes about twice the size of the average chromosomes are usually attributed to the fusion of two chromosomes, while small to average-sized biarmed elements probably are derived from pericentric inversions in single chromosomes. In certain groups of fishes (e.g., goodeids—Uyeno et al., 1983; mugilids—LeGrande and Fitzsimons, 1976; and clupeiforms—Doucette and Fitzsimons, Ms), sharp differences in chromosome sizes make it possible to estimate the kind of chromosomal rearrangements that have occurred and to suggest with some confidence what the ancestral karyotype probably looked like. In ariid catfishes, the gradual decrease in size of chromosomes in both major classes (biarmed vs. uniarmed) would make this

Table 1. Distribution of chromosome counts in four males, three females, and two immatures of *Bagre marinus*. Parentheses indicate number of cells. Modal counts are in boldface. AN, arm number; m, metacentric; sm, submetacentric; stt, subtelo-telocentric.

Chromosome number		Chromosome type		
2n	AN	m	sm	stt
50 (3)	67 (1)	6 (1)	3 (2)	27 (1)
51 (2)	68 (1)	10 (6)	4 (1)	30 (5)
53 (4)	69 (1)	11 (1)	6 (1)	31 (3)
54 (67)	70 (2)	12 (50)	8 (42)	32 (3)
56 (1)	71 (1)	13 (1)	9 (1)	34 (40)
	72 (3)	14 (1)	10 (2)	35 (1)
	74 (42)		12 (4)	36 (2)
	76 (2)		13 (1)	45 (1)
	77 (1)		14 (1)	
	78 (3)			
	81 (1)			

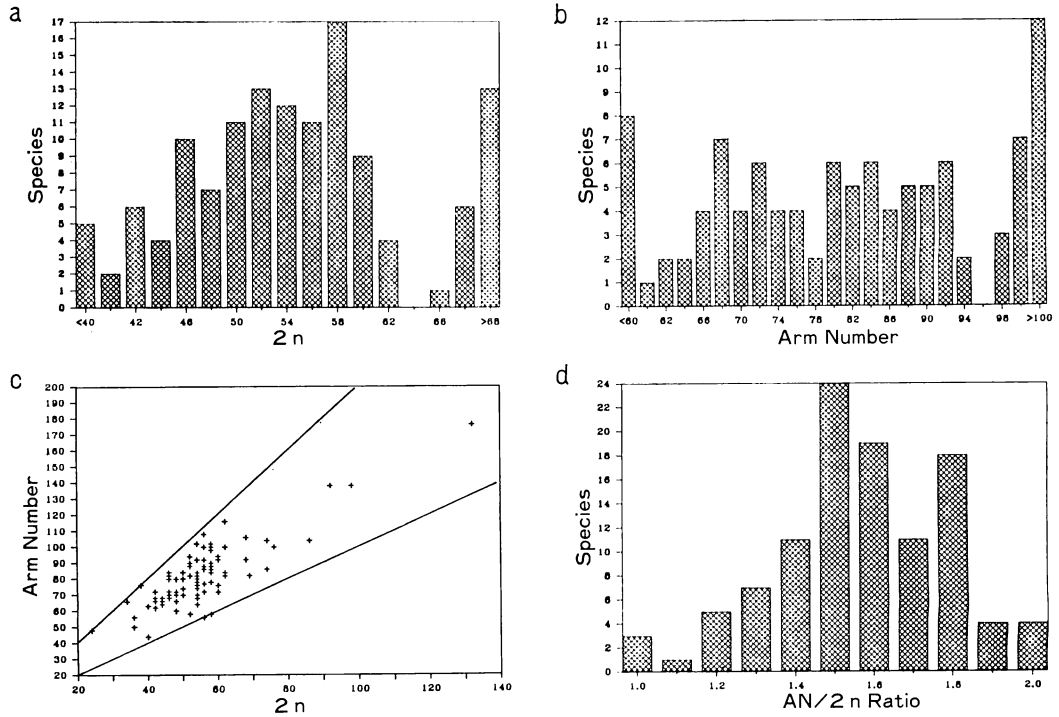


Fig. 2. Diploid numbers (a), distribution of arm numbers (b), diploid vs. arm number (c), and AN/2n ratios (d) for siluriform fishes. Diagonal lines in c indicate the theoretical limits of chromosomal variation in catfishes, with the upper line representing all meta-submetacentrics and the lower line, all subtelo-telocentrics.

Table 2. Chromosome complements of ariid fishes. AN, arm number; m, metacentric; msm, meta-submetacentric; sm, submetacentric; st, subtelocentric; stt, subtelo-telocentric; t, telocentric.

Species	2n	AN	m	msm	sm	st	stt	t	Reference
<i>Arius dussumieri</i>	54	84	12	18	18	12		12	Rishi et al., 1983
<i>A. felis</i>	54	80		26			28		LeGrande, 1980
<i>Bagre marinus</i>	54	74	12		8		34		present study

Table 3. Chromosome numbers in catfishes.

Family	Diploid number						Arm number				
	No. spp.	Min.	Max.	Range	Avg.	Mode	No. spp.	Min.	Max.	Range	Avg.
Amblycipitidae	2	24	34	10	29.0	—	2	48	66	18	57.0
Ariidae	3	54	54	0	54.0	54	3	74	84	10	79.0
Bagridae	29	38	60	22	53.4	52	23	56	108	52	86.6
Callichthyidae	19	44	132	88	65.9	46	15	66	176	110	94.4
Clariidae	4	50	56	6	53.5	56	3	58	88	30	73.3
Cranoglanididae	1	74	74	0	74.0	74	—	—	—	—	—
Heteropneustidae	2	56	58	2	57.0	56-58	2	58	86	28	72.0
Ictaluridae	34	40	69	29	50.9	42	34	62	100	38	76.0
Loricariidae	13	48	74	26	66.5	68	6	76	106	30	90.3
Pimelodidae	6	46	62	16	55.7	56	5	84	116	32	100.0
Plotosidae	2	36	48	12	42.0	—	2	56	60	4	58.0
Schilbeidae	3	58	66	8	60.7	58	2	88	98	10	93.0
Siluridae	10	40	86	46	59.4	58	9	44	104	60	86.2
Sisoridae	4	36	52	16	47.5	52	2	50	80	30	65.0
TOTALS	132	24	132	108	56.1	58	108	44	176	132	83.0

procedure largely a matter of speculation. However, we tentatively conclude that the diploid number for ariids is near the modal number (58) for most catfishes and may resemble the ancestral condition (see below).

Chromosome numbers among siluriform fishes. Interpretations of available karyologic data (Table 3) must be regarded as tentative; some families are represented by only a few species and one, the Callichthyidae, includes apparent polyploids. Diploid chromosome numbers for catfishes range from the mid-20's to well over 100 with most species having a diploid set in the mid-40's to upper 50's, with a modal $2n$ of 58 (Table 3, Fig. 2a). Arm numbers range from the mid-40's to upper 100's, but no clear modal number or range of numbers is suggested by the data (Fig. 2b). An increase (or decrease) in diploid chromosome number is associated with a concomitant change in arm number (Fig. 2c). Most species have karyotypes composed of a mixture of uniarmed and biarmed chromosomes; only a few have complements composed of all uniarmed or all biarmed elements (Fig. 2d). In a study of chromosomal evolution in ictalurid catfishes, one of us (LeGrande, 1981) noted that a diploid chromosome number of 56 ± 2 was widespread among 70 species of catfishes in 10 families and was especially frequent in four families, the Ariidae, Bagridae, Ictaluridae, and Pimelodidae. These observations are corroborated by data including an additional 62 species and four families (Table 3). An average diploid count of 56 and modal count of 58 for catfishes is approximated by the average and/or modal counts for ariids (all 54), bagrids (mostly 50–60, with a weak mode at 52), clariids (50, 52, and 56), ictalurids (mostly 56–60, with the exclusion of divergent karyotypes in *Noturus*), and pimelodids (mostly 56). LeGrande (1981) hypothesized an ancestral karyotype of $2n=58$ for ictalurids and pointed out that the closeness in this number to those reported for the Ariidae (one species), Bagridae (12), and Pimelodidae (6) coincides with Gosline's suggestion (1975a, b), based mainly on osteology, that these four families plus the Doradidae constitute a group near the ancestral stock from which living catfishes evolved. Karyotypes for doradids remain unreported, but this interpretation is not altered by new information for ariid (two species) and bagrid (17) catfishes.

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海産ナマズ的一种 *Bagre marinus* の核型とナマズ目染色体数の分析

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Bagre marinus の複相染色体数は 54 本で、12 本の中
部着糸染色体、8 本の次中部着糸染色体、および残りの

端部又は次端部着糸染色体からなる。ハマギギ科の 3 種
(*Arius dussumieri*, *A. felis*, *Bagre marinus*) の核型は同
じ複相染色体数を示しているが、おのおのの種の腕数は
異なっている。14 科 132 種のナマズ類の中では複相染
色体数が 56 ± 2 本のものが多く、この範囲の数は特に
ハマギギ科、ギギ科、Ictaluridae, Pimelodidae におい
て最もよく見られる。骨学的研究からも、これらの科に
Doradidae (核型は未知) を加えたものが、現生ナマズ
類の祖先型に近い 1 グループを形成すると考えられてい
る。