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Occurrence of a Rare Squaloid Shark, *Trigonognathus kabeyai*, from the Hawaiian Islands[1]

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ABSTRACT: The first occurrence of the rare viper shark, *Trigonognathus kabeyai,* from the central Pacific Ocean is reported. Morphometrics are compared between this specimen and the type specimens from Japan, and this specimen differs from the types in only a few measurements. The poor preservation of this specimen precluded examination of internal anatomy.

THE SHARK *Trigonognathus kabeyai* belongs to a recently described genus and species in the family Squalidae. Only three specimens, all from Japan, have been reported since this species was described in 1990 (Mochizuki and Ohe 1990, Shirai and Okamura 1992; L. J. V. Compagno, pers. comm.). This shark differs in skeletal morphology from other squaloid sharks and is distinguished from similar genera by the presence of a triangular jaw and long, caninelike teeth (Shirai and Okamura 1992). Shirai and Okamura (1992) grouped the genus *Trigonognathus* into the subfamily Etmopterinae and speculated about the mode of feeding used by this shark. We report on the capture of an individual of *T. kabeyai* from the Northwestern Hawaiian Islands, which represents the fourth known specimen of this shark and the first occurrence in the central Pacific Ocean. We compare morphometric measurements of the Hawai'i specimen with those of specimens captured in Japan.

MATERIALS AND METHODS

On 15 August 1987, a 41.3-cm total length (TL) female *T. kabeyai* was captured during exploratory fishing for armorhead (*Pseudopentaceros wheeleri*) aboard the NOAA ship *Townsend Cromwell* at 29° 48.0′ N, 179° 04.6′ E on Southeast Hancock Seamount, approximately 300 km northwest of Kure Atoll, Northwestern Hawaiian Islands. The shark was caught in an Aberdeen bottom trawl, which was towed east to west across the seamount at a depth of approximately 270 m. Towing speed was between 2.5 and 3.0 knots (4.6–5.6 km/hr) and the trawl was hauled at approximately 2200 hours.

The shark was frozen aboard ship, transferred to an onshore freezer, and stored frozen until we examined it. Measurements were taken according to Compagno (1984) and expressed as percentage of total length. The specimen was x-rayed for determination of vertebral number and deposited in the Bernice P. Bishop Museum, Honolulu (BPBM 38354).

RESULTS

Description

Our specimen is similar in physical appearance to individuals described in other studies. Both jaws are sharply triangular and contain widely spaced, long, slender, slightly curved teeth (Figure 1*a*). Tooth counts for both upper and lower jaws of our specimen are 9-1-10. The snout over the upper jaw is very flexible and can be easily separated from the jaw and retracted as far back as below the eye (Figure 1*b*). Spines are present on both

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a

FIGURE 1. *Trigonognathus kabeyai*, female, 41.3 cm total length, from Hawai'i, BPBM 38354. *a*, Close-up of head with distinct caninelike teeth. *b*, Head with flexible snout distended. Scale bar = 1 cm.

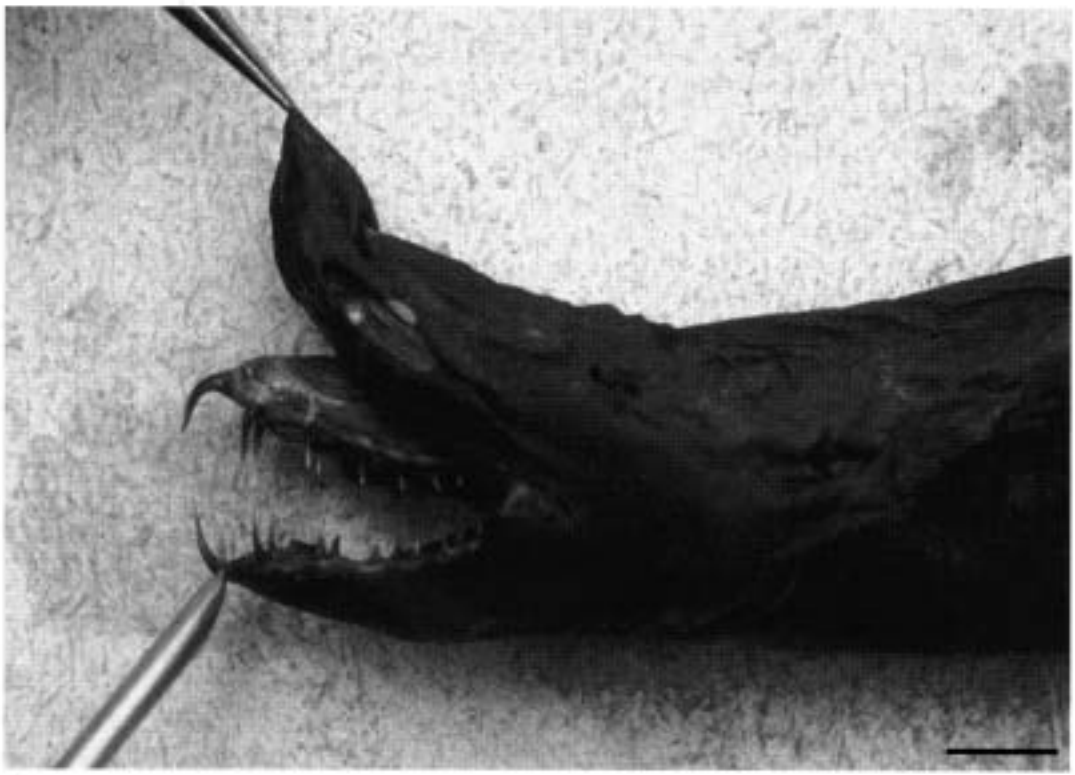
dorsal fins; the length of the second dorsal fin spine is more than two times that of the first dorsal fin spine. Flank markings are present on the underside of the body and appear to contain photophores. All fins are small and thin to the point of being translucent.

Morphology

Measurements of our specimen generally agree with those of Mochizuki and Ohe (1990) and are presented in Table 1. A number of measurements for the Hawai'i specimen differ considerably from the measurements presented for the holotype and paratype. For example, the length of the base of the first dorsal fin for our shark is 7.7% of the TL, but only 4.6 and 4.7% for the Japan sharks. The length of the first gill slit of the Hawai'i specimen is 2.7% TL compared with 0.9 and 1.8% for the Japan sharks. Distance from the snout tip to the eye is 3.1% of the TL for our shark and 4.9 and 5.4% for the Japan sharks. The height of the trunk at the origin of the pectoral fin is only 6.5% of TL compared with 12.0 and 12.4% for the Japan sharks. Differences are also fairly large between our specimen and the Japan specimens for the length of the second dorsal fin base, pelvic fin base, and lower lobe of the caudal fin.

Biology

Because of the prolonged storage in a freezer, the internal organs of our specimen were not well preserved and few biological observations were obtained for this shark. It



b

Figure 1. (continued)

was not possible to identify reproductive structures and the stomach was empty. Other elasmobranchs captured in the same trawl as our specimen were six shortspine spurdog (*Squalus mitsukurii*) and five smooth lantern sharks (*Etmopterus pusillus*).

DISCUSSION

This is only the fourth known specimen of *T. kabeyai*, and the first outside Japan. The three other specimens were all collected fairly close to each other, east of Kochi Prefecture in southern Japan. The occurrence in the Northwestern Hawaiian Islands greatly expands the distribution of this species. There are apparently several species of deep-sea sharks that are common to both Japanese waters and to the Northwestern Hawaiian Islands or nearby seamounts (Borets 1986, Shirai and Tachikawa 1993, Wetherbee and Crow 1996).

Depth of capture for the Hawai'i specimen (270 m) was slightly shallower than that reported for the holotype (330 m) and paratype (360 m) in Japan (Mochizuki and Ohe 1990). Our specimen may have been part of an assemblage of squaloid sharks that are common near the bottom on slopes of seamounts in the Northwestern Hawaiian Islands (B.M.W., unpubl. data). Although the condition of our specimen precluded examination of reproductive structures, this is the second female captured, and it is considerably larger than the previous female reported (25.8 cm TL) by Shirai and Okamura (1992). The largest specimen found previously was a 37.2-cm TL male (Mochizuki and Ohe 1990).

Some of the differences in morphometric

TABLE 1

TOTAL LENGTH AND PROPORTIONAL DIMENSIONS (AS PERCENTAGE OF TOTAL LENGTH) FOR *Trigonognathus kabeyai* FROM THE HAWAIIAN ISLANDS AND FROM JAPAN

MEASUREMENT	HAWAI'I (cm)	%TL	HOLOTYPE[a] %TL	PARATYPE[a] %TL
Sex	f		m	m
Total length (cm)	41.3		21.6	37.2
Snout tip to:				
Nostrils	0.4	1.0	1.2	1.0
Mouth	1.0	2.4	2.3	2.0
Eye	1.3	3.1	4.9	5.4
Spiracle	3.8	9.2	10.9	10.2
First gill slit	6.5	15.7	18.1	17.5
Fifth gill slit	8.9	21.5	22.2	22.3
Pectoral origin	8.9	21.5		
Pectoral insertion	9.9	24.0	22.2	23.4
First dorsal origin	14.8	35.8	37.5	37.9
Pelvic origin	23.8	57.6		
Second dorsal origin	25.2	61.0	60.6	63.2
Cloaca	25.4	61.5	60.2	61.0
Pelvic insertion	26.8	64.9	55.6	58.9
Upper caudal origin	33.9	82.1	81.9	83.3
Distance between bases:				
First and second dorsal	7.8	18.9	21.5	23.7
Second dorsal and caudal	5.4	13.1	15.0	14.1
Pectoral and pelvic	14.5	35.1	32.9	32.7
Pelvic and caudal	7.5	18.2	19.2	18.3
Distance between pectoral and pelvic origins	15.2	36.8		
Mouth width	3.0	7.3	8.1	9.1
Horizontal eye diameter	2.1	5.1	5.3	5.2
Interorbital space	2.8	6.8	7.9	7.1
Interspiracle space	2.2	5.3	5.5	5.9
Internostril space	1.1	2.7		
Gill slit length:				
First gill slit	1.1	2.7	0.9	1.8
Fifth gill slit	0.8	1.9	1.6	2.1
First dorsal fin:				
Overall length	4.2	10.2	9.5	9.8
Posterior margin length	1.8	4.4	4.7	4.8
Height	1.0	2.4	2.3	2.2
Base length	3.2	7.7	4.7	4.6
Spine length	0.5	1.2		3.5
Second dorsal fin:				
Overall length	5.5	13.3	11.9	12.1
Posterior margin length	1.9	4.6	4.6	5.0
Height	1.4	3.4	3.2	3.6
Base length	3.7	9.0	7.4	7.3
Spine length	1.2	2.9		
Pectoral fin lengths:				
Overall	3.7	9.0	11.1	9.8
Base	1.4	3.4		
Anterior margin	2.8	6.8		
Posterior margin	2.4	5.8		
Interior margin	2.3	5.6		
Span	10.8	26.2		
Pelvic fin lengths:				
Overall	4.7	11.4	10.7	11.7
Base	3.4	8.2	6.3	6.7

TABLE 1 (continued)

MEASUREMENT	HAWAI'I (cm)	%TL	HOLOTYPE[a] %TL	PARATYPE[a] %TL
Caudal fin:				
Upper lobe length	7.1	17.2	19.2	17.6
Lower lobe length	2.9	7.0	8.6	8.6
Trunk at origin of pectoral fin:				
Width	4.3	10.4	9.3	11.0
Height	2.7	6.5	12.0	12.4
Tooth counts:				
Upper jaw	9-1-10		7-1-7	8-1-8
Lower jaw	9-1-10		7-1-7	8-1-8
Vertebral centra:				
Precaudal	63		62	62
Total	87		87	88

[a]From Mochizuki and Ohe (1990).

measurements between our specimen and those from Japan are likely artifacts of a prolonged frozen state. However, differences between measurements of more rigid structures, less likely to have been altered by freezing, were also observed. To address the question of potential morphological differences between our specimen and the types, the type specimens were reexamined and those data were compared with the published data (Mochizuki and Ohe 1990). In both data sets the Hawaiian specimen differed from the types by greater than 10% on three morphological measurements. Snout tip to eye, length of the first gill slit, and height of the trunk at the origin of the pectoral fins all show large differences from the type specimens. Differences in the distance from snout tip to eye and height of the trunk might be artifacts of prolonged freezing, but length of the first gill slit on the Hawaiian specimen is three times greater than that of the paratype (Table 1). Sexual dimorphism might account for some differences because our specimen is a female, whereas both the holotype and paratype are males. Also, differences in some measurements might be attributable to allometry because our specimen is nearly 20 cm longer than the holotype.

The teeth of *T. kabeyai* differ from those of other squaloids in shape (long and slender), number (fewer), and arrangement (large gaps between neighboring teeth). Most squaloids have short, spikelike teeth in the upper jaw and a continuous band of larger, sawlike teeth in the lower jaw. The triangular jaws of *T. kabeyai* are also dissimilar to the semicircular shape common among other squaloids and are probably most similar in shape to those of the frilled shark (*Chlamydoselachus anguineus*). Shirai and Okamura (1992) postulated a grasping type of feeding mode for *T. kabeyai* based on the dentition, jaw structure, musculature, and articulation of the upper jaw and cranium. The feeding mode of *T. kabeyai* may resemble that of the goblin shark (*Mitsukurina owstoni*), which also has long, awl-like teeth and a flexible snout that enables rapid projection from the head (Compagno 1984). The mouth of *T. kabeyai* reminded Mochizuki and Ohe (1990) of an alligator, but we suggest that the common name "viper shark" is more descriptive and indicative of the similarity between this species and the viperfish (*Chauliodus sloani*).

Shirai and Okamura (1992) suggested that *Trigonognathus* was possibly a sister group to *Etmopterus* and *Miroscyllium* and grouped this new genus in the subfamily Etmopterinae, which also includes the genera *Aculeola, Centroscyllium, Etmopterus,* and *Miroscyllium* (Compagno 1973, Shirai and Nakaya 1990). From the head back, *T. kabeyai* is very similar in appearance to several species in the genus *Etmopterus* and shares characteristics such as body shape, a second dorsal

fin spine that is larger than the first dorsal fin spine, and the presence of dark flank markings. In fact, the biologists that collected the Hawai'i specimen of *T. kabeyai* inadvertently included it with *E. pusillus* specimens. As deep-sea fisheries around the world expand, more individuals of this rarely captured, poorly known, yet unique looking species of shark will be obtained and its biology will be better understood.

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