Karyotypic Variation Found among Five Species of the Family Platycephalidae

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Abstract Karyotypes of five species of the family Platycephalidae were analyzed in relation to morphology. The number of diploid chromosomes are 48 in all the five species. Structural modification by pericentric inversion is observed gradually from species to species. The most generalized karyotype in the family is represented by *Onigocia macrolepis*, in which all chromosomes are acrocentric. The greatest modification in karyotype was shown by *O. spinosa*. Robertsonian translocation of chromosomes was not found in the family. The genus *Onigocia* has been thought to be the most generalized group among the family Platycephalidae from the view point of morphology and biochemical aspects. However, the genus includes two extremes of karyotype, viz. the most generalized and specialized types.

Nearly thirty species of the order Cottiformes have been analyzed of their karyotypic features. Arai and Fujiki (1978) briefly reviewed the karyotypes of the group. Most of the species previously examined belong to two families, viz., Scorpaenidae and Cottidae. The diploid chromosome numbers of the fishes of the subfamily Sebastinae (Scorpaenidae) are 46 or 48 consisting of two or four metacentric and the remaining acrocentric chromosomes. It may be said that the karyotype of fishes of the subfamily Sebastinae is rather stable. While that of the family Cottidae varies from species to species ranging from 40 to 52 in 2n. Only three species have been analyzed in the remaining families of the order, i.e., Synanceiidae, Congiopodidae, and Platycephalidae.

In the course of karyotypic analysis of coastal fishes of Japan, we found a great variety among the fishes of the family Platycephalidae. Their karyotypes are described below.

Materials and methods

All materials were collected by SCUBA diving with a hand net from depths of 5 to 20 m except for *Platycephalus indicus* which was taken by a set net. Collection data and sizes of the five species are listed below (Table 1).

Each live specimen was injected with a solution of 0.3% colchicine, 0.03～0.06 ml/100 mm SL in dose, and kept for about 12 hours in an aquarium. Then the gills from the right side were removed and soaked in a hypotonic solution of KCl (N/200) for 30 to 45 minutes at room temperature. Gill tissues were fixed in Carnoy solution, and the remaining procedures were identical to those described by Ida et al. (1978).

Counts for branched caudal rays and vertebrae are based on radiographs. Identification of the species followed Matsubara (1955), Masuda et al. (1975), and Schultz et al. (1966). Classification of chromosomes followed Levan et al. (1964). Metacentrics and submetacentrics are treated as two-arm chromosomes and subtelocentrics and acrocentrics as one-arm chromosomes.

Thysanophrys chiltonae Schultz, represented by two specimens, is recorded for the first time from Japanese waters. Both specimens were collected at Kuroshima, Yaeyama Islands. Its diagnostic characters are described below. We propose the following new Japanese name for the species: kuroshimagochi (Fig. 1).

Thysanophrys chiltonae Schultz

Diagnosis. Vomerine teeth arranged in two parallel rows; cheek with two bony ridges, the lower less distinct; opercle with two spines; preopercle with three spines, the uppermost largest, lacking accessory spines

Fig. 1. Dorsal view of *Thysanophrys chiltonae*, 124.5 mm SL, from Kuroshima Island, Okinawa.

on its base; interopercle with a large hemicircular dermal flap on its lower margin; head and nape slightly scaled; anterior nasal with a moderate dermal flap; eye without ocular cirrus; iris with a finely branched lappet, lower pupil with three rounded cirri; anterior two lateral line scales bearing a spine; teeth all villiform, without canines; suborbital ridge without fine serrae below eye, several distinct spines on its ridge behind eye.

The present species is clearly distinguished from other species of the family Platycephalidae by the extremely large eye, 8.5~8.7% of SL or 23.3~24.5% of HL; narrow interorbital space; smooth edge of suborbital below eye; and a broad opercular flap. The present specimens agree fairly well with the original description except for the number of branched caudal rays counting 5+5 in our two cases while 4+5 in the original description.

Results

Frequency distribution of chromosome numbers for each species is shown in Table 2. The modal chromosome number is 48 in all the five species. Photographs of mitotic metaphase chromosomes and their karyotypes are shown in the two figures (Figs. 2, 3). Karyotypes with fundamental numbers and new arm numbers (Arai and Nagaiwa, 1976)

Table 1. Sampling data of the materials.

Species	Date	Locality	No. of specimen	SL (mm)	Method
Onigocia macrolepis	1978-4-4	Kumomi, Izu	1	72.8	hand net
	78-10-5	Futo, Izu	7	70.0~96.5	hand net
Onigocia spinosa	78-4-30	Miyake-jima, Tokyo	1	59.0	hand net
	78-8-20	Miyake-jima, Tokyo	1	69.0	hand net
	78-10-5	Futo, Izu	7	117.0	hand net
Thysanophrys chiltonae	78-11-18	Kuroshima, Okinawa	2	124.5~162.3	hand net
Inegocia guttata	78-10-6	Futo, Izu	1	280.0	hand net
Platycephalus indicus	78-10-1	Sanriku, Iwate	1	244.0	set net

Table 2. Distribution of chromosome counts for five species of the family Platycephalidae.

Species	Chromosome count											No. of cells observed
	40	41	42	43	44	45	46	47	48	49	50	
Onigocia macrolepis	1	1		1	1	2	1	2	13		1	23
Onigocia spinosa		2			1	1			9			13
Thysanophrys chiltonae			1					1	4			6
Inegocia guttata								1	4			5
Platycephalus indicus									2			2

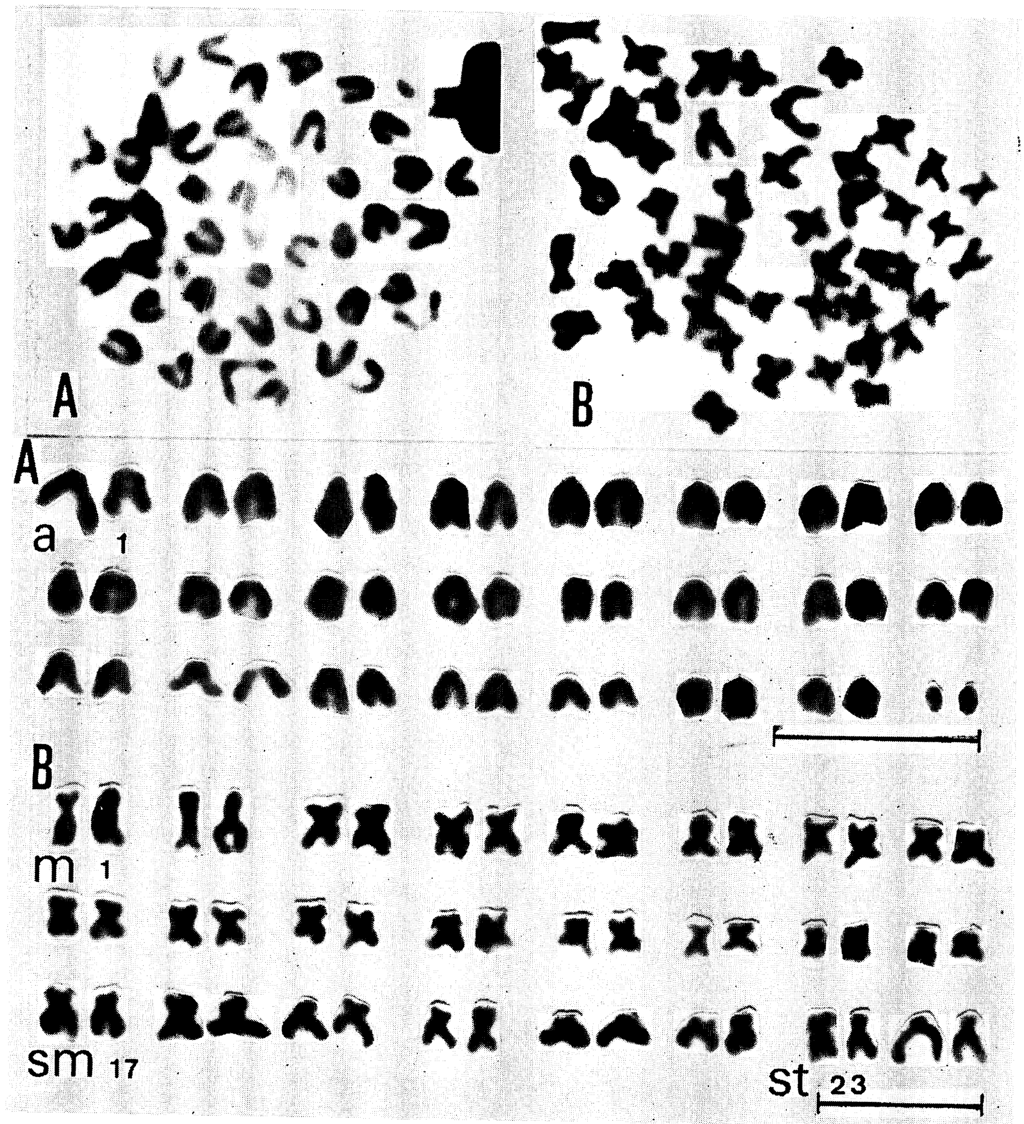

Fig. 2. Mitotic metaphase chromosomes and karyotype. A: *Onigocia macrolepis*. B: *Onigocia spinosa*. Each scale indicates 10 μm.

Table 3. Karyotypes of the five species of the family Platycephalidae.

Species	2N	Acro-centric	Subtelo-centric	Submeta-centric	Meta-centric	FN	NAN*
Onigocia macrolepis	48	48	0	0	0	48	48
Onigocia spinosa	48	0	4	12	32	92	48
Thysanophrys chiltonae	48	4	10	12	22	82	48
Inegocia guttata	48	12	6	10	20	78	48
Platycephalus indicus	48	40	6	2	0	50	48

* For details, see Arai and Nagaiwa (1976).

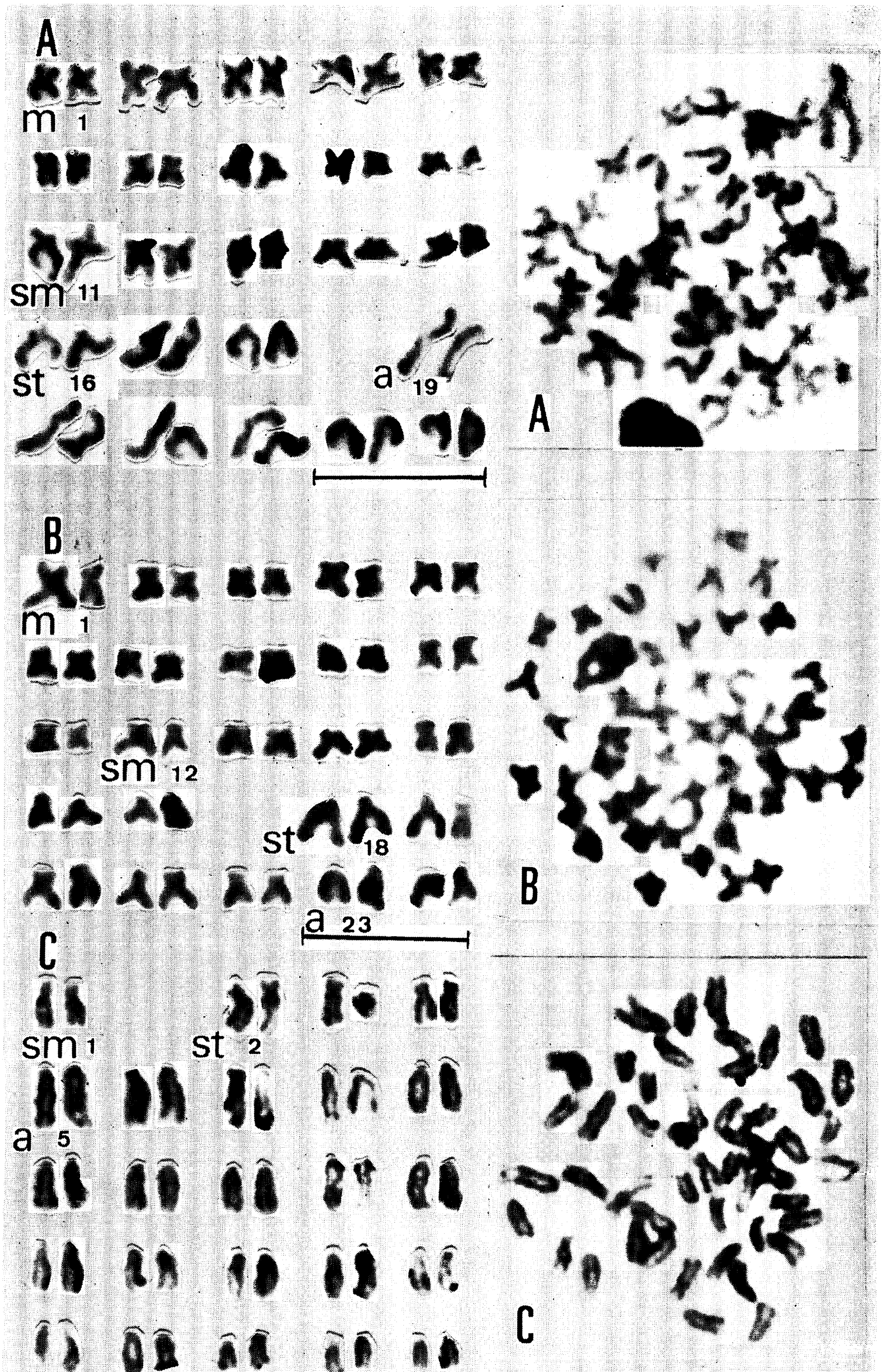

Fig. 3. Mitotic metaphase chromosomes and karyotype. A: *Inegocia guttata*. B: *Thysonophrys chiltonae*. C: *Platycephalus indicus*. Each scale indicates 10 μm.

are listed in Table 3.

Details of karyotype for each species are as follows:

Onigocia macrolepis (Bleeker) (Fig. 2A): Japanese name: Anesagochi. The karyotype of *Onigocia macrolepis* consists of only acrocentric chromosomes. The size of chromosomes decreases gradually except for the last pair, which is less than half the size of the 23rd pair.

Onigocia spinosa (Temminck et Schlegel) (Fig. 2B): Japanese name: Onigochi. The karyotype ot *Onigocia spinosa* consists of 16 pairs of metacentric, 6 pairs of submetacentric, and 2 pairs of subtelocentric chromosomes. The two pairs of metacentric (the 1st and 2nd) and the two subtelocentric (the 23rd and 24th) chromosomes are larger than the rest. The sizes of the rest decrease gradually.

Thysanophrys chiltonae (Schultz) (Fig. 3B): New Japanese name: Kuroshimagochi. The karyotype of *Thysanophrys chiltonae* consists of 11 pairs of metacentric, 6 pairs of submetacentric, 5 pairs of subtelocentric, and 2 pairs of acrocentric chromosomes. Size of the largest submetacentric (12th) and the 3 pairs of subtelocentric (18～20th) chromosomes are larger than the rest.

Inegocia guttata (Cuvier) (Fig. 3A): Japanese name: Wanigochi. The karyotype of *Inegocia guttata* consists of 10 pairs of metacentric, 5 pairs of submetacentric, 3 pairs of subtelocentric and 6 pairs of acrocentric chromosomes. The size of chromosomes decreases gradually, but the smallest metacentric (10th) and the 24th acrocentric chromosomes are smaller than those anterior to them.

Platycephalus indicus (Linnaeus) (Fig. 3C): Japanese name: Kochi. The karyotype of *Platycephalus indicus* consists of 1 pair of submetacentric, 3 pairs of subtelocentric, and 20 pairs of acrocentric chromosomes. The difference of chromosomes in size is very gradual and there is no abrupt change.

Meristic characters, such as fin ray counts, number of lateral line scales, and vertebral composition, are shown in Table 4. As can be seen from the table, the vertebrae are composed of 12 abdominal and 15 caudal vertebrae in *Onigocia macrolepis* and *Platycephalus indicus* and 11 and 16 in *Thysanophrys chiltonae* and *Inegocia guttata*. *Onigocia macrolepis* shows both types of vertebral composition. The number of branched caudal rays are 5+5 in all except for *Inegocia guttata Platycephalus indicus* both which have 6+5 branched rays. The differences in counts for gill-rakers, dorsal and anal fin rays between species are not distinct. The most striking difference between species is found in the count for lateral line scales. The smallest count was observed for *Onigocia spinosa* followed by *O. macrolepis*, *Thysanophrys chiltonae*, and *Inegocia guttata* in order. The greatest count was observed for *Platycephalus indicus*.

Discussion

Karyotypes of species of the family Platy-

Table 4. Selected meristic characters of the five species of the family Platycephalidae.

Species	Dorsal rays*	Pectoral rays	Anal rays	Branched caudal rays	Lateral line scales	Gill-rakers	Vertebral composition Abdom.+Caudal=Total
Onigocia macrolepis	VIII-11～12	17～20	13	5+5	48～50	1+1+3～4	11+16=27 12+15=27
Onigocia spinosa	VIII～IX-11	19～20	11～12	5+5	37～40	1+1+3	12+15=27
Thysanophrys chiltonae	VII～VIII-11	20～21	11	5+5	52～55	1+1+4～5	11+16=27
Inegocia guttata	IX-11	21	11	6+5	55	1+1+4	11+16=27
Platycephalus indicus	VIII-14	18	14	6+5	76	2+1+7	12+15=27

* Most authors discriminate the anteriormost one or two dorsal spines from the remaining ones, but we observed a very gradual degree of incization of the dorsal fin membrane and there is little difference between the shape and the interval of proximal pterygiophores. We combined the first one or two spines with other spines.

cephalidae show a rather wide variation. The most generalized formula is represented by *Onigocia macrolepis* in which all chromosomes are acrocentric, while the most specialized type is represented by a species of the same genus, *O. spinosa*. The karyotype of *Platycephalus indicus* follows *O. macrolepis* in simplicity, but 8 chromosomes are modified slightly by pericentric inversion to submeta- or subtelocentric chromosomes. Two species, viz. *Thysanophrys chiltonae* and *Inegocia guttata*, intervene between *O. spinosa* and *P. indicus*.

Natarajan and Subrahmanyam (1974) reported karyotype of *Platycephalus indicus* as having 19 pairs of median and 5 pairs of submedian chromosomes. However, judging from their figures, the karyotype consisted of 18 acrocentric and 6 subtelocentric or submetacentric chromosomes. Thus there is a slight difference in karyotype of *Platycephalus indicus* between the present results and their report. At present, it is not clear that the difference is caused by artifact or by actual difference of the materials.

From the view point of osteology, Matsubara and Ochiai (1955) studied the phylogeny of the family Platycephalidae and placed *Platycephalus* as the most specialized genus and *Onigocia* as the most generalized one. Their conclusion was reinforced by the analysis of muscle protein and some isozymes by electrophoresis (Taniguchi et al., 1972). From the karyological point of view, there seems to be a general tendency that any structural change in chromosomes will be accompanied with some morphological modifications. For example, among the family Salmonidae, reduction in the number of chromosomes by Robertsonian translocation occurs together with morphological specialization. Among the family Pomacentridae, the degree of modification of karyotypes by pericentric inversion seems to be related to specializations in morphology, especially in the reduction of squamation (Arai and Inoue, 1976; Arai et al., 1976).

If the morphological specialization is represented by the reduction of scale size, it would be expected that members of the genus *Platycephalus* have the most specialized karyotypes and those of the genus *Onigocia* have the most generalized ones among the family Platycephalidae. The results of our experiments are rather complicated. The karyotype of *Platycephalus indicus* is less specialized, but the karyotypes of the genus *Onigocia* show both extremes, most generalized and specialized types, as mentioned above.

The fundamental number of chromosomes varies from 48 observed for *Onigocia macrolepis* to 92 for *O. spinosa*. The size of chromosomes within each species changes gradually and there is no clear-cut size difference of chromosomes caused by Robertsonian translocation. The NAN (new arm number, Arai and Nagaiwa, 1976) is 48 for all species. Thus, the relation between change in lateral line scale numbers and karyological change in the family Platycephalidae is not clear. At present, it may be said that the striking difference in karyotypes found among the genus *Onigocia* suggests the possibility of the heterogeneity of the group. Data from this viewpoint seem to be needed for the analysis of karyotypic variety.

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コチ科魚類5種に認められた核型の変異

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本邦産コチ科魚類5種の核型を air-drying 法により分析した．染色体数はいずれも $2n=48$ で，核型はアネサゴチで端部着糸型染色体 (A)=48; オニゴチで A=0, 次端部着糸型染色体 (ST)=4, 次中部着糸型染色体 (SM)=12, 中部着糸型染色体 (M)=32; クロシマゴチ（新称）で A=4, ST=10, SM=12, M=22; ワニゴチで A=12, ST=6, SM=10, M=20; コチで A=40, ST=6, SM=2, M=0 であった．形態面では上記の順に側線鱗数が多くなっているが，この形質と核型の特化には関連性が認められなかった．松原・落合 (1955) によるとアネサゴチ属がコチ科では最も普遍的な属とされているが，同属の2種の核型には最も普遍的なものと最も特化したものとが認められた．なお *Thysanophrys chiltonae* は本邦からの初記録でありクロシマゴチの新称を与えた．

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