Japanese Journal of Ichthyology
Vol. 29, No. 2 1982

魚類学雑誌
29巻2号 1982年

Karyotypes in Eight Species of *Sebastes* from Japan

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(Received November 6, 1980)

Abstract Karyotypes of eight species of the genus *Sebastes*, family Scorpaenidae, from Japanese waters were analyzed in relation to morphology. Six of the eight species examined here are new to karyological study. The number of diploid chromosomes is 48 in all species excepting *Sebastes hubbsi*, which has 46 chromosomes. The karyotypes of the other seven species, viz. *S. thompsoni*, *S. joyneri*, *S. schlegeli*, *S. oblongus*, *S. vulpes*, *S. pachycephalus nudus* and *S. trivittatus*, consist of two meta- or submetacentric and 46 acrocentric chromosomes, while the karyotype of *S. hubbsi* consists of two large-sized and two medium-sized metacentric and 42 acrocentric chromosomes. Morphological differences between these two groups are not clear except for the difference found in the number of dorsal spines. The present results emphasize the stability of karyotypes among the fishes of the genus *Sebastes*, compared with rather various karyotypes found in other families of the order Scorpaeniformes.

The fishes of the order Scorpaeniformes exhibit a great morphological diversity and offer interesting materials for comparative karyology in relation to morphological diversification. This study was attemped to examine relationships between polarities in karyotypes and morphological characters in the genus *Sebastes* of the family Scorpaenidae. Some 25 Japanese scorpaeniform species have been studied karyologically. As for chromosomes of *Sebastes*, five species have been studied. We observed chromosomes of eight species of *Sebastes*, of which six species are new to karyological study.

Materials and methods

Fish specimens used for this study were collected from waters around the Izu Peninsula at Futo, Shizuoka Prefecture, southern Pacific coast of the Tohoku district at Sanriku-cho, Iwate Prefecture, and Rishiri Island in the Sea of Japan, northern Hokkaido. Material data are shown in Table 1.

For chromosomal studies, live specimens were injected with a solution of 0.3% colchicine at 0.3～0.06 ml/100 mm (standard length), and maintained in a 100-liter aquarium for about 12 hours. Gill tissues were then dissected from the right side, soaked in a hypotonic solution of N/100 KCl for 30～45 minutes at room temperature, and fixed in Carnoy's solution for at least 1 hour. The tissues were then squashed, using forceps, in a test tube containing Carnoy's solution. The suspension in the test tube was centrifuged for 5 minutes at 1000 rpm, and cells were recovered from the upper layer of the sediment. Chromosome spreading was achieved by the routine air-drying method. Giemsa solution was employed for staining the preparations. Classification of chromosomes followed that of Levan et al. (1964). Metacentrics and submetacentrics were treated as two-arm chromosomes, and acrocentrics as one-arm chromosomes. The new arm number (NAN) used here is that of Arai and Nagaiwa (1976).

For morphological studies, counts for finrays and vertebrae were made on radiographs. Caudal vertebrae were defined as vertebrae having closed haemal spines. Identification of species followed Matsubara (1955).

Results

Karyology. Frequency distributions of chromosome counts obtained in the eight species are given in Table 2. From the modal numbers, the diploid chromosome number is determined as 46 in *Sebastes hubbsi* and 48 in all of the remaining seven species. The fundamental number (FN) and the new arm number (NAN) are 50 and 48, respectively. Mitotic metaphase nuclear plates and karyograms of these species are shown in Figs. 1～3. Details of the karyotype of each species are described below.

Sebastes thompsoni (Jordan et Hubbs), Japanese name: usu-mebaru (Fig. 1A): Karyotype

Fig. 1. Photographs of mitotic metaphase chromosomes and karyotypes of *Sebastes*. A: *Sebastes thompsoni*, female. 2n=48. B: *Sebastes joyneri*, sex not determined. 2n=48. C: *Sebastes schlegeli*, male. 2n=48. Each scale indicates 10 μm.

analysis was successful in only one female specimen. The karyotype consists of 2 submetacentric and 46 acrocentric chromosomes. The submetacentric pair is somewhat heteromorphic. The acrocentrics show a gradation in size; the length of the largest chromosome is about three times of the smallest.

Sebastes joyneri Günther, Japanese name:

Table 1. List of the materials.

Species	Date	Locality	Method	SL (mm)	Sex
Sebastes thompsoni	1978–4–15	Sanriku-cho	set net	115	female
Sebastes joyneri	1978–10–8	Futo, Izu	gill net	103	?
Sebastes schlegeli	1978–7–14	Sanriku-cho	angling	190	male
	1979–5–25	Sanriku-cho	angling	160	male
Sebastes oblongus	1979–5–21	Sanriku-cho	set net	276	female
	1978–5–25	Sanriku-cho	set net	225	male
Sebastes vulpes	1979–6–10	Shakotan	angling	74	?
Sebastes pachycephalus nudus	1978–8–25	Sanriku-cho	angling	160	female
	1979–6–30	Sanriku-cho	hand net	139	male
Sebastes trivittatus	1979–7–11	Rishiri	angling	161	male
Sebastes hubbsi	1976–9–20	Sanriku-cho	angling	107	male

Table 2. Frequency distributions of diploid chromosome numbers and karyotypes of eight species of *Sebastes*.

Species	2n												Total	2n	M, SM	A	FN	NAN
	40	41	42	43	44	45	46	47	48	49	50	51						
Sebastes thompsoni			1						4				5	48	2	46	50	48
Sebastes joyneri	1	1					1		5				8	48	2	46	50	48
Sebastes schlegeli		1		2	1	1	2	3	12				22	48	2	46	50	48
Sebastes oblongus	1		1		1				6		1		10	48	2	46	50	48
Sebastes vulpes				1			1		5		1		8	48	2	46	50	48
Sebastes pachycephalus nudus	1			1			3		14	1	1	1	22	48	2	46	50	48
Sebastes trivittatus			1	2	2		3	2	20	2			32	48	2	46	50	48
Sebastes hubbsi			1		2	1	7	2	1	2			16	46	4	42	50	48

Table 3. Selected morphological characters of the material fish*.

Species	D.	A.	P_1	Branched caudal ray	Gillrakers	L.l.	Vert-ebrae	Squamation on brst.	Squamation on jaws	Auxiliary scale
Sebastes thompsoni	XIII, 14	III, 7	16	7(or 6)+6	10+1+26	51	11+15	+	+	+
Sebastes joyneri	XIII, 13 or 14	III, 7	16	7(or 6)+6	10+1+23(or 25)	49～50	11+15	+	+	+
Sebastes schlegeli	XIII, 12 or 13	III, 6 or 7	17 or 18	6+6	7+1+16	40, 49	11+15	−	(+)***	+
Sebastes oblongus	XIII, 12	III, 6	17	6+6(or 5)	6+1+11	45	11+15	−	+	+
Sebastes vulpes	XIII, 12 or 13	III, 6 or 7	17 or 18	6+6	7+1+15	32, 36	11+15	−	(+)***	(+)***
Sebastes pachycephalus nudus	XIII, 12	III, 6	16 or 17	6+6	7+1+13	31, 33	11+15	−	−	+
Sebastes trivittatus	XII**, 12	III, 7	17	6+5	8+1+14	33	11+15	−	−	+
Sebastes hubbsi	XIV, 11	III, 6	16 or 17	6+6	7+1+12	29, 30	11+15	−	−	−

* Counts for individuals in which we failed in obtaining nuclear plate are also included.

** Malformation; though the number of spines is 12, there observed pterygiophores for 13 spines.

*** Presence is not constant.

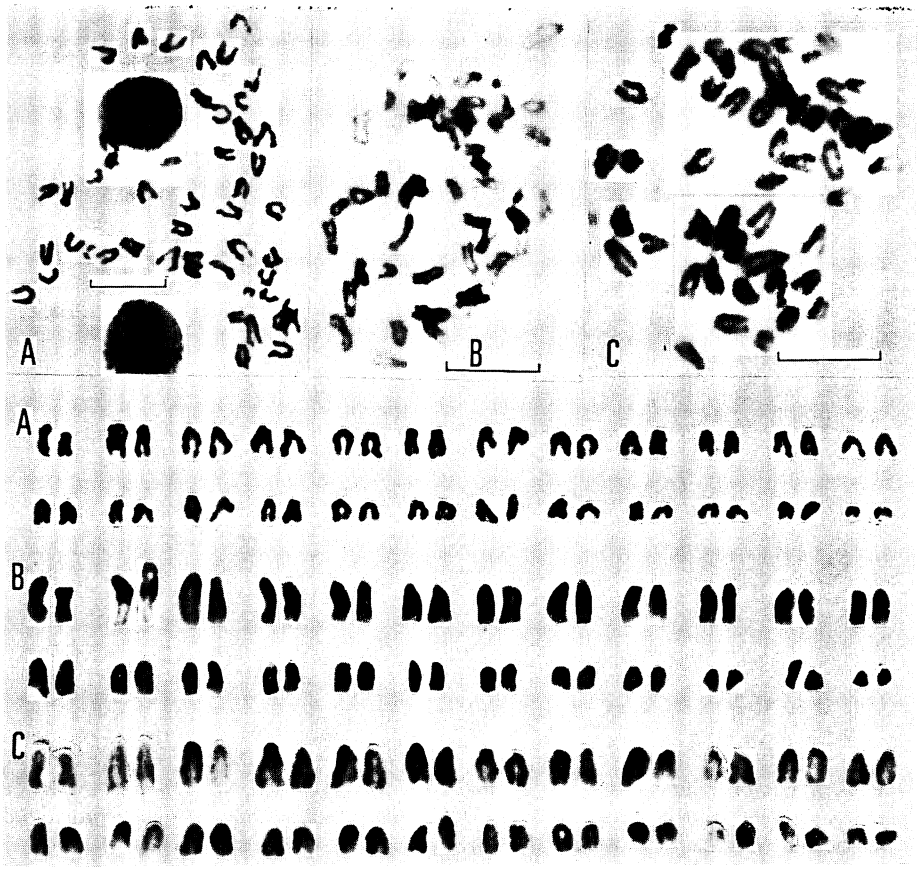

Fig. 2. Photographs of mitotic metaphase chromosomes and karyotypes of *Sebastes*. A: *Sebastes oblongus*, female. 2n=48. B: *Sebastes vulpes*, sex not determined. 2n=48. C: *Sebastes trivittatus*, male. 2n=48. Each scale indicates 10 μm.

togotto-mebaru (Fig. 1B): Of several specimens obtained only one specimen of unknown sex provided nuclear plates available for karyotype analysis with reliable results. The karyotype includes 2 metacentric and 46 acrocentric chromosomes. The two metacentrics are equal in size. Other karyotypic features are similar to those of *S. thompsoni*.

Sebastes schlegeli Hilgendorf, Japanese name: kuro-mebaru (Fig. 1C): Two male specimens were available for chromosomal observations. The karyotype consists of 2 metacentric and 46 acrocentric chromosomes. The two metacentrics are medium in size and homomorphic. The acrocentrics show a serial change in size, the largest being about twice as large as the smallest.

Sebastes oblongus Günther, Japanese name: takenoko-mebaru (Fig. 2A): One male and one female specimen produced clear chromosome figures. The karyotype comprises 2 submetacentric and 46 acrocentric chromosomes. The submetacentric pair from the female specimen shows a slight difference in size.

Sebastes vulpes Steindachner et Döderlein, Japanese name: kitsune-mebaru (Fig. 2B): The sex of the single specimen available for this study could not be determined. The karyotype includes 2 metacentric and 46 acrocentric chromosomes. The metacentrics are somewhat heteromorphic. The size differences among the acrocentrics are gradual; the length of the largest chromosomes is more than three times that of the smallest.

Sebastes trivittatus Hilgendorf, Japanese name: shima-soi (Fig. 2C): Only one male specimen

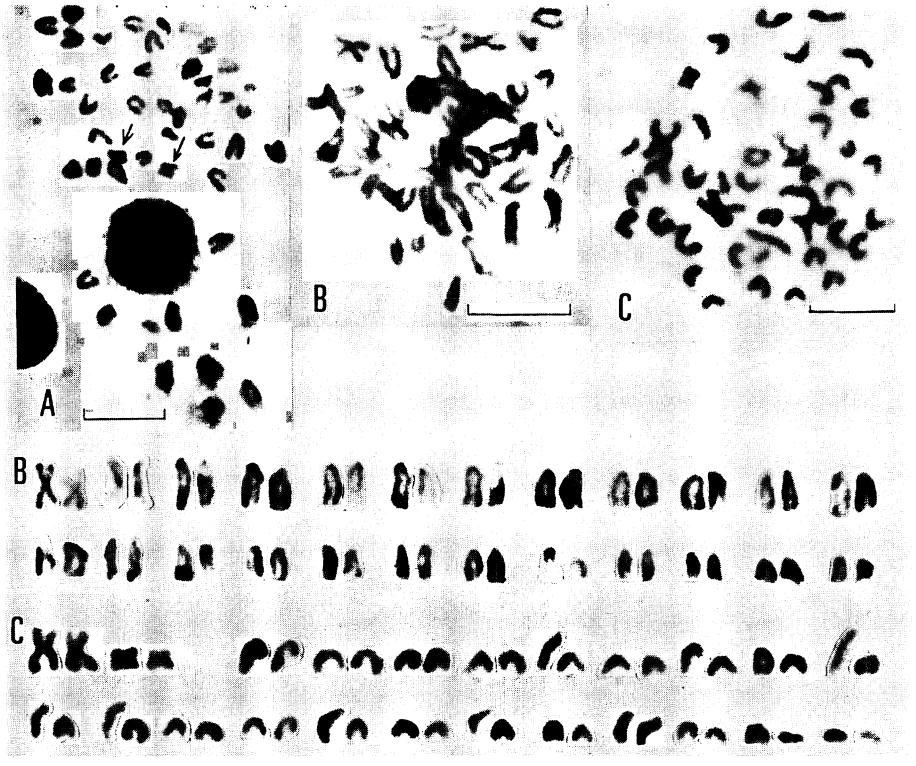

Fig. 3. Photographs of mitotic metaphase chromosomes and karyotypes of *Sebastes*. A, B: *Sebastes pachycephalus nudus*, male and female. 2n=48. Arrows indicate homomorphic chromosome pair of metacentric in male. C: *Sebastes hubbsi*, male. 2n=46. Each scale indicates 10 μm.

was obtained. The karyotype is composed of 2 metacentric and 46 acrocentric chromosomes. The metacentrics are medium-sized and homomorphic. The acrocentrics decrease serially in size, the largest being a little more than twice the smallest in length.

Sebastes pachycephalus nudus Matsubara, Japanese name: ohgon-murasoi (Fig. 3A, B): One male and one female specimen were examined. The karyotype consists of 2 metacentric and 46 acrocentric chromosomes. The metacentric chromosomes from the female are slightly heteromorphic, while those from the male are homomorphic. The acrocentrics show a gradual decrease in size; the length of the largest pair is more than twice that of the smallest.

Sebastes hubbsi (Matsubara), Japanese name: yoroi-mebaru (Fig. 3C): Only one male specimen was available. The karyotype consists of 4 metacentric chromosomes, of which 2 are large and the other 2 are medium-sized, and 42 acrocentric chromosomes. The larger metacentrics are twice as large as the medium-sized metacentrics. The acrocentrics show a gradation in size; the largest pair is about twice as large as the smallest pair.

Morphology. The karyotype analyses described above show a clear gap between *Sebastes hubbsi* and the other seven species. However, meristic separation of *S. hubbsi* from the rest is not obvious; the only difference being found in the dorsal spine count, which is 14 in *S. hubbsi* against 13 in all other species (Table 3). Further morphological differences are noted in the absence of the auxiliary scale in *S. hubbsi* and the position of the pterygiophore of the last dorsal spine which is situated immediately before the third caudal (=14th) vertebra in *S. hubbsi* and before the neural spine of the second caudal (=13th) vertebra in the other species. The vertebral composition is invariably 11+

15=26 in all species.

Discussion

Five species of *Sebastes* from Japanese waters, including *S. hubbsi* and four other species that are not dealt with in this study, have been analysed in their karyotypes (Nishikawa et al., 1977; Sasaki and Sakamoto, 1977). Thus, the present study adds six more species to the karyological knowledge of this genus. All of these *Sebastes* species other than *S. hubbsi* show closely similar karyotypes, consisting invariably of 2 medium-sized two-arm chromosomes and 46 one-arm chromosomes. There are no peculiar chromosomes among the acrocentrics, and the grouping of these chromosomes is virtually impossible because of their smooth gradation of size. The karyotype of *S. hubbsi* is unique. As Nishikawa et al. (1977) have already pointed out, there are two large metacentrics, in addition to the medium-sized metacentrics, which are probably homologous with the metacentrics in other *Sebastes* species. These large chromosomes have probably originated from the Robertsonian translocation and resulted in a reduction of the chromosome number by two.

Though the difference in size is not large, the heteromorphic chromosomes were always observed in females but not in males. Heterogamety has been observed in many teleostans. Male heterogamety was found in *Bathylagus* (Bathylagidae), *Fundulus* (Cyprinodontidae), *Gasterosteus* (Gasterosteidae) (Ebeling and Chen, 1970), *Megupsilon* and *Allodontichthys* (Goodeidae) (Miller and Walters, 1972; Miller and Uyeno, 1980), and *Stephanolepis* (Monacanthidae) (Murofushi et al., 1980). Female heterogamety was found in *Anguilla* (Anguillidae) and *Astroconger* (Congridae) (Park and Kang, 1976), two species of *Saurida* (Synodontidae) (Nishikawa and Sakamoto, 1978), *Gambusia* (Poecilidae) (Chen and Ebeling, 1968), *Apeletes* (Gasterosteidae), and *Symphurus* (Cynoglossidae) (LeGrande, 1975). It is thus seen that both male and female heterogamety occur in the Cyprinodontiformes and in the Gasterosteidae. The heteromorphic pair in females of the genus *Sebastes* needs further study.

From a morphological point of view, Matsubara (1955) placed the family Scorpaenidae as the most generalized group among the order Scorpaeniformes. Arai and Fujiki (1978) briefly reviewed the karyotypes of the fishes of the order so far reported. From the table shown by them the karyotypes of the members of the subfamily Sebastinae have rather generalized formulae, including only 2 or 4 metacentric chromosomes and more than 42 acrocentric chromosomes, which is the largest count for one-arm chromosomes. Members of the other families of the order have more than 4, usually more than 6, metacentrics. Ida and Yunokawa (1980) described the karyotypes of the five species of the family Platycephalidae. The karyotypes of this family are unique in having the same chromosome number, counting 48, in all five species in spite of their varied karyotypes, and present a contrast to the family Cottidae, in which the number of both diploid and metacentric chromosomes vary from species to species. The generalized karyotypes of the genus *Sebastes* seem to support Matsubara's (1955) conclusion.

Acknowledgments

We are grateful to Drs. Yasuhiko Taki of the Tokyo University of Fisheries and Ryoichi Arai of National Science Museum, Tokyo, for their kind advice and for critical reading of the manuscript. We wish to thank Mr. Hajime Masuda and other staff of Izu Marine Park and Mr. Kyukichi Iwaki and other staff of Okiami setnet who offered specimens.

Literature cited

Arai, R. and A. Fujiki. 1978. Chromosomes of three species of cottid fishes from Japan. Bull. Nat. Sci., Mus., Tokyo, ser. A, 4 (3): 233～239, figs. 1～2.

Arai, R. and K. Nagaiwa. 1976. Chromosomes of tetraodontiform fishes from Japan. Bull. Nat. Sci. Mus., Tokyo, ser. A, 2 (1): 59～72, pls. 1～6.

Chen, T. R. and A. W. Ebeling. 1968. Karyological evidence of female heterogamety in the mosquitofish, *Gambusia affinis*. Copeia, 1968 (1): 70～75, figs. 1～2.

Ebeling, A. W. and T. R. Chen. 1970. Heterogamety in teleostean fishes. Trans. Amer. Fish. Soc., 1970 (1): 131～138, figs. 1～3.

Ida, H. and K. Yunokawa. 1980. Karyotypic variation found among five species of the family

Platycephalidae. Japan. J. Ichtyol., 27 (2): 122～128, figs. 1～3.
LeGrande, W. H. 1975. Karyology of six species of Louisiana flatfishes (Pleuronectiformes: Osteichthyes). Copeia, 1975 (3): 516～522, figs. 1～3.
Levan, A., K. Fredga and A. A. Sandberg. 1964. Nomenclature for centromeric position on chromosomes. Hereditas, 52: 201～220, figs. 1～3.
Matsubara, K. 1955. Fish morphology and hierarchy. Pt. 2. Ishizaki-shoten, Tokyo, i～v+791～1605, figs. 290～536.
Miller, R. R. and T. Uyeno. 1980. *Allodontichthys hubbsi*, a new species of goodeid fish from southwestern Mexico. Occ. Pap. Mus. Zool. Univ. Michigan, (692): 1～13, figs. 1～6.
Miller, R. R. and V. Walters. 1972. A new genus of cyprinodontid fish from Nuevo Leon, Mexico. Contr. Sci. Nat. Hist. Mus. Los Angels County, (233): 1～13, figs. 1～5.
Murofushi, M., S. Oikawa, S. Nishikawa and T. H. Yosida. 1980. Cytogenetical studies on fishes. III. Multiple sex chromosome mechanism in the file fish, *Stephanolepis cirrhifer*. Japan. J. Genetics, 55 (2): 127～132, figs. 1～2.
Nishikawa, S., M. Honda and A. Wakatsuki. 1977. Comparative studies on the chromosomes in Japanese fishes-II. Chromosomes of eight species in scorpionfishes. J. Shimonoseki Univ. Fish., 25 (3): 187～191, pls. 1～2. (In Japanese).
Nishikawa, S. and K. Sakamoto. 1978. Comparative studies on the chromosomes in Japanese fishes-IV. Somatic chromosomes of two lizardfishes. J. Shimonoseki Univ. Fish., 27 (1): 113～117, fig. 1. (In Japanese).
Park, E. H. and Y. S. Kang. 1976. Karyotype conservation and difference in DNA amount in anguilloid fishes. Science, 193: 64～66, fig. 1.
Sasaki, T. and K. Sakamoto. 1977. Karyotype of the rockfish, *Sebastes taczanowskii* (Steindachner). Chromosome Information Service, (22): 7～8, fig. 1.

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本邦産メバル属8種の核型

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本邦産メバル属8種の染色体を air-drying 法により観察した．染色体数はヨロイメバルの 2n=46 を除きウスメバル，トゴットメバル，クロソイ，タケノコメバル，キツネメバル，オウゴンムラソイ，シマソイの7種はいずれも 2n=48 であった．核型はヨロイメバルでは1対の大型の中部着糸型 M=2，中型の M=2，端部着糸型 A=42 であり，他の7種ではいずれも M=2, A=46 であった．端部着糸型の染色体の大きさはほぼ 5～2 μm の範囲にあって連続的配列を示した．8種の間には形態上背鰭の棘条数の他は顕著な差は少なく，核型からはヨロイメバルを除く7種の近縁性が追認された．

タケノコメバルとオウゴンムラソイの2種では雌個体の1対の中部着糸型染色体は異型性を示したが，これが性染色体であるか artifact であるかは不明である．

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