

# Notes on the Presence of *Mustelus sinusmexicanus* and *Hexanchus nakamurai* (Chondrichthyes: Elasmobranchii) in Mexican waters

## Abstract

The taxonomy and distribution of 2 deep water sharks, *Mustelus sinusmexicanus* and *Hexanchus nakamurai*, is discussed here on the basis of 3 specimens from the Gulf of Mexico. Both species are distributed in the area; however, they are rarely found in ichthyological collections as they are seldom caught and due to the challenge of curating such large specimens. Thus, this is the first time that Gulf Smooth hound and Bigeye Sixgill shark specimens have been curated in a Mexican ichthyological collection, confirming its presence in México.

**Keywords:** New documented records; Hexanchidae; Triakidae; Mexican sharks; *Mustelus sinusmexicanus*; *Hexanchus nakamurai*

## Introduction

Selachii comprise a taxon of particular interest for their unique biology, ecology, and behavior; but, intensive fisheries have been reduced dramatically their abundances [1]. Thus, it is imperative that we taxonomically verify any reports and curate samples of the specimens in the corresponding reference collections. In Mexico, Selachii or sharks are represented by 109 species, which in turn constitute 30% of the world's species richness [2].

In this study, we present information regarding the taxonomic characteristics and distribution of Gulf Smooth hound (*Triakidae*) and Bigeye Sixgill sharks (*Hexanchidae*) based on the examination of three specimens from the Gulf of Mexico. While both species are distributed in the area, very few are included in reference collections [3,4] this is due to the rarity of capturing them and the difficulty of curating such large samples.

## Material and Methods

Three specimens of the 2 species reported here were caught by the commercial fishery using bottom long lines near the Campeche Bank in Mexico. These specimens were deposited and cataloged in the ichthyology collection at El Colegio de la Frontera Sur (ECOSC). The specimens were identified following the relevant literature [2,5-11]. Additionally, biometrics were recorded for each specimen which follow to Ebert et al. [9] and Heemstra [10] with some modifications and additions based on the morphology of the organisms examined (Table 1). The nomenclature and taxonomic arrangement are after Page et al. [12].

## Description

We identified a total of 2 genera corresponding to an equal number of families and orders, which were described as follows:

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## Taxonomy summary

Class: Chondrichthyes

Subclass: Elasmobranchii

Order: Carcharhiniformes

Family: Triakidae

Genus *Mustelus* Linck 1790

The genus *Mustelus* includes 27 species distributed in tropical, subtropical, and temperate climates of the world's oceans [5,7,8,9], representing 33.3% of the species in Mexican waters [2,13]. *Mustelus sinusmexicanus* Heemstra, 1997 (Figure 1, Table 1).

- Common name:** Cazón del Golfo (Spa.), Gulf Smooth hound
- Material examined:** Two eviscerated, sexually mature specimens, 1 male (ECOSC 7471-1; 800 mm TL, 1,100 g) and 1 female (ECOSC 7471-2; 1,092 mm TL, 3,500 g). Both specimens were caught at 48.6 km north of the San Pedro Port, Centla, Tabasco, Mexico, near of the Campeche Canyon (18°38'36"N and 98°28'07"W) by a commercial fishing vessel using bottom longlines, on April 30, 2010.
- Description:** The Gulf Smoothhound specimens were identified based on a number features, including their long,

lean bodies that are flattened on the ventral side; a flattened head; a pointed, long rostrum (pre-oral length 6.2-7.2% TL); 5 pairs of gill slits, the fourth pair on the origin of the pectoral fins; large, oval eyes(2.6-3.2% TL) with nictitating membranes at their base; the presence of small spiracles; the nostril width(1.5-1.6% TL); the internarinal width (2.1-2.9% TL); a wide mouth (5.5% TL) with longer upper labial furrows (1.6-2% TL); a limited number of small teeth arranged in a mosaic of several rows; and the presence of tricuspid dermal denticles between the pectoral and pelvic

fins. Biometric data for the specimens are presented in Table 1 most measurements were within the ranges indicated by Compagno [6] and Heemstra [10] for this species.

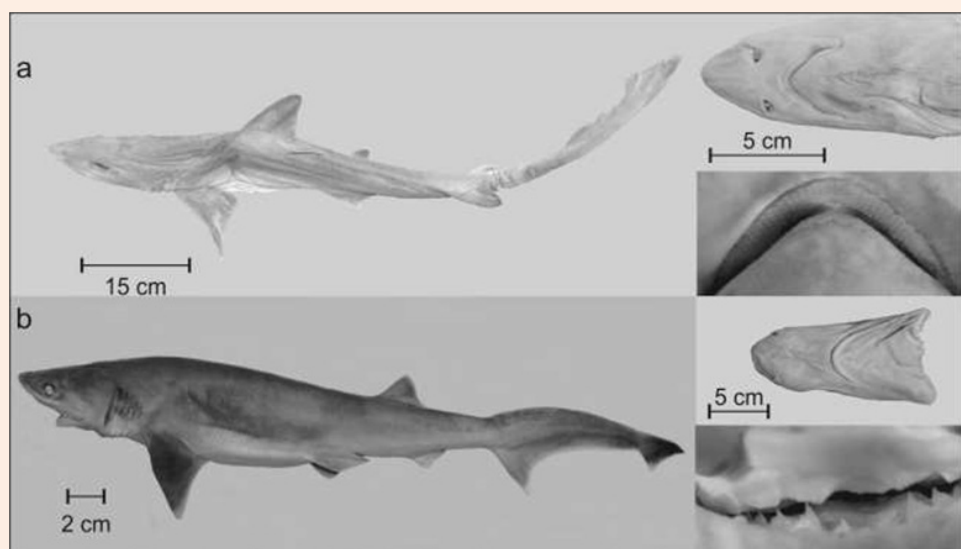
d. **Distribution:** This species of shark is considered endemic to the Gulf of Mexico, with a distribution that extends from Panama City, Florida, USA to the Campeche bay, Mexico [5,8,10]. Prior to this study, there have been no verified records of voucher specimens deposited in national reference collections; however, other researchers have previously discussed the species' presence in Mexican waters [2].

**Table 1:** Morphometric data for *Mustelus sinusmexicanus* [MSM] and *Hexanchus nakamurai* [HN] form Mexican waters. Boldface measurements are expressed as percentages of total length.

Biometrics (mm)	MSM	MSM	HN
	ECOSC 7471	ECOSC 7472	ECOSC 7414
Total length	800	1092	896
Pre-caudal length	614.0 <b>(76.7)</b>	935.0 <b>(85.6)</b>	570.0 <b>(65.6)</b>
Pre-narinal length	32.0 <b>(4.0)</b>	52.0 <b>(4.7)</b>	13.0 <b>(1.5)</b>
Pre-oral length	58.0 <b>(7.2)</b>	68.0 <b>(6.2)</b>	51.0 <b>(5.8)</b>
Pre-orbital length	65.0 <b>(8.1)</b>	76.0 <b>(6.9)</b>	34.0 <b>(3.8)</b>
Pre-spiracle length	40.0 <b>(5.0)</b>	55.0 <b>(5.0)</b>	96.0 <b>(10.9)</b>
Pre-gill length	145.0 <b>(18.1)</b>	167.0 <b>(15.3)</b>	123.0 <b>(14.0)</b>
Pre-pectoral length	160.0 <b>(20.0)</b>	210.0 <b>(19.2)</b>	146.0 <b>(16.6)</b>
Pre-pelvic length	345.0 <b>(43.1)</b>	490.0 <b>(44.8)</b>	341.0 <b>(38.9)</b>
Snout-ventral length	382.0 <b>(47.7)</b>	475.0 <b>(43.5)</b>	366.0 <b>(41.8)</b>
Pre-dorsal length	200.0 <b>(25.0)</b>	307.0 <b>(28.1)</b>	420.0 <b>(47.9)</b>
Dorsal-caudal space	298.0 <b>(37.2)</b>	453.0 <b>(41.5)</b>	99.0 <b>(11.3)</b>
Pre-anal length	525.0 <b>(65.6)</b>	705.0 <b>(64.5)</b>	468.0 <b>(53.4)</b>
Pectoral-pelvic space	168.0 <b>(21.0)</b>	310.0 <b>(28.3)</b>	143.0 <b>(16.3)</b>
Pelvic-anal space	151.0 <b>(18.9)</b>	169.0 <b>(15.5)</b>	62.0 <b>(7.1)</b>
Anal-caudal space	80.0 <b>(10.0)</b>	150.0 <b>(13.7)</b>	72.0 <b>(8.2)</b>
Pelvic-caudal length	274.0 <b>(34.2)</b>	319.0 <b>(29.2)</b>	68.0 <b>(7.7)</b>
Eye length	26.0 <b>(3.2)</b>	28.0 <b>(2.6)</b>	35.0 <b>(3.9)</b>
Eye height	12.0 <b>(1.5)</b>	14.0 <b>(1.3)</b>	1.8 <b>(0.16)</b>
Inter orbital length	58.0 <b>(7.2)</b>	73.0 <b>(6.7)</b>	72.0 <b>(8.2)</b>
Nostril width	13.0 <b>(1.6)</b>	17.0 <b>(1.5)</b>	8.0 <b>(0.9)</b>
Internarinal width	17.0 <b>(2.1)</b>	32.0 <b>(2.9)</b>	36.0 <b>(4.1)</b>
Anterior nasal fold	5.0 <b>(0.6)</b>	7.0 <b>(0.6)</b>	7.0 <b>(0.8)</b>
Spiracle length	5.0 <b>(0.6)</b>	7.0 <b>(0.6)</b>	3.0 <b>(0.3)</b>
Eye-spiracle length	7.0 <b>(0.9)</b>	8.0 <b>(0.7)</b>	37.0 <b>(4.2)</b>
Mouth length	57.0 <b>(7.1)</b>	85.0 <b>(7.8)</b>	103.0 <b>(11.7)</b>
Mouth width	44.0 <b>(5.5)</b>	60.0 <b>(5.5)</b>	90.0 <b>(10.3)</b>
Upper labial furrow	16.0 <b>(2.0)</b>	18.0 <b>(1.6)</b>	50.0 <b>(5.7)</b>
Lower labial furrow	13.0 <b>(1.6)</b>	15.0 <b>(1.4)</b>	21.0 <b>(2.4)</b>
First gill arch height	25.0 <b>(3.1)</b>	41.0 <b>(3.7)</b>	85.0 <b>(9.7)</b>

Second gill arch height	27.0 (3.4)	45.0 (4.1)	75.0 (8.5)
Third gill arch height	25.0 (3.1)	37.0 (3.4)	63.0 (7.2)
Fourth gill arch height	28.0 (3.5)	35.0 (3.2)	61.0 (6.9)
Fifth gill arch height	17.0 (2.1)	22.0 (2.0)	58.0 (6.6)
Sixth gill arch height	-	-	35.0 (3.9)
Head height	90.0 (11.2)	140.0 (12.8)	77.0 (8.8)
Head width	150.0 (18.7)	190.0 (17.4)	94.0 (10.7)
Trunk height	65.0 (8.1)	85.0 (7.8)	87.0 (9.9)
Trunk width	73.0 (9.1)	113.0 (10.3)	78.0 (8.9)
Caudal peduncle height	22.0 (2.7)	30.0 (2.7)	37.0 (4.2)
Caudal peduncle width	12.0 (1.5)	18.0 (1.6)	24.0 (2.7)
Pectoral fin length	72.0 (9.0)	159.0 (14.6)	105.0 (11.9)
Anterior margin of pectoral fin	115.0 (14.4)	170.0 (15.6)	107.0 (12.2)
Pectoral fin base length	35.0 (4.4)	47.0 (4.3)	44.0 (5.0)
Pectoral fin height	109.0 (13.6)	144.0 (13.2)	82.0 (9.3)
Pectoral fin inner margin	60.0 (7.5)	75.0 (6.8)	49.0 (5.6)
Posterior margin of pectoral fin	100.0 (12.5)	125.0 (11.4)	88.0 (10.0)
Pelvic fin length	74.0 (9.2)	103.0 (9.4)	81.0 (9.2)
Anterior margin of pelvic fin	67.0 (8.4)	75.0 (6.8)	40.0 (4.5)
Pelvic fin base length	48.0 (6.0)	50.0 (4.6)	56.0 (6.4)
Pelvic fin height	47.0 (5.9)	47.0 (4.3)	25.0 (2.8)
Pelvic fin inner margin	40.0 (5.0)	55.0 (5.0)	23.0 (2.6)
Posterior margin of pelvic fin	53.0 (6.6)	73.0 (6.7)	56.0 (6.4)
Outer clasper length	65.0 (8.1)	-	27.0 (2.9)
Inner clasper length	78.0 (9.7)	-	28.0 (3.2)
Clasper base length	10.0 (1.2)	-	8.0 (0.9)
First dorsal fin length	115.0 (14.4)	179.0 (16.4)	65.0 (7.4)
Anterior margin of first dorsal fin	97.0 (12.1)	163.0 (14.9)	50.0 (5.7)
First dorsal fin base length	87.0 (10.8)	130.0 (11.9)	49.0 (5.6)
First dorsal fin height	64.0 (8.0)	103.0 (9.4)	26.0 (2.9)
Inner margin of first dorsal fin	50.0 (4.6)	50.0 (4.6)	18.0 (2.0)
Posterior margin of first dorsal fin	90.0 (8.2)	149.0 (13.6)	45.0 (5.1)
Second dorsal fin length	86.0 (10.7)	116.0 (10.6)	-
Anterior margin of second dorsal fin	77.0 (9.6)	101.0 (9.2)	-
Second dorsal fin base length	56.0 (7.0)	85.0 (7.8)	-
Second dorsal fin height	49.0 (6.1)	64.0 (5.8)	-
Inner margin of second dorsal fin	33.0 (4.1)	73.0 (6.7)	-
Posterior margin of second dorsal fin	64.0 (8.0)	78.0 (7.1)	-
Anal fin length	56.0 (7.0)	80.0 (7.3)	53.0 (6.0)
Anterior margin of anal fin	49.0 (6.1)	68.0 (6.2)	23.0 (2.6)

Anal fin base length	40.0 (5.0)	51.0 (4.7)	37.0 (4.2)
Anal fin height	25.0 (3.1)	45.0 (4.1)	14.0 (1.6)
Inner margin of anal fin	20.0 (2.5)	33.0 (3.0)	13.0 (1.5)
Posterior margin of anal fin	22.0 (2.7)	47.0 (4.3)	27.0 (3.1)
Dorsal margin of caudal fin	422.0 (52.7)	614.0 (56.2)	282.0 (31.0)
Pre-ventral caudal fin margin	73.0 (9.1)	82.0 (7.5)	63.0 (7.2)
Lower post-ventral caudal fin margin	27.0 (3.4)	33.0 (3.0)	34.0 (3.8)
Upper post-ventral caudal fin margin	77.0 (9.6)	85.0 (7.8)	160.0 (18.2)
Sub-terminal caudal fin margin	27.0 (3.4)	34.0 (3.1)	44.0 (5.0)
Terminal caudal fin margin	56.0 (7.0)	67.0 (21.8)	28.0 (3.2)
Terminal caudal lobe length	172.0 (21.5)	254.0 (23.3)	64.0 (7.3)
Caudal fork length	63.0 (7.9)	65.0 (5.9)	60.0 (6.8)
Distance between the origin of the first dorsal fin and the origin of the anal fin	307.0 (38.4)	486.0 (44.5)	46.0 (5.2)
Distance between the origin of the first dorsal fin and the origin of the anal fin	255.0 (31.9)	380.0 (34.8)	34.0 (3.9)
Distance between the origin of the second dorsal fin and the origin of the anal fin	48.0 (6.0)	90.0 (34.8)	-
Distance between the origin of the second dorsal fin and the insertion point of the anal fin	25.0 (3.1)	54.0 (8.2)	-
Caudal width space	22.0 (2.7)	28.0 (2.6)	33.0 (3.7)
Caudal fork width	22.0 (2.7)	28.0 (2.6)	33.0 (3.7)
Sex	Mature male	Female	Immature male
Weight (g)	1,100	3,500	1,560
Gastric contents	Eviscerated	Eviscerated	Empty



**Figure 1:** a) *Mustelus sinuamexicanus*, ECO-SC 7471-1 (male specimen, 800 mm TL, 1,100 g); and b) *Hexanchus nakamurai*, ECO-SC 7414 (male specimen, 896 mm TL, 1,560 g) from the Gulf of Campeche, Mexico.

Order: Hexanchiformes

Family: Hexanchidae

Genus *Hexanchus* Rafinesque 1810

The genus *Hexanchus* is represented by 2 species with a circumglobal distribution [5,7,8,9], in Mexico's Atlantic and Pacific watersheds [2,14]. *Hexanchus nakamurai* Teng 1962 (Figure 1b; Table 1)

- a. **Common name:** Cazón ojigrande de seis branquias (Spa.); Bigeyed Sixgill Shark.
- b. **Materials examined:** A sexually immature male specimen (ECOSC 7414; 896 mm TL, 1,560 g) was captured at a depth of 118.8 m by a commercial fishing boat using bottom longlines in the vicinity of Cayo Arcas (west of the Obispo Bank) near the Campeche Canyon (20°27'36"N and 92°12'39"W) and southwest of the Yucatan Peninsula, Mexico, on May 11, 2012.
- c. **Description:** The *H. nakamurai* specimen was identified based on the presence of 6 pairs of gill slits, the first longer (8.5% TL) than the rest; a slim body; a flattened head with a long rostrum (41.8% TL), the head is pointed and narrow relative to the robust body and head of the related *H. griseus* Günther 1879 [14]; relatively large eyes with a diameter 3.9% TL; a ventrally-located mouth; 5 large teeth in the mandible in a comb-like arrangement on each side of the symphyseal tooth (located in the center of each mandible); an upper jaw with nine teeth on each side, with a knife-like anterior apex; a single dorsal fin located in the space between the posterior part of the pelvic fin and the origin of the anal fin; a long (11.3% TL) thin (2.7% TL) caudal peduncle; and a deep notch in the upper lobe of the caudal fin. The specimen's biometrics are presented in Table 1; 68% are within the ranges reported by Ebert et al. [9] for the Sixgill Shark; the remaining 32% are within the range of variability in the specimens examined by those authors.
- d. **Distribution:** The Sixgill Shark has a cosmopolitan distribution in the tropical and temperate oceans of the world (except the eastern Pacific). The species is distributed in the western Atlantic watershed from Florida to the West Indies, including the Gulf of Mexico and Caribbean Sea, to Venezuela and the Guianas, in the eastern Atlantic, from France to Morocco including the Mediterranean Sea; and in the southwest Indian Ocean, the Sea of Japan, Taiwan, and Australia. The species typically inhabits depths of 90-621 m, but is occasionally found on the surface or near the coast [5, 6, 7, 8, 9, 15]. On the Atlantic coast of Mexico, the species has been reported off the coast of Veracruz [2, 16, 17, 18], although national ichthyologic reference collections previously lacked curated examples.
- e. **General comments:** This report of the Sixgill Shark, *H. nakamurai* Teng 1962 in Mexican waters is significant; the species' taxonomy had been challenged by its apparent morphological similarity [19-22] with the Bigeye Sixgill Shark, *H. vitulus* Springer and Waller 1969; although they are genetically distinct [23,24,25]. Based on a taxonomic

study of both species, Ebert et al. [9] determined that *H. nakamurai* should be recognized as a valid species that is widely distributed in the world's oceans in accordance to the re-description and designation of a neotype for this species (NMMBP 15835) supported by a specimen from Taiwan, as well as establishing *H. vitulus* as junior synonym [9]. The specimen reported here is the first to be deposited in a national ichthyological collection.

## Discussion

Due to our limited knowledge of the biology and ecology of these species, they have been assigned a conservation status of "data deficient" [sic] in the IUCN Red List of Threatened Species [15,26]. Therefore, it is necessary to conduct basic studies of their population dynamics and other aspects of their basic biology in order to more accurately determine the current conservation status of their populations [5,11].

In recent years, there has been an increase in the number of studies reporting new species of sharks [13], including new records of their presence and extensions to their distribution in Mexican waters [1]. This situation highlights the fact that we have yet to fully explore the entirety of the country's cartilaginous fish, making further studies focusing on these species imperative.

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