

Chromosomes of Nine Species of Chaetodontidae and One Species of Scorpidae from Japan

By

Ryoichi ARAI

Department of Zoology, National Science Museum, Tokyo

and

Masayuki INOUE

College of Agriculture and Veterinary Medicine, Nihon University, Tokyo

Recently many studies of fish chromosomes have been reported (PARK, 1974), and karyological approach to fish systematics has become more valuable. As far as we know, however, we have no karyological data of butterflyfishes in the world.

As we had the chance to examine chromosomes of nine species of the family Chaetodontidae including four genera, *Pomacanthus*, *Centropyge*, *Megaprotodon* and *Chaetodon*, the results of the observation are described in the present paper.

On the other hand, *Microcanthus strigatus* had been placed in the family Chaetodontidae before FRASER-BRUNNER (1945) changed its systematic position from Chaetodontidae to Scorpidae. For karyological comparison with butterflyfishes, we also carried out the chromosome examination of this species.

Method of chromosome preparation is the same as that of ARAI and KATSUYAMA (1973).

Classification of chromosomes is adopted from LEVAN *et al.* (1964). Metacentrics and submetacentrics are described as two-arm chromosomes, and subtelocentrics and acrocentrics as one-arm chromosomes.

All the specimens used for the experiments are deposited in the fish collection of the Department of Zoology, National Science Museum, Tokyo.

Pomacanthus semicirculatus (CUVIER) "Sazanami-yakko"

(Plate 1, figs. 1 and 3)

A specimen, 43.5 mm in total length, was collected from Kusugô (30°25'N, 130°36'E), Yakushima Island, and another specimen, 73.8 mm in total length, from Shimama (30°28'N, 130°52'E), Tanegashima Island, off southern Kyushu (Table 1).

As shown in Table 2, the diploid chromosome number is 48. The karyotype of this species comprises 24 pairs of acrocentric chromosomes. The chromosomes are comparable in appearance and show a gradation in size that makes it impossible to arrange them in size groups. The arm number is 48.

Table 1. Characters of ten species of material fishes.

Species	No. of fish	S.L. (mm)	D	A	VN
Chaetodontidae					
<i>Pomacanthus semicirculatus</i>	2	34.8–60.0	XIII, 21	III, 19	10+14
<i>Centropyge vrolikii</i>	1	80.1	XIV, 16	III, 16	10+14
<i>Megaprotodon strigangulus</i>	2	54.0–83.0	XIV, 15	IV, 14	10+14
<i>M. plebeius</i>	1	43.8	XIV, 16	IV, 15	10+14
<i>Chaetodon auriga</i>	1	88.0	XIII, 22	III, 19	10+14
<i>C. vagabundus</i>	2	64.3–66.0	XIII, 24	III, 19	10+14
<i>C. trifasciatus</i>	1	52.5	XIII, 20	III, 19	10+14
<i>C. collaris</i>	3	38.1–55.5	XII, 23–24	III, 19–20	10+14
<i>C. lunula</i>	1	46.0	XII, 24	III, 18	10+14
Scorpidae					
<i>Microcanthus strigatus</i>	5	36.7–50.6	XI, 16	III, 14	10+15

***Centropyge vrolikii* (BLEEKER) “Namera-yakko”**

(Plate 1, figs. 2 and 4)

A specimen, 98.0 mm in total length, was caught at Kusugô, Yakushima Island (Table 1).

The diploid chromosome number is 48 (Table 2). The karyotype comprises 24 pairs of acrocentric chromosomes. In size, one-arm chromosomes show a gradation from largest to smallest, hence cannot be easily divided into size groups. The arm number is 48.

***Megaprotodon strigangulus* (GMELIN) “Yari-katagi”**

(Plate 2, figs. 1 and 3)

Two specimens, 64.0 and 96.0 mm in total length, were collected at Yonehara (24°27'N, 124°11'E), Ishigaki Island, southern Ryukyus (Table 1).

As shown in Table 2, the diploid chromosome number is 48. The karyotype comprises a pair of submetacentric, and 23 pairs of acrocentric chromosomes. The arm number is 50. The karyotype of this species differs from those of *Pomacanthus semicirculatus* and *Centropyge vrolikii* by arm number.

***Megaprotodon plebeius* (CUVIER) “Sumitsuki-tonosama-dai”**

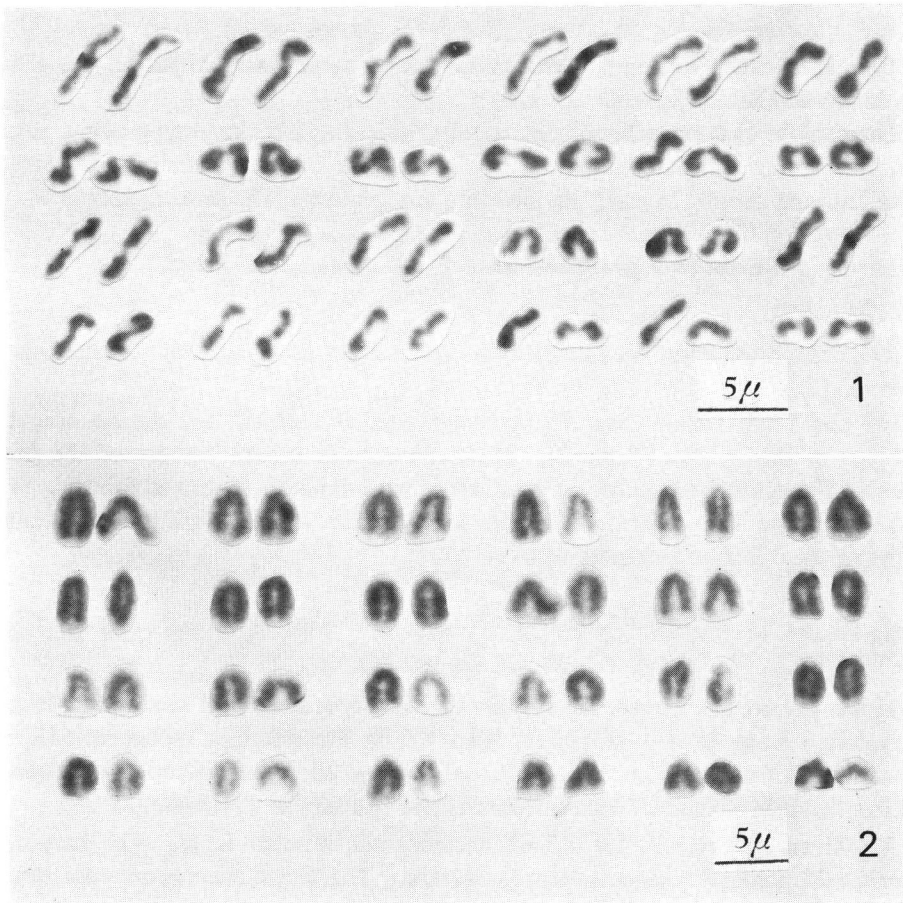
(Plate 2, figs. 2 and 4)

A specimen, 53.0 mm in total length, was caught at Shimama, Tanegashima Island (Table 1).

The diploid chromosome number is 48 (Table 2). The karyotype comprises a pair of metacentric, and 23 pairs of acrocentric chromosomes. The arm number is 50. The karyotype of this species agrees well with that of *M. strigangulus* in arm

Table 2. Frequency distributions of diploid chromosome counts in ten species of chaetodontoid fishes.

Species	2n										Total
	41	42	43	44	45	46	47	48	49	50	
<i>Pomacanthus semicirculatus</i>		1	1	1	1	4	9	22	3		42
<i>Centropyge vrolikii</i>			2	2	2	1	7	26	1		41
<i>Megaprotodon strigangulus</i>	2	2	1	5	5	12	22	2	2		53
<i>M. plebeius</i>			2		1	4	17	1			25
<i>Chaetodon auriga</i>	1			3	1	3	9	20	1		38
<i>C. vagabundus</i>			2	2	3	2	5	9	1		24
<i>C. trifasciatus</i>	2	2	2	1	1		2				10
<i>C. collaris</i>	2		3	4	7	7	31	2			57
<i>C. lunula</i>			3	1	4	7	18	2			35
<i>Microcanthus strigatus</i>					1	1	4	21	3	1	31



Figs. 1-2. Karyotypes of *Chaetodon*. — 1. *C. vagabundus*, $2n=48$, $NF=48$, $\times 2400$. — 2. *C. trifasciatus*, $2n=48$, $NF=48$, $\times 1970$.

number, but differs from the latter in the morphology of two-arm chromosomes.

Chaetodon auriga FORSSKÅL “Toge-chôchô-uo”

(Plate 3, figs. 1 and 3)

A specimen, 104.0 mm in total length, was collected from Yonehara, Ishigaki Island (Table 1).

As shown in Table 2, the diploid chromosome number is 48. The karyotype comprises 24 pairs of acrocentric chromosomes. The chromosomes are comparable in appearance and show a gradation in size that makes it impossible to arrange them in size groups. The arm number is 48.

Chaetodon vagabundus LINNAEUS “Fûrai-chôchô-uo”

(Fig. 1)

Two specimens, 76.5 and 78.2 mm in total length, were caught at Yonehara, Ishigaki Island (Table 1).

The diploid chromosome number is 48 (Table 2). The karyotype comprises 24 pairs of acrocentric chromosomes. Each chromosome shows a gradation from largest to smallest, and cannot be easily divided into size groups. The arm number is 48.

Chaetodon trifasciatus MONG PARK “Misuji-chôchô-uo”

(Fig. 2)

A specimen, 62.2 mm in total length, was caught at Yonehara, Ishigaki Island (Table 1).

We could not obtain clear chromosome figures sufficient for determining the karyotype of this species (Table 2). However, considering karyotypes of the other species of the genus *Chaetodon*, we consider it reasonable to report as follows. The diploid chromosome number is 48, and the karyotype comprises 24 pairs of acrocentric chromosomes. The arm number is 48.

Chaetodon collaris BLOCH “Chôchô-uo”

(Plate 3, figs. 2 and 4)

Three specimens were used for examination. A specimen, 46.1 mm in total length, was collected from Amatsu-kominato, Awa, Chiba Prefecture, a specimen, 65.0 mm in total length, from Kusugô, Yakushima Island, and the other specimen, 68.0 mm in total length, from Shimama, Tanegashima Island (Table 1).

As shown in Table 2, the diploid chromosome number is 48. The karyotype comprises 24 pairs of acrocentric chromosomes. The chromosomes are comparable in appearance and show a gradation in size that makes it impossible to arrange them in size groups. The arm number is 48.

Chaetodon lunula (LACEPÈDE) "Chôhan"

(Plate 4, figs. 1 and 3)

A specimen, 58.5 mm in total length, was caught at Kusugô, Yakushima Island (Table 1).

The diploid chromosome number is 48 (Table 2). The karyotype comprises 24 pairs of acrocentric chromosomes. In size, one-arm chromosomes show a gradation from largest to smallest, hence cannot be easily divided into size groups. The arm number is 48.

Microcanthus strigatus (CUVIER) "Kagokaki-dai"

(Plate 4, figs. 2 and 4)

Five specimens, 44.0 to 61.2 mm in total length, were collected at Amatsu-kominato, Awa, Chiba Prefecture (Table 1).

As shown in Table 2, the diploid chromosome number is 48. The karyotype comprises a pair of submetacentric, and 23 pairs of acrocentric chromosomes. The arm number is 50. The karyotype of this species is similar to that of *Megaprotodon strigangulus*.

Table 3. Number of anal spines in the suborder Chaetodontoidei from Japan.

Family	Species	Genus	No. of anal spines
Monodactylidae	1	1	3
Drepanidae	2	1	3
Ephippidae	1	1	3
Platacidae	4	1	3
Scorpidae	1	1	3
Antigoniidae	2	1	3
Chaetodontidae	51	11	{ 10 1*
Scatophagidae	1	1	4
Zanclidae	2	1	3
Acanthuridae	24	8	{ 3** 5***

* *Megaprotodon*.** *Callicanthus*, *Naso* and *Cyphomycter*.*** *Acanthurus*, *Zebrosoma*, *Paracanthurus*, *Ctenochaetus* and *Prionurus*.

Relationship between Karyotypes and Numbers of Anal Spines in the Family Chaetodontidae

In this study, there were found two types of karyotypes, i.e., 48 and 50 in arm number, in nine species of Chaetodontidae. Then we tried to find out characters which separate two kinds of karyotypes, and it was found that the number of anal

spines is three in seven species with 48 arm number, and four in two species with 50 arm number. Although it is unknown whether or not the number of anal spines is connected with different karyotypes of Chaetodontidae, we examined the number of anal spines to confirm if it is useful for fish systematics. Table 3 shows numbers of anal spines in 10 families of the suborder Chaetodontoidei from Japan, the systematic classification of which accords with that of MATSUBARA (1955). As shown in Table 3, the number of anal spines is very stable at family level except for Chaetodontidae and Acanthuridae. However, even in both of Chaetodontidae and Acanthuridae, the number of anal spines is stable at genus level.

On the other hand, almost all the Japanese ichthyologists excepting AOYAGI (1943) have not used the genus *Megaprotodon* for *strigangulus* and *plebeius*, although *Megaprotodon* was erected by GUICHENOT in 1848 on the basis of the number of anal spines (WOODS, 1953), i.e., species with three or four anal spines have been classified to the genus *Chaetodon*. However, it seems to be reasonable that *strigangulus* and *plebeius* belong to the genus *Megaprotodon*, which we used in this paper.

Acknowledgments

We wish to express our gratitude to Dr. H. IDA of Kitasato University, and Mr. K. NAGAIWA for collecting material.

References

- AOYAGI, H., 1943. Coral Fishes. i-xii+1-224 pp. 54 figs., 37 pls. Maruzen, Tokyo.
- ARAI, R., & I. KATSUYAMA, 1973. Notes on the chromosomes of three species of shore-fishes. *Bull. Natn. Sci. Mus., Tokyo*, **16**: 405-408, pl. 1.
- FRASER-BRUNNER, A., 1945. On the systematic position of a fish, *Microcanthus strigatus* (C. & V.). *Ann. Mag. nat. Hist.*, (11), **12**: 462-468, figs. 1-3.
- LEVAN, A., K. FREDGA & A. A. SANDBERG, 1964. Nomenclature for centromeric position on chromosomes. *Hereditas*, **52**: 201-220, figs. 1-3.
- MATSUBARA, K., 1955. Fish Morphology and Hierarchy. Part II. i-v+791-1605 pp., figs. 290-536. Ishizaki Shoten, Tokyo. (In Japanese.)
- PARK, E. H., 1974. A list of the chromosome number of fishes. *College Review, Coll. Lib. Art Sci., Seoul Natn. Univ.*, **20**: 346-372.
- WOODS, L. P., 1953. Subfamily Chaetodontinae. In: Fishes of the Marshall and Marianas Islands. *Bull. U. S. Natn. Mus.*, **202** (1): 566-596, pls. 49-58.

Explanation of Plates 1-4

Plate 1

Figs. 1-2. Photomicrographs of mitotic metaphase chromosomes from gill epithelial cells of butterflyfishes. — 1. *Pomacanthus semicirculatus*, $2n=48$. $\times 2,500$. — 2. *Centropyge vrolikii*, $2n=48$. $\times 2,700$.

Figs. 3-4. Karyotypes of butterflyfishes. — 3. *Pomacanthus semicirculatus*, from Fig. 1, $NF=48$. $\times 2,500$. — 4. *Centropyge vrolikii*, from Fig. 2, $NF=48$. $\times 2,700$.

Plate 2

Figs. 1-2. Photomicrographs of mitotic metaphase chromosomes from gill epithelial cells of butterflyfishes. — 1. *Megaprotodon strigangulus*, $2n=48$. $\times 2,650$. — 2. *M. plebeius*, $2n=48$. $\times 3,000$.

Figs. 3-4. Karyotypes of the genus *Megaprotodon*. — 3. *M. strigangulus*, from Fig. 1, $NF=50$. $\times 2,650$. — 4. *M. plebeius*, from Fig. 2, $NF=50$. $\times 3,000$.

Plate 3

Figs. 1-2. Photomicrographs of mitotic metaphase chromosomes from gill epithelial cells of butterflyfishes. — 1. *Chaetodon auriga*, $2n=48$. $\times 1,600$. — 2. *C. collaris*, $2n=48$. $\times 1,900$.

Figs. 3-4. Karyotypes of butterflyfishes. — 3. *Chaetodon auriga*, from Fig. 1, $NF=48$. $\times 1,600$. — 4. *C. collaris*, from Fig. 2, $NF=48$. $\times 1,900$.

Plate 4

Figs. 1-2. Photomicrographs of mitotic metaphase chromosomes from gill epithelial cells of Chaetodontidae and Scorpidae. — 1. *Chaetodon lunula*, $2n=48$. $\times 2,460$. — 2. *Microcanthus strigatus*, $2n=48$. $\times 2,250$.

Figs. 3-4. Karyotypes of Chaetodontidae and Scorpidae. — 3. *Chaetodon lunula*, from Fig. 1, $NF=48$. $\times 2,460$. — 4. *Microcanthus strigatus*, from Fig. 2, $NF=50$. $\times 2,250$.

