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Blainville's Dogfish, *Squalus blainville*, from Japan, with Notes on S. *mitsukurii* and S. *japonicus*

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Abstract *Squalus blainville* (Risso) is described for the first time from Japan. Two closely allied species, *S. mitsukurii* Jordan et Fowler and *S. japonicus* Ishikawa, are redescribed and reviewed to clarify the classification of the genus *Squalus* in Japan. The three species are separable by a combination of differences in snout length, mouth width, dorsal fin height, dorsal fin spine length, and vertebral counts.

The genus *Squalus* is characterized among the members of the Squalidae by its well developed dorsal spines without lateral grooves, its caudal fin without subterminal notch, its teeth with a single cusp in both the upper and lower jaws, and lack of barbels. In spite of these distinctive characters, however, there are only a few characters for discriminating many nominal species within the genus. For this reason, attempts have been made to review or revise the genus. In recent years, the taxonomy of *Squalus* by Bigelow and Schroeder (1957) and Garrick (1960, 1961) has been generally adopted. They divided nominal species of the genus into three species groups, represented by *S. acanthias*, *S. blainville* (syn. *S. fernandinus*) and *S. megalops-cubensis*. In addition to these groups, a fourth group, *S. asper-barbifer*, was proposed by synonymizing the genus *Cirrhigaleus* with *Squalus* (Bass et al., 1976). *S. asper* Merrett is certainly different from the above three groups in shape and size of dermal denticles, and we believe the differences warrant the retention of *Cirrhgaleus* as a separate genus.

It has been generally accepted that three species of *Squalus* are distributed around Japan (Matsubara, 1936, 1955), namely, *S. acanthias* Linnaeus, 1758 (syn. *S. suckleyi*), *S. mitsukurii* Jordan et Fowler, 1903, and *S. brevirostris* Tanaka, 1917. According to Bigelow and Schroeder (1957) and Garrick (1960), *S. acanthias* falls into the *acanthias* group, *S. mitsukurii* into the *blainville* group, and *S. brevirostris* into the *megalops-cubensis* group. In fact, Teng (1962) and Matsubara (1965) substituted *S. fernandinus* for *S. mitsukurii* and *S. megalops* for *S. brevirostris* in Japan and adjacent seas. However, *S. fernandinus* should be replaced by *S. blainville* according to Garrick (1960), who stated *S. fernandinus* was a member of the *acanthias* group. In addition, an unidentified species of *Squalus* which did not correspond to any existing species in the genus appearing in Okada and Matsubara (1938) was reported to be distributed in the East China Sea (Kibesaki, 1954). Thus, there is much confusion in the classification of the genus *Squalus* around Japan.

During the course of a systematic study of *Squalus*, we found that three species belonging to the *blainville* group, i.e., *S. blainville*, *S. mitsukurii*, and *S. japonicus*, occur in Japan. These three species are distinguishable from *S. acanthias* in having no white spots on the upper surface of the body, the 1st dorsal spine anterior to the inner pectoral corner, and a complex and bilobed anterior nasal flap, and from *S. brevirostris* in having a rounded inner pectoral corner and tridentate dermal denticles.

This paper describes the three species of the *blainville* group making morphological comparisons.

Material and methods

All specimens used in this study were collected from fish markets at Nagasaki, Kagoshima, Kochi, Tokyo, Choshi, and Hachinohe, from September, 1974 to March, 1977. The sharks were caught mainly by bottom long lines or trawls.

Squalus blainville. 27 specimens ranging

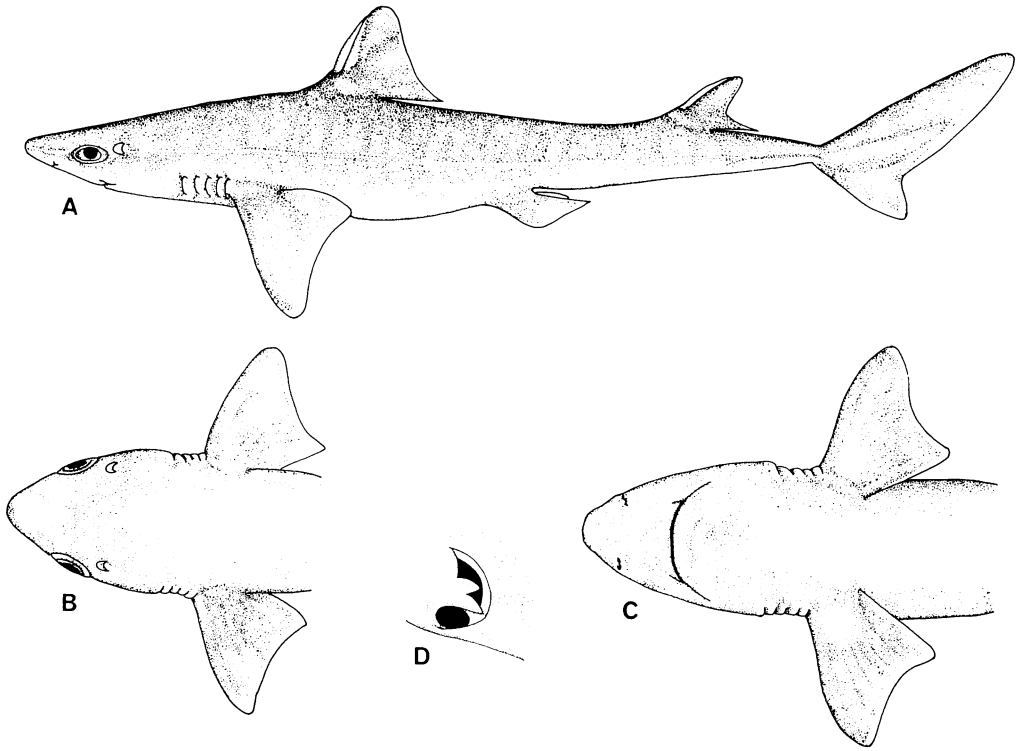

Fig. 1. *Squalus blainville*, male, 631 mm TL (SCUM 1020), from Nagasaki. A: Lateral view. B: Dorsal view of head. C: Ventral view of head. D: Right nostril.

from 57 to 81 cm in total length (TL) were examined. All the specimens were taken from depths of 180～380 m in waters off Kyushu and Shikoku. One male and four females are preserved in the Shark Collection of the University Museum, University of Tokyo (SCUM): one male, 631 mm TL (SCUM 1020), and four females, 668 mm TL (SCUM 1018), 684 mm TL (SCUM 1017), 796 mm TL (SCUM 1016), and 814 mm TL (SCUM 1010) from Nagasaki.

Squalus mitsukurii. 54 specimens ranging from 23 to 110 cm TL were examined. All specimens were taken from depths of 180～300 m from the middle of Honshu to north-eastern Japan. Four males, 651 mm TL (SCUM 1015), 652 mm TL (SCUM 1011), 660 mm TL (SCUM 1012), and 887 mm TL (SCUM 1014), and one female, 573 mm TL (SCUM 1013) from Choshi are preserved.

Squalus japonicus. 92 specimens ranging from 20 to 91 cm TL were examined. All the specimens were taken from depths of 150～300 m in the waters off Kyushu, Shikoku, and Choshi. One male, 465 mm TL (SCUM 1009) from Nagasaki, two females, 650 mm TL (SCUM 1006) and 708 mm TL (SCUM 1008) from Nagasaki, one male, 612 mm TL (SCUM 1027) and one female, 790 mm TL (SCUM 1029) from Choshi are preserved.

All specimens were measured in a fresh state. Measurements followed chiefly Bigelow and Schroeder (1948). Vertebral counts were made according to Springer and Garrick (1964).

Squalus blainville (Risso, 1826)
(Japanese name: Hiretaka-tsunozame)
(Figs. 1, 2)

Acanthias blainville Risso, 1826: 133～134, pl. III (fig. 6) (off Nice).

Squalus fernandinus; Poll, 1951: 59～61, figs. 31, 32, pl. IV (fig. 3), pl. XII (fig. 6); Totonese, 1956: 173～175, figs. 92, 93.

Diagnosis. *S. blainville* can be distinguished from *S. mitsukurii* and *S. japonicus* in having

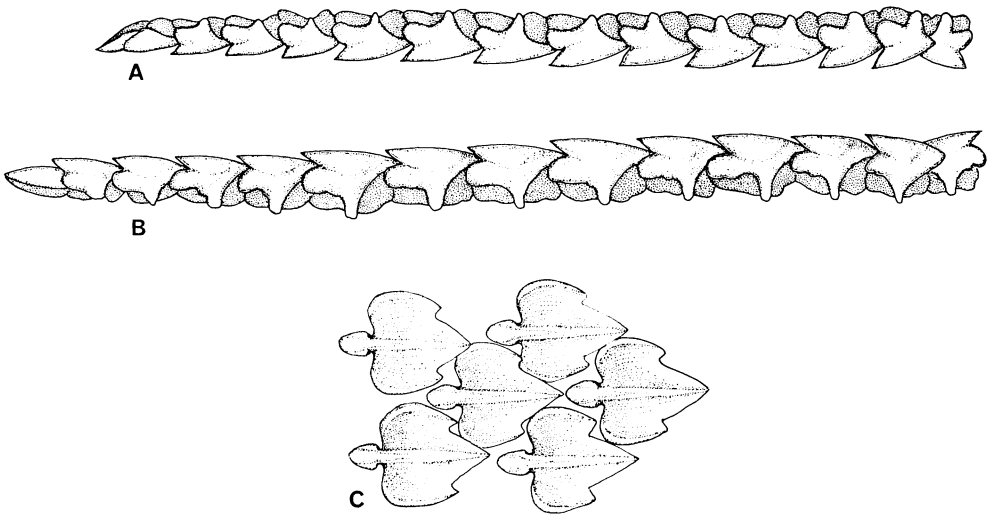

Fig. 2. *Squalus blainville*. A: Upper teeth of a female, 630 mm TL, from Nagasaki, right side, about 8x. B: Lower teeth of the same. C: Dermal denticles from the trunk region below 1st dorsal fin of a female, 623 mm TL.

the height of 1st dorsal fin more than 3/4 of its overall length, 1st dorsal spine as long as 1st dorsal base, the height of 2nd dorsal fin more than 5 percent of total length, and 2nd dorsal spine usually more than 6 percent of total length.

Description. Based mainly on a male 631 mm TL (SCUM 1020), variation in other specimens is given in parentheses.

Head depressed, snout bluntly pointed and eyes large; trunk stout and ovoid in section. Dorsal profile more arched than ventral. Height of trunk at pectoral origin 8.8 (8.0～8.8) in the length to caudal origin. Caudal peduncle bearing a prominent dermal keel along each side below the mid-level, extending from below the posterior insertion of 2nd dorsal fin to about 1/3 of distance along the caudal axis. Upper and lower precaudal pits present at the origin of dorsal and ventral lobes; upper one deeper and better defined than lower one. Dermal denticles on sides of trunk closely packed, each with a nearly horizontal, subcircular, tridentate blade arising from a rhomboidal base; a strong median dorsal ridge, thickened anteriorly, with weaker lateral ridges on each side.

Snout tip to 1st gill opening 5.9 (5.4～6.5) in total length; depressed wedge-shape in profile so that snout tip is bluntly pointed. Snout broadly pointed, expanding prominently at the level of nostrils. Snout tip to anterior corner of eye 3.7 (3.2～4.0) in head length measured to 5th gill opening. Eyes large, horizontal diameter longer than vertical diameter and 2.0 (1.9～2.3) in snout length measured to mouth. Spiracles large, situated slightly above the level of posterior corner of eye and separated from eye by a distance approximately equal to the greatest diameter of spiracles. Gill openings rather long, almost vertical, slightly concave, placed in a horizontal series anterior to pectoral origin, gradually increasing in length from 1st to 5th, 5th gill opening being 1.9 (1.5～2.0) in horizontal diameter of eye. Interspace between gill openings subequal, with space between 1st and 2nd being largest.

Nostrils almost transverse, placed nearer to tip of snout than to mouth. Interspace between nostrils 1.1 (1.1～1.4) in snout tip to eye. Each nostril subdivided externally by anterior and posterior nasal flaps, forming an approximately triangular inner apperture and circular outer apperture. Mouth wide, little arched, its width 1.2 (1.0～1.2) in snout length measured to mouth. Preoral clefts short, extending inwards, continued as furrows outward and posteriorly.

Teeth similar in both jaws. Dental formula

Table 1. Proportional dimensions in percent of total length of *S. blainville*.

Character	Catalogue No. (SCUM)				
	1017	1020	1018	1016	1010
Sex	♀	♂	♀	♀	♀
Total length	684	631	668	796	814
Snout tip to					
outer nostrils	3.3	3.1	2.9	3.2	3.5
eye	5.8	5.5	5.9	5.2	6.3
mouth	8.7	8.7	8.5	8.5	8.8
1st gill opening	17.9	16.9	17.3	16.7	18.0
3rd gill opening	20.3	19.0	19.3	17.8	20.0
5th gill opening	21.7	20.7	20.8	19.8	21.3
pectoral insertion	21.7	20.7	20.8	19.8	21.3
pelvic insertion	47.3	46.2	45.2	47.4	48.1
1st dorsal spine origin	31.7	29.3	30.5	30.7	31.3
2nd dorsal spine origin	65.2	64.9	64.3	65.3	66.8
upper caudal origin	78.9	78.7	78.1	79.4	80.4
Distance between bases					
1st and 2nd dorsal	28.3	29.7	28.2	28.7	30.1
2nd dorsal and caudal	10.3	10.7	10.7	9.8	10.3
Nostrils: distance					
between inner corners	4.5	4.9	4.7	4.4	4.9
Mouth: width	8.4	7.1	7.7	8.1	8.1
Gill-opening lengths					
1st	1.7	1.5	1.8	1.6	2.2
3rd	1.9	2.0	2.1	2.1	2.2
5th	2.4	2.3	2.5	2.3	2.4
Eye					
horizontal diameter	4.5	4.4	4.3	4.1	3.9
1st dorsal fin					
overall length	12.5	11.7	12.1	12.3	12.1
length base	5.8	5.5	5.9	6.0	5.9
height	9.9	9.1	9.4	10.3	9.8
spine length	5.7	5.7	6.4	—	7.3
2nd dorsal fin					
overall length	9.5	8.4	8.9	9.5	9.2
length base	3.8	3.3	5.0	4.4	4.0
height	5.7	5.8	5.2	6.2	5.9
spine length	6.1	6.5	5.9	7.0	7.1
Pectoral fin					
length base	5.4	5.3	4.7	5.4	6.0
length ant. margin	16.0	14.2	15.1	16.3	16.3
length distal margin	12.7	12.0	11.9	12.8	12.0
length post. margin	8.4	8.0	7.7	8.1	8.4
Pelvic fin					
overall length	10.6	9.9	10.1	10.9	11.0
length base	4.6	4.6	5.0	5.0	5.0
length ant. margin	7.0	6.6	6.5	6.9	7.3
length distal margin	7.0	6.1	5.9	—	6.6
length claspers	—	5.8	—	—	—
(from pelvic axil)	—	0.6	—	—	—
Caudal fin					
length dorsal lobe	23.6	22.1	20.5	22.3	20.8
length ventral lobe	12.5	11.4	10.9	12.0	11.0
Trunk at pectoral origin					
width	13.7	13.1	13.4	13.8	13.7
height	10.9	8.5	9.4	10.0	11.4
Dental formula	13−24 / 11−12	13−14 / 11−12	13−14 / 12−11	13−14 / 12−11	13−14 / 12−11

$\frac{13-14}{11-12}\left\{\frac{(13-14)-(12-15)}{(11-12)-(11-12)}\right\}$ rows. Base of teeth broader than high, with a single, smooth-edged, triangular cusp. Cusp of teeth deeply notched on its anterior margin, and so strongly oblique that its medial margin overlaps from one tooth to the next to form a continuous cutting edge. Upper teeth a little smaller than lower.

First dorsal large, triangular, its dorsal spine origin much nearer to pectoral origin than to pelvic origin. Height of 1st dorsal fin much greater than base length measured from spine origin. First dorsal spine pigmented anteriorly, erect, long, and sturdy, its tip reaching to at least 4/5 of length of anterior margin. Anterior margin of 1st dorsal convex and distal margin strongly concave.

Second dorsal nearer to lower precaudal pit than to pelvic origin, its height 1.6 (1.5～1.9) in that of 1st dorsal, and its base measured from spine origin 1.7 (1.0～1.7) in 1st dorsal base. Length of posterior extention about equal to length of base measured from spine origin. Second dorsal spine slightly longer than 1st dorsal one, its tip reaching apex of the fin, the spine triangular without any grooves, but its distal margin slightly hollowed out.

Upper caudal lobe 4.5 (4.2～4.8) in total length, well developed without subterminal notch, its upper margin almost straight except for the distal portion, its lower margin somewhat sinuous, and the apex rounded or bluntly pointed. Lower lobe about half as long as the upper.

Pectoral fins large, originating just posterior to 5th gill opening. Anterior margin slightly convex, posterior margin almost straight, and distal margin comparatively concave. Inner corners of pectorals rounded.

Pelvic fins entirely anterior to 2nd dorsal origin, shallowly triangular. Anterior, posterior, and distal margins of pelvics almost straight. The apex of the fin smoothly rounded. The posterior extention sharply pointed.

Total vertebral number 125 (118～125), monospondylous 48 (44～50), precaudal 94 (90～96).

Color in fresh state: Greyish brown above, merging to a lighter colour below. Distal margin of each fin whitish. Iris of eye greyish blue.

Remarks. The specific name of *blainvillei* has been generally employed since Garrick's emendation (1961). However, we use *blainville* which appeared in the original description because Article 31 of the International Code of Zoological Nomenclature published in 1961 was replaced by Recommendation 31A in 1964.

The specimens described above differ from those described by Bigelow and Schroeder (1948), Garrick (1960), and Bass et al. (1976), in having higher dorsal fins and longer dorsal spines. Bass et al. (1976: 12) stated that Bigelow and Shroeder's (1948) *S. fernandinus* is equivalent to their (and Garrick's (1960)) *megalops-cubensis* group. However, the description of *S. fernandinus* by Bigelow and Schroeder (1948: 478～479) indicates that this form is clearly separable from *megalops-cubensis* group in the shape of pectoral fin and dermal denticles. We suppose that Bass et al. (1976) incorrectly placed *S. fernandinus* in the *megalops-cubensis* group instead of the *blainville* group.

Strictly speaking, Risso's (1826) original description and figure do not conform to any species of *Squalus*. However, Risso's figure of *blainville* possesses high dorsal fins and long spines. Dorsal fins and spines of *S. fernandinus* (syn. *S. blainville*) described from the Mediterranean, its type locality, by Poll (1951) are also high, and nearly coincide with our specimens. Tortonese (1956) also stated that height of the 1st dorsal spine is 4/5 as high as the 1st dorsal fin, although one of his illustrations of *S. fernandinus* (syn. *S. blainville*) has a short 1st dorsal spine. Similarly, Bigelow and Schroeder (1948: 454) pointed out in their fig. 8 that the dorsal fin spines are considerably shorter in the eastern Pacific and Tasmanian specimens, and also in the South African and Argentine representatives of this group than in the Mediterranean or Japanese representatives. As will be discussed later, *S. fernandinus* (syn. *S. blainville*) described by Bigelow and Schroeder (1948) and *S. blainville* by Garrick (1960) are more similar to *S. mitsukurii* than to our specimens. Tentatively, we employ Poll's illustration as the

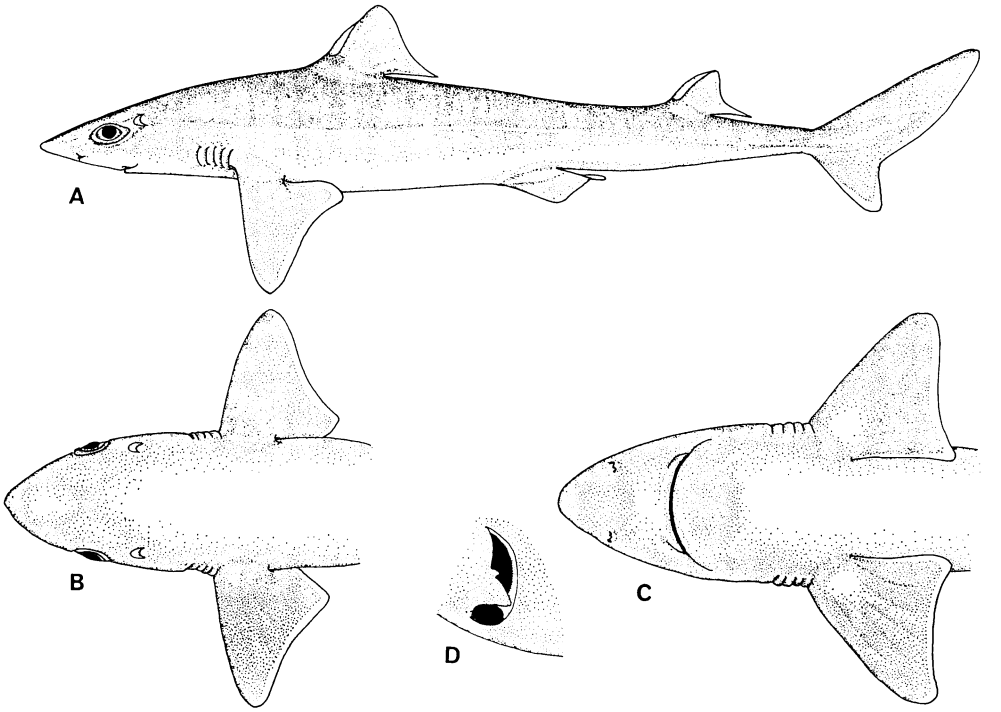

Fig. 3. *Squalus mitsukurii*, male, 887 mm TL (SCUM 1014), from Choshi. A: Lateral view. B: Dorsal view of head. C. Ventral view of head. D. Right nostril.

representative of *S. blainville* in the Mediterranean and here give the species name of *S. blainville* to the above species.

We propose the Japanese common name for this shark as "hiretaka-tsunozame" alluding to its high 1st and 2nd dorsal fins.

Squalus mitsukurii Jordan et Fowler, 1903
(Japanese name: Futo-tsunozame)
(Figs. 3, 4)

Squalus mitsukurii Jordan et Snyder, 1901: 129, name only (Misaki); Jordan and Fowler, 1903: 629 (Misaki); Jordan and Evermann, 1905: 45, fig. 6 (Hawaii); Fang and Wang, 1932: 248, fig. 15 (Chefoo).

Diagnosis. *S. mitsukurii* is distinguishable from *S. blainville* in having the height of the 1st dorsal fin less than 2/3 of its overall length, the 1st dorsal spine shorter than the 1st dorsal base, the height of the 2nd dorsal fin usually less than 5 percent of the total length, and the 2nd dorsal spine less than 6 percent of the total length, and from *S. japonicus* in having a snout in front of mouth shorter than the mouth width, eyes nearer to the tip of snout than the 1st gill opening, and the inner corners of the nostrils nearer to the tip of snout than to the mouth.

Description. Based mainly on a mature male, 887 mm TL (SCUM 1014), variation in other specimens is given in parentheses.

Head broad, depressed; snout bluntly pointed; trunk stout. Dorsal profile more arched than ventral. Caudal peduncle bearing a prominent dermal keel along each side, below the mid-level, extending from below the posterior insertion of 2nd dorsal fin to about 1/3 of distance along the caudal axis. Upper and lower precaudal pits present at the origin of dorsal and ventral lobes.

Dermal denticles on sides of trunk closely packed; each with a nearly horizontal, subcircular, tridentate blade arising from a rhomboidal base; a strong median dorsal ridge, thickened anteriorly, with weaker lateral ridges on each side.

Snout tip to 1st gill opening 5.5 (5.0~6.1) in total length; snout broadly pointed, ex-

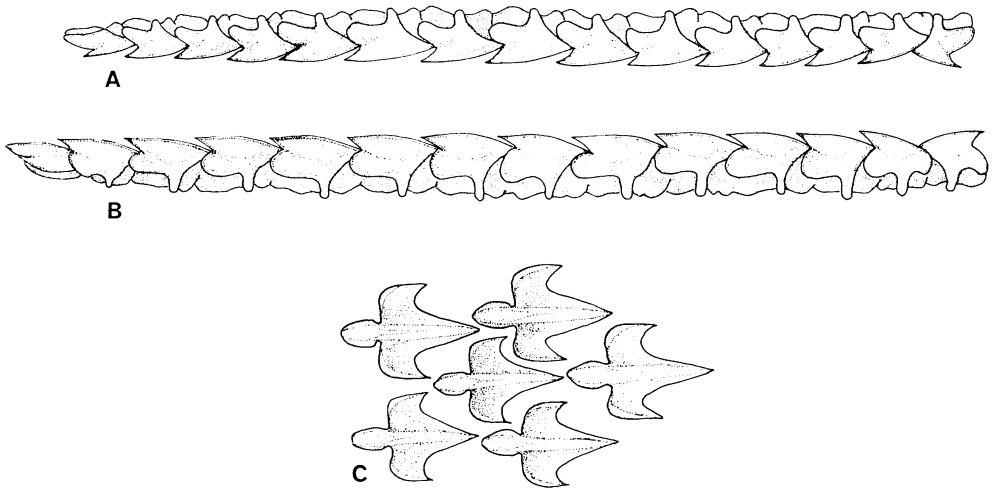

Fig. 4. *Squalus mitsukurii*. A: Upper teeth of a male, 834 mm TL, from Choshi, right side, about 6x. B: Lower teeth of the same. C: Dermal denticles from the trunk region below 1st dorsal fin of a female, 573 mm TL.

panding prominently at the level of nostrils. Snout tip to anterior corner of eyes 3.9 (3.2～3.9) in head length measured to 5th gill opening. Spiracles large, directly behind eyes, separated by a distance approximately equal to the diameter of the spiracles. Gill openings almost vertical, slightly concave, placed in front of the base of pectorals, gradually increasing in length from 1st to 5th, 5th gill opening being 1.8 (1.4～2.3) in the horizontal diameter of eye.

Nostrils almost transverse, placed a little nearer to snout tip than to mouth. Interspace between nostrils 1.1 (1.2～1.5) in the distance from snout tip to eyes. Nasal flap complex, bilobed. Mouth wide, little arched, its width 1.2 (1.1～1.4) in snout length measured to mouth. Preoral clefts short, extending inwards, continued as furrows outward and posteriorly.

Teeth moderate, similar in both jaws. Dental formula $\frac{14-13}{12-11}\left\{\frac{(13-15)-(12-15)}{(11-13)-(10-12)}\right\}$ rows. Base of teeth broader than high with a single smooth-edged, triangular cusp. Upper teeth a little smaller than lowers.

First dorsal large, triangular, its dorsal spine origin nearer to snout tip than to 2nd dorsal spine origin. Height of 1st dorsal fin greater than base length measured from spine origin. First dorsal spine reaching up almost 2/3 of length of anterior margin of the fin. Anterior margin of 1st dorsal slightly convex, and distal margin concave.

Second dorsal smaller than 1st, spine nearer to lower precaudal pit than to pelvic origin, height 1.5 (1.5～2.1) in 1st dorsal height, distal margin concave, apex more acute. Second dorsal spine slightly longer than 1st, its tip reaching the apex of the fin.

Upper caudal lobe 4.9 (4.5～5.1) in total length, well developed without subterminal notch. Lower lobe about half as long as the upper one.

Pectoral fins large, triangular, originating just posterior to 5th gill opening, anterior margin slightly convex, posterior margin almost straight, distal margin comparatively concave, inner corner rounded.

Pelvic fins nearer to 2nd dorsal fin than to the 1st, shallowly triangular, anterior, posterior, and distal margins almost straight.

Total vertebral number 122 (118～127), monospondylous 48 (45～51), precaudal 92 (87～93).

Color in fresh state: Greyish brown above, whitish below. Distal margin of each fin whitish. Iris of eyes greyish blue.

Remarks. *S. mitsukurii* Jordan et Snyder, 1901 is a nomen nudum because they men-

Table 2. Proportional dimensions in percent of total length of *S. mitsukurii*.

Character	Catalogue No. (SCUM)				
	1013	1015	1011	1012	1014
Sex	♀	♂	♂	♂	♂
Total length	573	651	652	660	887
Snout tip to					
outer nostrils	4.5	4.3	4.1	4.1	3.7
eye	7.0	6.0	6.3	6.1	5.5
mouth	10.5	9.2	9.1	9.6	9.2
1st gill opening	18.5	17.1	17.2	17.3	17.1
3rd gill opening	21.1	19.2	19.8	19.7	19.3
5th gill opening	22.7	20.8	21.5	21.4	21.6
pectoral insertion	22.7	20.8	21.5	21.4	21.6
pelvic insertion	35.3	48.2	47.4	51.5	47.8
1st dorsal spine origin	32.3	32.7	30.7	32.6	30.2
2nd dorsal spine origin	66.3	66.5	65.9	68.3	67.4
upper caudal origin	81.5	80.0	79.6	81.1	82.2
Distance between bases					
1st and 2nd dorsal	20.2	28.9	28.5	29.7	32.4
2nd dorsal and caudal	11.2	10.3	10.4	9.6	11.4
Nostrils: distance					
between inner corners	5.1	4.5	4.8	5.2	4.8
Mouth: width	7.9	7.8	8.4	7.9	7.9
Gill-opening lengths					
1st	1.9	1.8	1.8	1.7	1.8
3rd	2.1	2.0	2.3	1.9	2.1
5th	2.8	2.3	2.6	2.3	2.4
Eye					
horizontal diameter	4.2	4.0	4.1	4.7	4.2
1st dorsal fin					
overall length	11.5	12.0	11.2	12.4	11.9
length base	5.2	5.1	5.2	5.6	5.9
height	7.5	7.8	7.4	8.2	7.6
spine length	3.7	—	3.5	3.5	4.2
2nd dorsal fin					
overall length	8.6	8.3	8.6	9.4	8.7
length base	3.7	4.5	3.4	3.3	3.9
height	4.7	5.2	4.9	4.6	4.9
spine length	5.1	5.4	4.8	4.9	4.1
Pectoral fin					
length base	6.1	5.5	5.7	5.6	5.9
length ant. margin	14.0	14.1	14.0	16.2	14.6
length distal margin	10.3	10.5	10.3	11.1	13.1
length post. margin	7.3	7.7	7.7	8.8	7.2
Pelvic fin					
overall length	10.5	11.2	10.4	11.5	11.2
length base	4.7	5.2	4.9	5.2	5.6
length ant. margin	6.3	7.1	6.8	7.6	5.9
length distal margin	6.5	8.0	6.3	6.7	7.1
length claspers	—	5.1	6.1	8.0	10.7
(from pelvic axil)	—	2.8	1.5	2.8	4.6
Caudal fin					
length dorsal lobe	22.2	22.3	20.4	—	20.4
length ventral lobe	11.5	12.4	11.2	—	11.7
Trunk at pectoral origin					
width	14.3	12.3	13.5	—	13.1
height	8.4	—	9.6	—	9.4
Dental formula	13−14 / 12−11	13−14 / 11−12	14−13 / 11−12	13−14 / 11−12	— / —

tioned only name and locality. Jordan and Fowler (1903) referred Jordan and Snyder as the authors of the name when they described *S. mitsukurii* as a new species. However, since we could not find any indication that Jordan and Snyder were responsible for the description by Jordan and Fowler, we regard Jordan and Fowler as the authors of the name according to Article 50 of the International Code of Zoological Nomenclature. This method of interpretation was previously adopted by Jordan and Hubbs (1925), Matsubara (1936, 1955), and Bigelow and Schroeder (1948, 1957).

As pointed out by Bigelow and Schroeder (1948, 1957), *S. mitsukurii* is a compound species, which results in much confusion in the taxonomy of Japanese *Squalus*. In fact, the figure originally pictured by Jordan and Fowler (1903) was clearly that of *S. acanthias*, and subsequently Tanaka (1917) described *S. acanthias* as *S. mitsukurii*. However, the original description of *S. mitsukurii* by Jordan and Fowler (1903) did not conform to *S. acanthias* and has been regarded to be valid or available (Jordan and Hubbs, 1925; Bigelow and Schroeder, 1948, 1957). However, the species name of *S. mitsukurii* has been used for the species described below since a review of Japanese *Squalus* was made by Jordan and Hubbs (1925) who synonymized *S. japonicus* with *S. mitsukurii*. For example, Matsubara (1936, 1955), Okada and Matsubara (1938), Tomiyama et al. (1958), and Abe (1963) employed the viewpoint of Jordan and Hubbs (1925). However, we found the two forms to be distinct if both original descriptions are carefully reviewed. The relevant descriptive portion for *S. mitsukurii* is as follows: head broad, the tip of snout rather broadly rounded, nostrils nearer tip of snout than mouth, eyes a little nearer tip of snout than 1st gill opening.

Further, we tried to examine the type specimens of *S. mitsukurii* and through the courtesy of Dr. L. J. V. Compagno and Mr. S. Kato we have scrutinized the photographs of the holotype deposited in Stanford University and paratypes in California Academy of Sciences. Judging from the photos, our specimens discussed here agree very well with the type of *S. mitsukurii*. In addition, the present specimens fit well into the original description. Therefore, we came to the conclusion that the name for this species is *S. mitsukurii*.

Originally, Jordan and Fowler (1903) called this species "tsunozame" in Japanese, but "tsunozame" had been used for the species described below. To avoid confusion, we propose a Japanese common name, futo-tsunozame, in reference to its heavy body.

Squalus japonicus Ishikawa, 1908
(Japanese name: Togari-tsunozame)
(Figs. 5, 6)

Squalus japonicus Ishikawa, 1908: 71 (Tokyo, Kagoshima); Tanaka, 1917: 467～470. pl. CXXX, figs. 365～367; Tanaka and Abe, 1955: 19.

Squalus mitsukurii; Jordan and Hubbs, 1925: 105～106; Matsubara, 1936: 101, fig. 73; Okada and Matsubara, 1938: 16; Matsubara, 1955: 124; Tomiyama, Abe and Tokioka, 1958: 295, fig. 879; Abe, 1963: 10, fig. 30.

Squalus fernandinus; Matsubara, 1965: 155, fig. 50.

Diagnosis. *S. japonicus* is distinguishable from *S. blainville* in having the height of the 1st dorsal fin less than 2/3 of overall length, 1st dorsal spine shorter than the 1st dorsal base, the height of the 2nd dorsal fin less than 5 percent of the total length, and the 2nd dorsal spine less than 6 percent of the total length, and from *S. mitsukurii* in having a snout in front of mouth longer than the mouth width, eyes nearer to the 1st gill opening than to the tip of snout, and the inner corners of nostrils nearer to the mouth than to the tip of snout.

Description. Based mainly on a mature male, 790 mm TL (SCUM 1029), variation in other specimens is given in parentheses.

Body elongate, slender. Head rather narrow, depressed. Snout pointed. Eyes rather large, lateral, a little nearer to 1st gill opening than to snout tip. Spiracles large, closely posterior to and a little above eyes. Nasal flap complex, bilobed, nearer to mouth than to snout tip. Interspace between nostrils 1.9 (1.6～2.0) in the distance from snout tip to eyes. Mouth moderate, slightly curved, its width 1.6 (1.5～1.9) in snout length measured to mouth. Preoral clefts short, extending

inwards, continued as furrows outward and posteriorly.

Dermal denticles on sides of trunk closely set, each with a nearly horizontal, subcircular, tridentate blade arising from a rhomboidal base. Each blade carries a strong median dorsal margin thickened anteriorly, with weaker lateral ridges on each side.

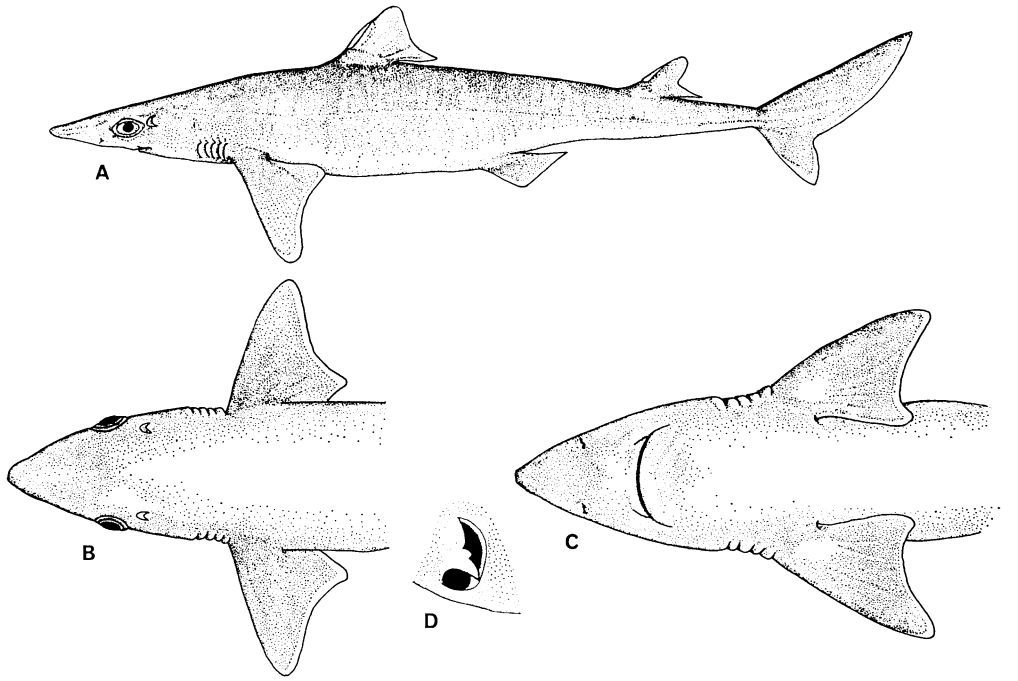

Fig. 5. *Squalus japonicus*, female, 790 mm TL (SCUM 1029), from Choshi. A: Lateral view. B: Dorsal view of head. C: Ventral view of head. D: Right nostril.

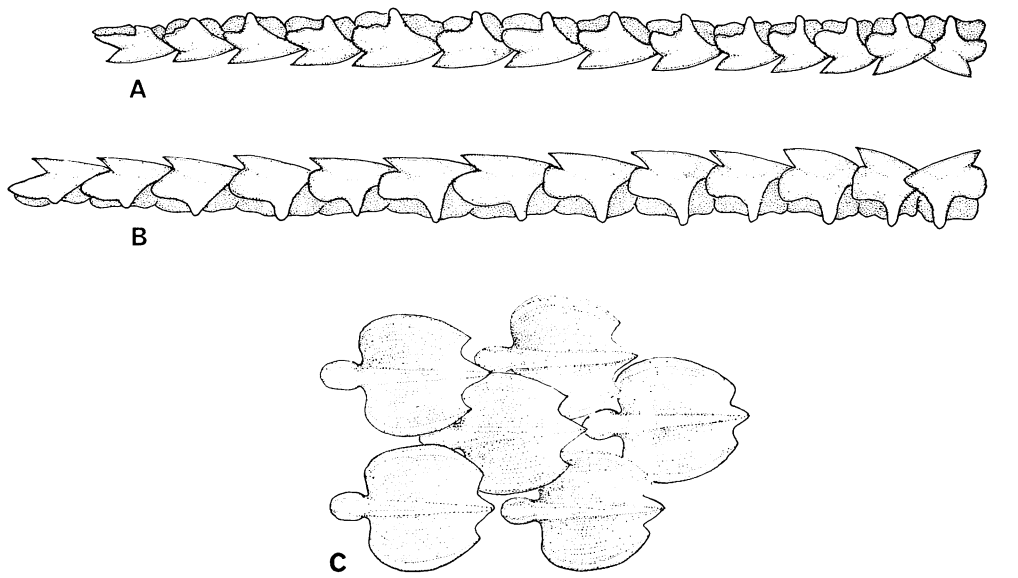

Fig. 6. *Squalus japonicus*. A: Upper teeth of a male, 686 mm TL, from Choshi, right side, about 8x. B: Lower teeth of the same. C: Dermal denticles from the trunk region below 1st dorsal fin of a female, 830 mm TL.

Table 3. Proportional dimensions in percent of total length of *S. japonicus*.

Character	Catalogue No. (SCUM)				
	1009	1027	1006	1008	1029
Sex	♂	♂	♀	♀	♀
Total length	465	612	650	708	790
Snout tip to					
outer nostrils	5.4	5.6	5.4	5.4	5.1
eye	8.0	7.8	8.8	8.5	8.1
mouth	11.4	11.1	10.2	10.9	10.5
1st gill opening	18.7	17.8	18.5	18.1	18.2
3rd gill opening	20.9	20.3	20.2	21.3	20.4
5th gill opening	22.4	22.4	21.4	22.9	22.0
pectoral insertion	22.4	22.4	21.4	22.9	22.0
pelvic insertion	46.9	47.1	48.0	50.1	49.6
1st dorsal spine origin	33.1	34.4	33.0	33.6	33.9
2nd dorsal spine origin	66.2	65.9	66.5	67.4	67.1
upper caudal origin	79.4	48.1	81.5	81.4	81.8
Distance between bases					
1st and 2nd dorsal	29.5	28.1	28.0	29.3	29.2
2nd dorsal and caudal	10.8	10.5	11.5	10.2	11.0
Nostrils: distance					
between inner corners	4.7	4.6	4.6	4.9	4.7
Mouth: width	6.9	6.5	6.4	6.8	6.4
Gill-opening lengths					
1st	1.3	1.3	1.5	1.1	1.5
3rd	1.3	1.5	1.9	1.4	1.7
5th	1.9	2.1	2.3	2.1	2.1
Eye					
horizontal diameter	4.0	3.9	4.2	4.0	3.8
1st dorsal fin					
overall length	10.1	10.6	10.4	11.0	10.8
length base	4.3	4.9	4.1	5.4	5.3
height	6.5	6.5	6.8	6.8	7.2
spine length	3.0	3.9	3.5	4.1	4.7
2nd dorsal fin					
overall length	8.0	8.3	8.4	7.9	8.2
length base	3.0	3.8	3.7	3.7	3.5
height	4.3	4.7	4.0	4.4	4.5
spine length	5.2	5.9	—	5.5	5.4
Pectoral fin					
length base	4.5	4.7	4.9	4.7	5.2
length an. margin	11.4	13.1	13.1	14.1	15.2
length distal margin	8.6	9.2	9.1	8.6	11.1
length post. margin	7.7	7.5	7.4	7.6	7.2
Pelvic fin					
overall length	11.4	11.1	9.2	10.6	10.6
length base	6.0	4.9	4.3	4.6	4.4
length ant. margin	6.5	6.2	6.2	6.4	6.4
length distal margin	6.0	6.7	5.4	6.1	6.6
length claspers	9.8	11.1	—	—	—
(from pelvic axil)	4.0	4.3	—	—	—
Caudal fin					
length dorsal lobe	20.7	20.4	20.9	20.2	21.1
length ventral lobe	11.2	10.6	11.4	11.4	11.3
Trunk at pectoral origin					
width	—	12.1	12.0	12.0	12.6
height	—	—	8.9	8.2	9.5
Dental formula	—	$\frac{13-13}{12-11}$	—	$\frac{14-13}{12-11}$	$\frac{13-14}{12-12}$

Snout tip to 1st gill opening 5.5 (4.9～5.9) in total length. Snout tip to anterior corner of eyes 2.7 (2.5～3.0) in head length measured to 5th gill opening. Gill opening moderate, in front of pectoral base, slightly concave, almost vertical, gradually increasing in length from 1st to 5th, 5th gill opening being 1.8 (1.6～2.5) in the horizontal diameter of eye.

Teeth moderate, similar in both jaws. Dental formula $\frac{13-14}{12-12}\left\{\frac{(13-15)-(13-14)}{(11-14)-(11-12)}\right\}$ rows. Upper teeth a little smaller than lowers, and more erect.

First dorsal moderate, triangular, its dorsal spine origin nearer to pectoral origin than to pelvic origin and situated midway between snout tip and 2nd dorsal spine origin. Height of 1st dorsal fin greater than base length measured from spine origin. First dorsal spine reaching almost 2/3 of length of anterior margin of the fin. Anterior margin of 1st dorsal fin slightly covex and distal margin concave.

Second dorsal fin smaller than 1st dorsal, spine nearer to lower precaudal pit than to pelvic origin, height 1.6 (1.3～1.7) in 1st dorsal height, distal margin concave, its apex more acute. Second dorsal spine slightly longer than 1st, tip reaches almost the apex of the fin.

Upper caudal lobe 4.7 (4.7～5.4) in total length, well developed without subterminal notch. Lower lobe half as long as the upper.

Pectoral fins large, originating just posterior to 5th gill opening, anterior margin slightly convex, posterior margin almost straight, distal margin somewhat concave, its inner corner rounded.

Pelvic fins situated about midway between 1st and 2nd dorsals, anterior, posterior, and distal margins almost straight, its apex smoothly rounded, and its posterior extension sharply pointed.

Total vertebral number 117 (110～119), monospondylous 42 (40～45), precaudal 87 (82～91).

Color in fresh state: Greyish brown above, white below. Distal margin of each fin whitish. Iris of eye greyish blue.

Remarks. As already mentioned, *S. japonicus* has been confused with *S. mitsukurii*. We also reviewed the original description of *S. japonicus* by Ishikawa (1908). The relevant descriptive portion is as follows: head rather narrow, snout produced, pointed; nostrils nearer mouth than tip of snout, eyes nearer 1st gill opening than end of snout. We attempted to examine the type specimens which were reported to be deposited in the National Science Museum in Japan. Unfortunately, we could not find the types, but examined two specimens labelled as *S. japonicus*. We found these specimens to be identical to *S. japonicus* as described by Ishikawa. Ishikawa collected the types at markets in Tokyo and Kagoshima where our specimens were taken. These support our conclusion that this species is indeed *S. japonicus*, although this name has not been used in Japan since the original description except by Tanaka (1917), Tanaka and Abe (1955), and Chyung (1961, 1977).

We employed togari-tsunozame as the Japanese common name for this species. This name was given to the species by Tanaka (1917). Most tsunozame appearing in the figures and descriptions of Japanese publications indicate the present species.

Comparison of *S. blainville*, *S. mitsukurii*, and *S. japonicus*

The three species mentioned above resemble each other in shape of fins, teeth, dermal denticles and nasal flaps and in lacking white spots on their body at all stages of growth. In addition, the most frequent tooth counts show no difference among them, though the range

Table 4. Variation in number of teeth in *S. blainville*, *S. mitsukurii*, and *S. japonicus*.

S. blainville

		upper jaw 27
lower jaw	23	23

S. mitsukurii

		upper jaw 25	26	27	28	29
lower jaw	22	—	—	1	—	—
	23	1	6	23	—	1
	24	—	—	—	1	—
	25	—	—	—	—	1

S. japonicus

		upper jaw 25	26	27
lower jaw	23	1	6	24
	24	—	—	2

of tooth counts for each species is not the same (Table 4). However, some characters are available for discriminating the three species.

The relationship between height of the 1st dorsal fin and body length measured to the upper precaudal pit is shown in Fig. 7. It is clear that *S. blainville* is distinguished from *S. mitsukurii* and *S. japonicus* in having a higher dorsal fin. Likewise, the 1st dorsal spine in *S. blainville* is longer than that in *S. mitsukurii* and *S. japonicus* (Fig. 8). The same is true of the 2nd dorsal height and the length

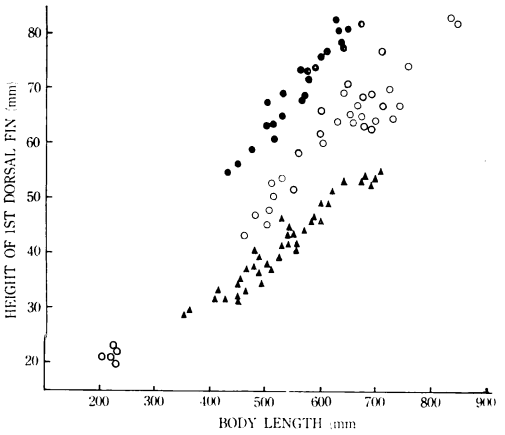

Fig. 7. Relationship between the length of the 1st dorsal fin and the body length for three species of *Squalus*. Solid circle, *S. blainville*; open circle, *S. mitsukurii*; triangular, *S. japonicus*.

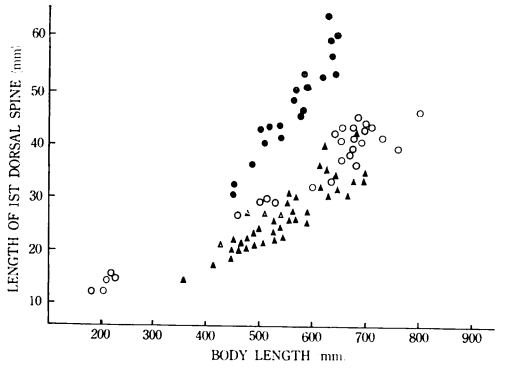

Fig. 8. Relationship between the height of the 1st dorsal spine and the body length in three species of *Squalus*. Solid circle, *S. blainville*; open circle, *S. mitsukurii*; triangular, *S. japonicus*.

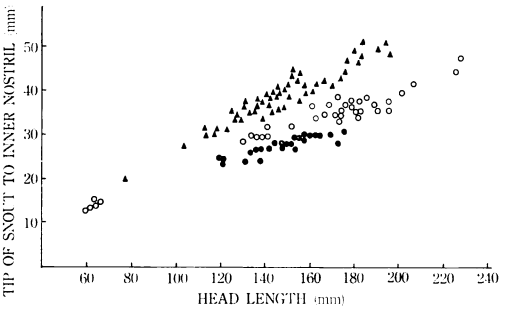

Fig. 9. Relationship between the distance from the tip of snout to inner nostril and the head length in three species of *Squalus*. Solid circle, *S. blainville*; open circle, *S. mitsukurii*; triangular, *S. japonicus*.

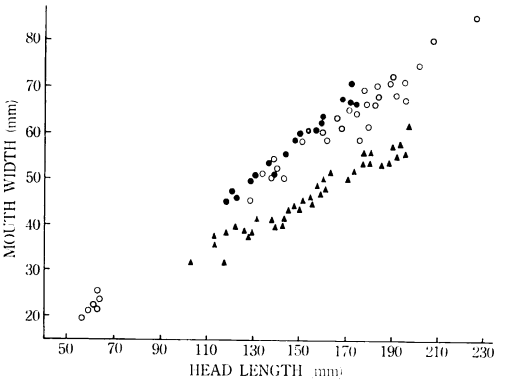

Fig. 10. Relationship between the mouth width and the head length for three species of *Squalus*. Solid circle, *S. blainville*; open circle, *S. mitsukurii*; triangular, *S. japonicus*.

of the 2nd dorsal spine.

The position of the nostrils with respect to head length is a useful character for discriminating *S. japonicus* from the others. It is clearly shown in Fig. 9 that the distance from the snout tip to the inner nostrils is greater in *S. japonicus* than in either *S. blainville* or *S. mitsukurii*.

The mouth width is also an important character. It is quite evident from Fig. 10 that mouth width is shorter in *S. japonicus* than in *S. blainville* and *S. mitsukurii*. In addition, the width of the trunk at the pectoral origin is narrower in *S. japonicus* than in *S. blainville* and in *S. mitsukurii*.

A further distinction is found in vertebral numbers (Table 5). The total vertebral number

is slightly fewer in *S. japonicus* (110～119), than in *S. blainville* (118～125) and in *S. mitsukurii* (118～127), though there are some overlaps.

Discussion

Since *S. blainville* was first described from the Mediterranean, many allied species have been reported from various regions. The confusion in the so-called *blainville* group was probably caused by Risso's insufficient description, which failed to clearly identify *S. blainville* and offered few distinguishing characters. For this reason, we employed Poll's description and illustration as a representative of *S. blainville* in the Mediterranean, type locality of this species. The Japanese shark with high dorsal fins and long spines is nearly identical to *S. blainville* described by Poll (1951). On the other hand, the sharks reported under *S. blainville* (including *S. fernandinus* sensu Bigelow and Schroeder, 1948) from the western North Atlantic (Bigelow and Schroeder, 1948), South Africa (Bass et al., 1976), and New Zealand (Garrick, 1960) show more resemblance to *S. mitsukurii* than to the *S. blainville* of the present study.

Squalus mitsukurii has been wrongly adopted for the form we name *S. japonicus*. There may be two plausible explanations for this confusion. One is that Jordan and Fowler's original description was not identical with their figure, which indicated *S. acanthias*. The other is that most Japanese ichthyologists followed Jordan and Hubbs (1925) rather than Tanaka (1917) who rightly employed *S. japonicus*.

Squalus japonicus has been neither described nor recorded from Japan since Tanaka (1917) except for the indication of the presence of this species by Tanaka and Abe (1955). This does not indicate the scarcity of *S. japonicus* around Japan but originates in the confusion of classification, as mentioned above. *S. japonicus* is more abundant than other species of *Squalus* at least in middle and southern Japan.

There are some differences in vertebral numbers between species and between regions under the same species name (Table 5). Regardless of the identity of *S. blainville*, this species in Japan has more vertebrae than those in any other regions. There is an especially clear distinction between the present specimens and those from the northwestern Pacific, Hawaii, northwestern Atlantic, and Mediterranean reported by Springer and Garrick (1964). Some doubts may occur in identification of Japanese specimens because large differences exist in vertebral numbers between those from Japan and the Mediterranean. However, large variation in vertebral numbers between regions was also observed in *S. acanthias*. For example, precaudal vertebrae of *S. acanthias* from the North Pacific range from 68 to 73 while those from the North Atlantic from 79 to 85 (from Table 1 of Springer and Garrick, 1964). There is no overlap in precaudal vertebral numbers between the two regions. Accordingly, apart from the problem of subspecific differentiation of *S. acanthias*, the difference in vertebral numbers can be attributable to variation within a single species.

In Japan, *S. blainville* is confined to

Table 5. Vertebral counts of *S. blainville*, *S. mitsukurii* and *S. japonicus* in Japan, with reported numbers for *S. blainville* from different localities.

Species	Locality	Precaudal		Total		No. of specimens (Source)
		Range	Mean	Range	Mean	
S. blainville	Northwest Pacific	86～69	88.3	114～118	116.0	4(Springer and Garrick, 1964)
S. blainville	Hawaii	84	84.0	113	113.0	1(Springer and Garrick, 1964)
S. blainville	Northwest Atlantic	85～87	86.0	115～117	115.6	5(Springer and Garrick, 1964)
S. blainville	Mediterranean	78～80	79.0	106～108	106.7	3(Springer and Garrick, 1964)
S. blainville	Southwest Indian Ocean	80～90	85.5	109～121	115.5	150(Bass et al., 1976)
S. blainville	Southern Japan	90～96	93.1	118～125	122.4	25(Present study)
S. mitsukurii	Middle Japan	87～93	90.0	118～127	120.8	28(Present study)
S. japonicus	Southern to middle Japan	82～91	86.4	110～119	114.8	82(Present study)

southern waters. This species is also distributed at least in eastern Taiwan. One of us (Chen) has seen *S. blainville* at the Taitung fish market in Taiwan. However, extention of its distribution to the Philippines is very doubtful, although Bigelow and Schroeder (1957) stated that *S. philippinus* Smith and Radcliffe was not separable from *S. fernandinus* (syn. *S. blainville*). We found by careful review of the original description of *S. philippinus* that it differs from *S. blainville* of the present study in the height of dorsal fins and length of spines. Outside Japan and adjacent seas, the distribution of this species is unknown except for its occurence in the Mediterranean.

Squalus mitsukurii is reported originally from Misaki, Kanagawa Prefecture. We collected specimens of this species from Hachinohe, Choshi, and the entrance of Tokyo Bay. Further, it was recorded under *S. mitsukurii* in southern China (Fang and Wang, 1932), and in the Hawaian Islands (Jordan and Evermann, 1905). The descriptions in the above reports show good agreement with *S. mitsukurii* of the present study. This species occurs at sea mounts in the North Pacific; one of us (Taniuchi) has seen many specimens taken from such areas. It is probable that it is also distributed widely in the South Pacific, judging from cruise reports of research ships. If these reports are true, New Zealand specimens of *S. blainville* described by Garrick (1960) may be identical with *S. mitsukurii*. However, *S. philippinus* is separable from *S. mitsukurii*.

Squalus japonicus has not been recorded outside Japan and Korea. Chyung (1961, 1977) employed *S. japonicus* for one of four species of *Squalus* distributed in Korea. However, his apical view of *S. japonicus* provides little information on the species. In addition, the photographs of *S. fernandinus* and *S. mitsukurii* by Chyung look more like *S. japonicus* than *S. blainville* in having a pointed snout. Anyway, so for as we know, descriptions representing characteristics of *S. japonicns* have not appeared outside Japan and adjacent seas. Around Japan, *S. japonicus* is found on the continental shelf of the Pacific coast from Choshi to Kagoshima and in the East China Sea.

This study is limited to three species of *Squalus* belonging to the *blainville* group. There remain a couple of problems regarding other species of *Squalus* in Japan. For example, we doubt if *S. acanthias* in Japan belongs to the short-pectoral-fin subspecies, *S. acanthias acanthias* as described by Lindberg and Ligeza (1956). Further, it is not settled whether morphological differences found between *S. megalops* (Macleay) and *S. brevirostris* Tanaka should be relegated to the species or subspecies level. In addition, the identity of the species reported by Kibesaki (1954) remains unsettled. For these reasons, a revision of the genus *Squalus* is much needed on the basis of worldwide examination of specimens and references.

Acknowledgments

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日本から初記録のヒレタカツノザメおよびフトツノザメとトガリツノザメ

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日本からヒレタカツノザメ *Squalus blainville* (Risso) を初めて報告した．また，日本のツノザメ属魚類の分類には混乱が認められるため，フトツノザメ（新称）*S. mitsukurii* Jordan et Fowler とトガリツノザメ *S. japonicus* Ishikawa も記載した．これら3種はいずれも *blainville* group に属し，形態がきわめて類似するが，吻長，口幅，背鰭の高さ背鰭棘の長さ，および，椎脊骨数などの違いを組合せることにより，3種が容易に区別されることがわかった．さらに，3種の分類上の問題点や地理的分布について論じた．

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