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Occurrence, biometrics, and morphometrics of the Filetail catshark *Parmaturus xaniurus* (Carcharhiniformes, Pentanchidae: Gilbert, 1892) from the northern Gulf of California, México

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Abstract: The occurrence of the Filetail catshark *Parmaturus xaniurus* is rare in the Gulf of California (GC), and its population structure is unknown. We reported its occurrence as bycatch of the Pacific hake fishery in the northern GC. We examined 22 mature females (412–620 mm total length) caught at 263.0–360.2 m depth.

Key words: Bycatch, Deep sea shark, Gulf of California.

Occurrencia, biometrías y morfometrías del Tiburón gato cola de lima *Parmaturus xaniurus* (Carcharhiniformes, Pentanchidae: Gilbert, 1892) del norte del Golfo de California, México. Resumen: La ocurrencia de tiburón gato cola de lima *Parmaturus xaniurus* es poco frecuente en el Golfo de California (GC), y se desconoce su estructura poblacional. Reportamos su ocurrencia como pesca incidental en la pesquería de merluza del norte del GC. Examinamos 22 hembras maduras (412–620 mm longitud total) capturadas a 263.0–360.2 m de profundidad.

Palabras clave: Captura incidental, Golfo de California, Tiburón de profundidad.

The Filetail catshark *Parmaturus xaniurus* (Gilbert, 1892) is a soft-bodied, grayish-brown, endemic shark of the northeastern Pacific Ocean, inhabiting deep waters from Washington (USA) to the Gulf of California (Castro, 2011). It is an oviparous species whose eggs take up to one year to hatch (Balart *et al*., 2000). Very little is known about the biology of this species, and the available information only comprises part of its range distribution.

In the continental slope of California (USA), the Filetail catshark has been found in hard-substrate banks from different origins and soft mud bottoms at 290–625 m depth bottom trawls (Cross, 1988).

However, it is known that their juveniles are mesopelagic and use the water column as a nursery area before maturation at 375–490 mm total length (TL; Castro, 2011; Balart *et al*., 2000). Its maximum reported length is 610 mm TL (Ebert 2003). The Filetail catshark feeds, in order of importance, over crustaceans, teleosts, and mollusks (Cross 1988). Its median size of maturity is 340–425 mm and 425–501 mm TL for females and males, respectively (Castro, 2011; Flammang *et al*., 2008; Balart *et al*., 2000; Cross, 1988).

In Mexican waters, Balart *et al*. (2000) found the Filetail shark using bottom trawls at depths ranging from 50–280 m. Their sample comprised 51 individuals from 104–380 mm TL, and the length-weight relationship indicated allometric growth. In the Gulf of California (GC), the occurrence of the Filetail shark has been documented in cold, low-oxygen, and deep waters in basins and troughs, and its diet has been described as composed of crustaceans and fish (Gallo *et al*., 2020; Castro-Aguirre *et al*., 2007). However, no further details of its biology in the GC are known. Currently, this species is classified as of Least Concern by the Red List of the International Union for the Conservation of Nature. However, given the little information available on its biology, there is an urgent need to provide additional data on the extent of its distribution range (Flammang *et al*., 2015).

This study aimed to provide details on the sites, depth, and temperature range of occurrence of the Filetail catshark in the GC. Its biometrics and morphometrics are provided to update the available information and prevent future misidentification of the Filetail catshark with other relatives in the area. In addition, this information could serve as a reference to understand their life history and potential threats better. Specimens of Filetail catshark were acquired from the bycatch of the Pacific hake fishery at the northern GC (Fig. 1) through the onboard observers' program of the Environmental Defense Fund. On average, the Pacific hake fishery occurs from January to March each year using bottom trawling as a fishing gear with mesh sizes ranging from 8.89 cm–10.16 cm and operates from 111–355 m on the slope of the Delfin Basin. The water temperature was measured using a HOBO Deep Ocean Temperature Data Logger (Onset Computer Corp., Bourne, MA). The details of the fishing operation of the Pacific hake fishery are found in Zamora-García *et al*. (2020).

During the Pacific hake fishing season in 2021, the observers registered the Filetail catshark in 8 out of 90 tows (8%). Species identification was made by observing the origin of the first dorsal fin and the position of the last second-gill slit concerning the pectoral and pelvic fins, respectively. Along with the coloration of the upper labial fold (Castro, 2011) (Fig. 2). Onboard, the observers identified the sex based on the presence or absence of claspers. The females were disected to visually inspect gonadal development. Then, they were consider mature by the presence of a well-developed oviducal gland or vitellogenetic ova. Internal measurements were done using an electronic vernier with an accuracy of 0.1 mm. Gravid females were those with egg presence (Flammang *et al*., 2008). Also, the observers recorded biometric measures such as Total length (TL, in cm) and Total weight (TW, in g) were measured using a digital balance with an accuracy of 1g. Three whole organisms were saved in plastic bags, labeled, and frozen in the ship's hold before transport to the lab.

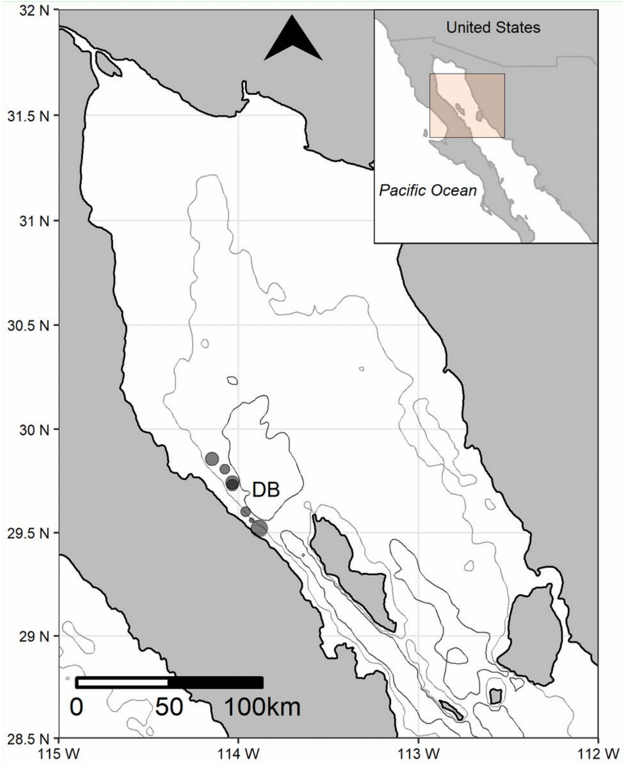

Figure 1. Study area, the northern Gulf of California in México. The dark-gray circles indicate sites where the Filetail catshark was found. The area of the circles is relative to the number of individuals caught (from 1–7). The 100 m and 400 m isobaths are indicated by light gray and dark gray lines, respectively. DB= Delfin Basin.

We recorded 73 morphometrics of the three samples in the lab using standard measurements and terminology for other *Parmaturus* species (Fahmi & Ebert, 2018). Additionally, liver weight (LT in g)

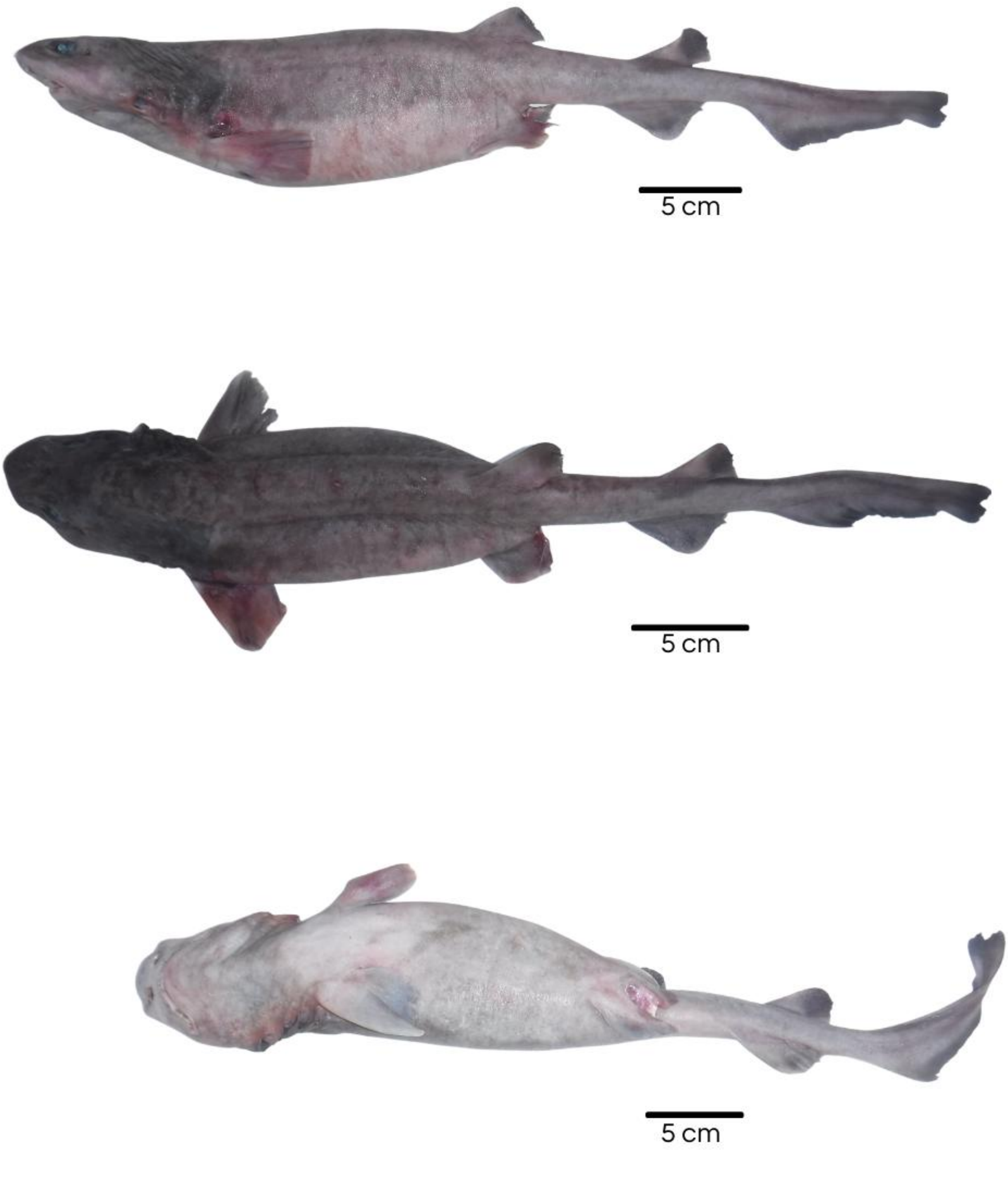

Figure 2. *Parmaturs xaniurus*. Adult female caught in the northern Gulf of California at 242 m depth (520 mm TL).

and stomach content was recorded. Finally, stomachs were visually inspected. Recognizable prey items were always shrimp. Closer identification of preys items was done based on the size, shape and numbers denticles in the rostral spine, position of the hepatic spine and presence or absence of spine in the first abdominal segment, according to Hendrickx (1995).

During February–March 2021, 21 Filetail catshark individuals were found at depths ranging from 263–360 m and water temperature ranging from 12.6–12.9 °C. This report is the first of the Filetail catshark as part of the bycatch of the Pacific hake in the northern GC. Catch depths are within the reported depth range distribution of the Filetail catshark (91–1251 m) (Flammang *et al*., 2015). However, the water temperature range is higher than previously reported in the west coast of Baja California, México (Balart *et al*., 2000).

The size ranged from 412–620 mm TL with an average ± standard deviation of 524 ± 52 mm. TW ranged from 411–798 g, averaging 639 ± 96 g. The largest individual observed in the present study (620 mm TL) surpasses the maximum TL reported on the east coast of Baja California (350 mm TL; Balart *et al*., 2000), the continental slope of southern California (574 mm TL; Cross, 1988) and inside the GC (450 mm TL; Castro-Aguirre *et al*., 2005). The warmer and oxygen-rich waters of the northern GC may aid their development, as has been suggested for other catsharks (Flammang, 2008).

All the individuals collected were adult females, and one of them was gravid with two egg cases. The mesopelagic behavior of the juveniles of Filetail catsharks could explain the absence of juveniles in bottom trawls (Cross, 1988). The absence of males in the sample could be due to the area used for spawning by females. Sexual segregation in sharks has been well documented in viviparous and oviparous sharks (Springer, 1967) and may be a strategy to reduce natural mortality due to predation (Castro, 2011). Future records with more spatiotemporal coverage will provide more information in this regard.

Just in four individuals (19%) prey items in their stomachs were observed. The prey items identified consisted of rock shrimps (*Sycionia pennicillata*), a common crustacean in the area (López-Martínez *et al*., 2020), unidentified digested teleost fish, and other melted organic matter. The Filetail exhibits a lower trophic level (3.6) than other Carchariniforms, except those of the Triakidae family. It is an opportunistic consumer of crustaceans on mollusks and fishes (Cortés 1999; Cross 1988). Also, scavenger behavior has been documented for the Filetail catshark (Springer, 1979).

The morphometric measurements were expressed in % TL (Table I). LW ranged from 57–96 g (11.2–19.2 % TW), and the width of the oviducal gland ranged from 2.9–3.7 mm, averaging 3.29 ± 0.37 mm. These morphometric ratios can be helpful to avoid confusion with other soft-bodied deep-water catsharks, such as the Peppered catshark (*Galeus piperatus*), a dwarf shark endemic of the northern GC sometimes bycaught in the Pacific hake fishery (Espino-Leal, 2022).

Table I. Morphometric measurements of three Filetail catsharks (*Parmaturus xianurus*) are shown as the total length percentage (cm). SD= Standard deviation, MIN= minimum, MAX= maximum.

Morphometric trait	**Mean**	**SD**	**Min.**	**Max.**
Pre second dorsal-insertion length	70.04	0.14	69.92	70.19
Pre second dorsal -origin length	64.31	0.60	63.67	64.85
Pre first dorsal-insertion length	53.58	1.27	52.56	55.00
Pre first dorsal -origin length	46.96	0.49	46.56	47.50
Pre first pectoral length	21.74	0.23	21.54	21.99
Pre second pectoral length	47.79	1.79	46.38	49.81
Prevent length	50.98	1.75	49.44	52.88
Preanal length	62.03	0.94	61.28	63.08
Precaudal length	75.85	0.40	75.58	76.32
Pre-branchial length	16.85	0.95	15.79	17.64
Pre-spiracular length	10.57	0.37	10.23	10.96
Pre-orbital length	5.14	0.41	4.76	5.58
Pre-outer nostril length	2.59	0.26	2.31	2.82
Pre-inner nostril length	3.95	0.17	3.76	4.06
Pre-oral length	4.75	0.14	4.62	4.89
Head length	21.05	0.74	20.19	21.52
Head height	10.34	1.34	9.21	11.82
Head width (mouth corners)	12.05	0.53	11.47	12.50

Morphometric trait	**Mean**	**SD**	**Min.**	**Max.**
Head width (max)	14.51	1.51	12.78	15.58
Mouth width	10.25	0.22	10.00	10.41
Mouth length	5.73	0.74	5.08	6.53
Internarial width	2.29	0.22	2.07	2.50
Upper labial furrow length	1.86	0.43	1.41	2.26
Lower labial furrow length	1.98	0.29	1.76	2.31
Orbit length	5.07	0.27	4.76	5.26
Orbit height	2.10	0.21	1.88	2.31
Nostril length	2.40	0.21	2.26	2.65
Nostril-mouth space	1.24	0.11	1.13	1.35
Interorbital width	5.68	0.13	5.58	5.83
1st gill height	4.82	0.16	4.70	5.00
3rd gill height	4.82	0.16	4.70	5.00
5th gill height	3.78	0.56	3.38	4.42
First dorsal -Second dorsal space	10.48	0.92	9.42	11.09
First dorsal -Second dorsal origins	16.86	0.48	16.35	17.29
First dorsal -Second dorsal insertions	16.18	0.31	15.96	16.54
First pectoral-Second pectoral space	22.02	1.72	20.11	23.46
First pectoral tip to Second pectoral origin	15.63	1.43	14.10	16.92
First pectoral-Second pectoral origins	25.89	0.97	25.00	26.92
First pectoral-Second pectoral insertions	26.33	5.06	20.49	29.45
Second pectoral-anal space	7.49	2.43	4.76	9.42
Second pectoral-anal origins	15.01	2.21	12.52	16.73
First dorsal length	10.25	0.74	9.40	10.77
First dorsal base length	5.75	1.59	4.14	7.31
First dorsal height	3.95	0.81	3.01	4.42
First dorsal free lobe length	5.59	2.99	3.53	9.02
Second dorsal length	7.76	2.02	5.45	9.17
Second dorsal base length	4.94	1.55	3.20	6.15
Second dorsal height	3.33	0.82	2.50	4.14
Second dorsal free lobe length	3.34	0.53	3.00	3.95
First pectoral base length	5.26	0.32	4.94	5.58
First pectoral anterior margin	10.45	0.56	10.05	11.09
First pectoral posterior margin	7.32	1.16	6.15	8.47
First pectoral inner margin	6.18	0.02	6.15	6.20
First pectoral width	7.44	1.15	6.35	8.64
Second pectoral anterior margin	6.03	1.17	4.89	7.23
Second pectoral length	11.43	0.69	10.96	12.22
Second pectoral base length	7.23	2.14	4.76	8.46
Second pectoral posterior margin	7.54	0.47	7.23	8.08
Second pectoral inner margin	3.20	0.44	2.88	3.70

Morphometric trait	**Mean**	**SD**	**Min.**	**Max.**
Anal base length (ceratotrichia)	9.20	0.32	8.83	9.42
Anal base length (muscle)	10.26	0.31	9.96	10.58
Anal anterior margin	8.41	0.70	7.94	9.21
Anal posterior margin	6.04	0.55	5.45	6.53
Anal height (muscle)	4.75	0.45	4.23	5.08
Anal inner margin	1.98	0.12	1.88	2.12
Caudal peduncle height	4.09	1.83	3.00	6.20
Caudal length	23.09	0.48	22.56	23.46
Caudal height	6.96	0.55	6.54	7.58
Caudal preventral margin	8.22	0.09	8.11	8.27
Caudal postventral margin	10.44	0.50	9.96	10.96
Caudal terminal lobe height	2.83	0.37	2.44	3.17
Caudal terminal lobe length	3.90	0.22	3.70	4.14

The genera *Parmaturus* and *Galeus* are similar due to their dorsal coloration, skin denticles, the lack of supraorbital shelves, and the continuous labial furrows around the mouth corners (Castro, 2011). However, apart from the conspicuous pepperlike melanophores (on the ventral and lateral surfaces of the Peppered catshark that are not easily recognizable), the mouth of the Filetail catshark is proportionally narrower (maximum [max]= 10.41% TL vs. 13.41% TL), the anal base is shorter (max=10.26%TL vs. 13.4% TL) than the Peppered catshark (Compagno, 1984). The mouth cavity lining is white in the Filteail catshark while dusky or dark in the Peppered catshark (Castro, 2011). The maximum size of adults could be also a practical reference for its identification in the field. Adults of the Peppered shark attain 370 mm TL, so individuals showing TL>370 mm could potencially be the Filetail shark (Castro, 2011).

It is crucial to monitor the occurrence of the Filetail catshark on the bycatch of the Pacific hake fishery or any other regional fishery to understand more about their bycatch rates and to learn more about its life-history. Unfortunately, the Filetail catshark population status is unknown in the GC, so it is currently impossible to predict the catch's effect in their populations. However, it has been demonstrated that the bycatch of trawling fisheries can significantly affect populations of other species of elasmobranchs (Cedrola *et al*., 2005).

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Ethical statement

La presente investigación no incluye animales regulados por alguna disposición legal y no requirió aprobación por un comité de Ética.

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