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Nota científica

A NEW RECORD OF BONY FISH PREY FOR THE GENUS *ISISTIUS* (CHONDRICHTHYES: DALATIIDAE) IN A COASTAL ZONE OF SOUTHEASTERN MEXICO

Nuevo registro de un pez óseo como presa del género *Isistius* (Chondrichthyes: Dalatiidae) en una zona costera del sureste de México

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ABSTRACT

The first report of bite wounds from cookiecutter shark in a specimen of cobia in the Southern Gulf of Mexico is described. The specimen was captured by artisanal fishery in the coastal zone of Tabasco, Mexico. It presented three bite wounds with 25 to 26 teeth marks per wound, major axis interval between 3.7 and 4.7 cm and all areas of less than 10 cm^2. This is new record of a bony fish as prey of genus *Isistius* maybe of *I. brasiliensis* in coastal waters over the continental shelf, in the Southern Gulf of Mexico.

Keywords: bite wounds, *Rachycentron canadum*, Tabasco, opportunistic feeding, continental shelf.

RESUMEN

Se describe el primer reporte de heridas por mordidas del tiburón cigarro a un espécimen de cobia en la parte sur del golfo de México. El espécimen fue capturado por pesquería artesanal en la zona costera de Tabasco, México. Presentó tres heridas por mordidas con 25 a 26 marcas de dientes por herida, un intervalo del eje mayor entre 3.7 a 4.7 cm y todas las áreas menores a 10 cm^2. Este es un nuevo registro de un pez óseo como presa del género *Isistius*, posiblemente *I. brasiliensis*, en aguas costeras sobre la plataforma continental, para el sur del golfo de México.

Palabras clave: heridas por mordidas, *Rachycentron canadum*, Tabasco, alimentación oportunista, plataforma continental.

The family Dalatiidae includes 10 species of sharks, all considered mesopelagic, with records of three species that predate on larger prey: *Dalatias licha* Bonnaterre, 1788, *Isistius brasiliensis* Quoy & Gaimard, 1824 and *I. plutodus* Garrick & Springer, 1964 (Ebert et al., 2021). The cookiecutter shark *Isistius brasiliensis* is a species that presents a maximum length of approximately 55 cm and is found in both coastal and oceanic habitats worldwide at depths ranging from 85 to 3700 m (Compagno, 1984; Ebert et al., 2021; Strasburg, 1963).

In the Gulf of Mexico, this species has been reported mainly in the northern zone with fewer records in the southern Gulf (Castro-Aguirre & García-Domínguez, 1988; Retzer, 1990; Ruiz-Abierno et al., 2016). Recently, Grace et al. (2018) reported cookiecutter shark bite wounds on cetaceans, showing the presence of this phenomenon over an extensive area of the Gulf of Mexico.

Cookiecutter sharks are small mesopelagic sharks that present diel vertical migrations (Strasburg, 1963; Widder, 1998) best known for their feeding behavior, which has been determined by some authors as ectoparasitic, feeding on pieces of flesh from large marine animals (Honebrink et al., 2011; Menezes et al., 2022) in addition to active predation over small bony fishes, squid and crustaceans (Compagno, 1984; Ebert et al., 2021). These sharks have been implicated as responsible for round-shaped wounds in marine megafauna (Dwyer & Visser 2011) and even humans (Honebrink et al., 2011). Cookiecutter attack wounds have been found in tuna, swordfish and billfish (Muñoz-Chápuli et al., 1988; Niella et al., 2018; Papastamatiou et al., 2010), white shark (Hoyos-Padilla et al., 2013), cetaceans (Dwyer & Visser, 2011), pinnipeds (Gallo-Reynoso & Figueroa-Carranza, 1992; Souto et al., 2009) and sirenians (Reddacliff, 1988).

The cobia (*Ranchycentrum canadum* [Linnaeus, 1766]) is a large and pelagic-coastal bony fish that is distributed in tropical and subtropical waters, in depths up to 70 m, except in the eastern Pacific (Shaffer & Nakamura, 1989). In Mexico, this fish is one of the fishing and aquaculture resources with high commercial importance (DOF, 2012), the dried-salted presentation works as a substitute for cod. However, even when its commercial importance is evident, there are no studies on its predators, leaving only anecdotes about the dolphin fish (Shaffer & Nakamura, 1989) and the mako shark (fisherman observations), with which the ecological niche of cobia cannot be reliably established.

Forensic analysis of shark bite wounds allows to establish a good approximation of the attacking species and the position of either the victim or the attacker and is widely used for shark-human relationship studies (Ribéreau-Gayon et al., 2017; Ritter & Levine, 2004). However, these studies have not been conducted on marks left by cookiecutter sharks on fish and marine mammals, allowing predator identification only at the supra-species level, with possible identification based solely on the current knowledge of the geographic distribution of the two *Isistius* species (Best & Photopoulou, 2016), without considering that the less abundant species increase their distribution when they are adequately identified (Zidowitz et al., 2004). An assertive identification of the attacking species would not only determine which species prey on the affected animals, but could also provide data that increase the regional taxonomic listings and allows a better understanding of the ecology and ethology of prey and predator.

The objective of this work is to provide the record of a new species of bony fish as prey of the genus *Isistius* in shallow Mexican waters of the Gulf of Mexico from the description of bite wounds on a cobia.

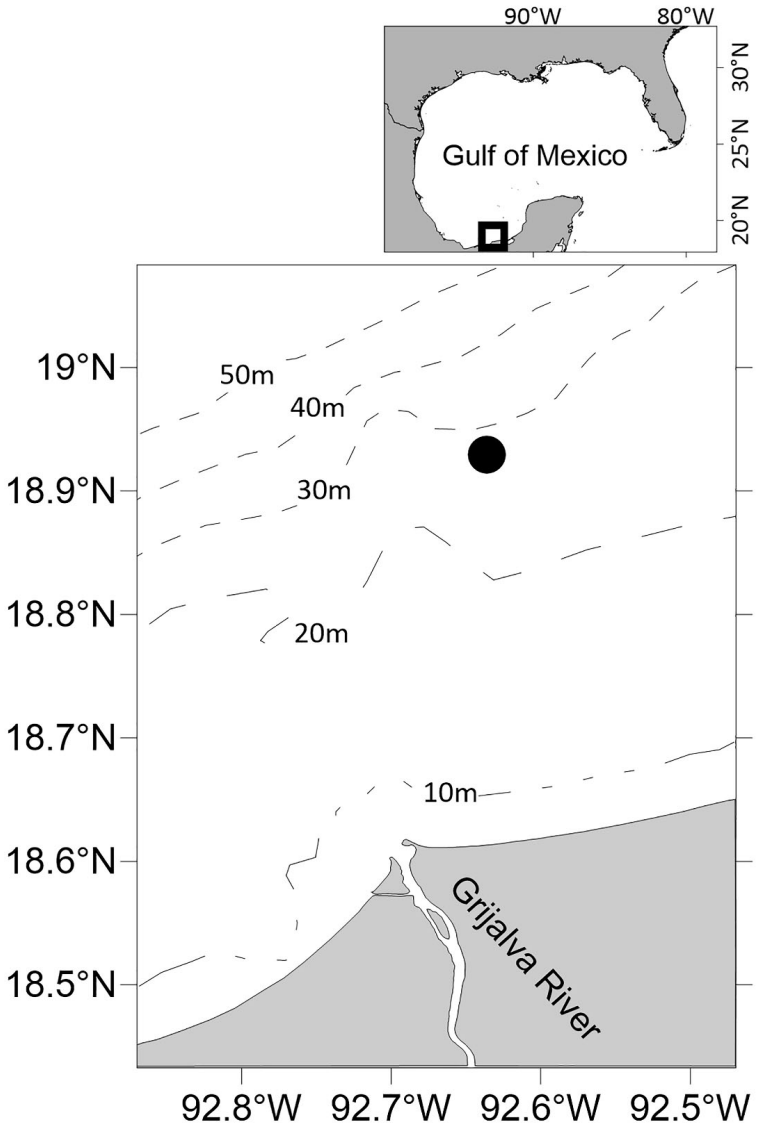

Figure 1. Sampling zone of the Cobia (*Rachycentron canadum*) with three cookiecutter shark (*Isistius* sp.) bite wounds in the Southern Gulf of Mexico.

On October 12, 2020, during a sampling performed at a monitoring of artisanal fishery in Barra Carlos Rovirosa, Tabasco, Mexico (92° 41' 05" W, 18° 35' 10" N), a cobia with three fresh wounds was found. It was caught with a 3.5 inch, 1389 m long gillnet operating at a depth of 30 m (92° 34' 36.162 W, 18° 55' 45.58 N) (Fig. 1). The specimen presents three ovoid shaped wounds in its right flank (Fig. 2a), with evident dental marks characteristic of those made by cookiecutter sharks (*Isistius* spp). The total length (TL) of the cobia and of the three wounds were measured with a 1.5 m tape measure (±1 mm). The wounds were measured along two axes (length and width) to calculate perimeters and areas.

The bite wounds were analyzed with Gimp 2.1 (Free Software Foundation), counting the entries or the grooves left by the cusps (Lowry et al., 2009) and delimiting them by the presence of shreds of skin or meat (Anislado-Tolentino et al., 2016). Since the bitemarks left on prey by *Isistius* leave a greater impression of the lower teeth (Ribéreau-Gayon et al., 2018), the counts obtained from the analysis were compared with the dental formulas of the lower jaw from the cookiecutter shark *Isistius brasiliensis* (12+1+13), the largetooth cookiecutter shark *I. plutodus* (9+1+9) (de Figueiredo Petean & De Carvalho, 2018) and the kitefin shark *Dalatias licha* (L 17–20) (Ebert et al., 2021).

The cobia had a TL of 82 cm, a standard length (SL) of 72 cm and weighed 8 kg. The three wounds were ovoid in shape with 25–26 lower teeth marks (Fig. 2b, c and d) and areas of less than 10 cm^2. The measurements of the bite wounds are presented in the Table I. Wound number 1 showed clearer evidence of 26 teeth marks (Fig. 2b). According to the counts carried out and the calculated wound areas, it could be deduced that the predatory species that caused the bites was a shark of the genus *Isistius*, with high probability was *Isistius brasiliensis*.

Ribéreau-Gayon et al. (2018) indicates that the major axis interval for *Isistius* bites is between 1–10 cm and the area is less than 10 cm^2. The measurements obtained in this study (Table I) show that the wounds are within the parameters established for the genus *Isistius*. Since *D. licha* (17–20) and *I. plutodus* (17–19) show fewer lower teeth than the dental marks (26) found in the bite wounds of the studied cobia (*R. canadum*), the species responsible for the feeding event was the cookiecutter shark *I. brasiliensis.*

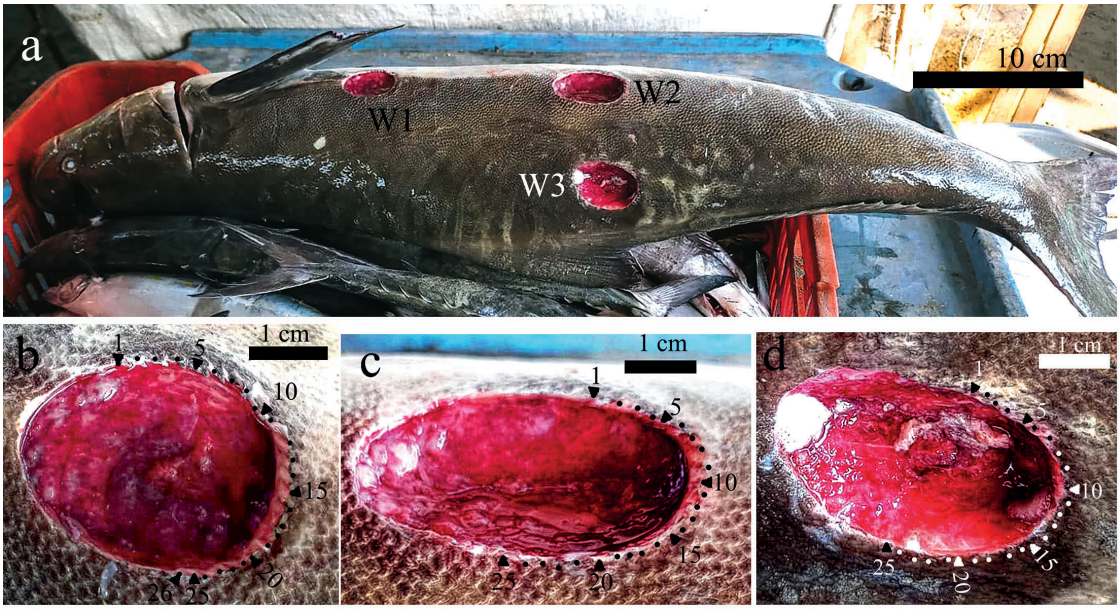

Figure 2. **a)** Studied cobia (*Rachycentron canadum*) with three bite wounds (W) on its right flank; **b)** wound 1 (W1) lower teeth mark count; dots indicate the lower teeth marks, visible shreds of skin from marks 1 to 11; in marks 12 to 26 the trajectory of the dental cusps can be appreciated; **c)** wound 2 (W2) with 25 lower teeth marks and **d)** wound 3 (W3) with 25 lower teeth marks. Photographs by Rodolfo Castro-Barbosa.

Table I. Measurements of the wounds shown in the right flank of the cobia (*Rachycentron canadum*). Numbers only identify the wounds (see Figure 1).

Wound (W) number	Major axis (cm)	Minor axis (cm)	Number of lower teeth marks	Perimeter (cm)	Area (cm^2)
1	3.3	1.7	26	6.28	4.41
2	4.7	2.1	25	10.88	7.75
3	4.1	2.7	25	9.83	8.91

Following the criteria of Papastamatiou et al. (2010), the bite wounds were fresh, which indicates that they could have been made when the organism was caught in the fishing net. On the other hand, the authors mention that most pelagic fish, caught with longlines present more than two wounds. Likewise, according to Widder (1998), since *I. brasiliensis* is a slow swimmer, attacks on large free-swimming prey results in only one bite per organism, with the shark displaying a feeding behaviour in which it holds on to the prey using its modified sucker-like lips and pharynx to later penetrate the skin and tissue with its large, cutting-type lower teeth, using the momentum of the fast-swimming prey to generate the rotational energy necessary to detach the piece of tissue, securing the piece of flesh with its upper teeth while the sharks pulls free (Ribéreau-Gayon et al., 2018). The presence of three wounds in the studied cobia suggests that the bites were the result of opportunistic predation by *I. brasiliensis*, taking advantage of the fish's inability to move when it was caught in the fishing net.

Some authors mention that cookiecutter sharks migrate at night from mesopelagic depths to shallower water (Compagno, 1984; Widder, 1998), and during the winter months (Papastamatiou et al., 2010), so the predatory events could be seasonal (Feunteun et al. 2018). This is also observed in the Mexican North Pacific of the Baja California peninsula, where during the winter and early spring months (February to March) that correspond to the fishing season of Pacific bluefin tuna *Thunnus orientalis* (Temminck & Schlegel, 1844), it is common for tuna caught using longlines to display bites of cookiecutter shark on their bodies.

According to Carlisle et al. (2021), *I. brasiliensis* preys upon epipelagic, mesopelagic, and vertically emigrant fishes (Table II) and presents a diel cycle, hunting during the day at the mesopelagic zone migrating, perhaps following prey, to the epipelagic zone at night. Fishing catches that normally show evidence of cookiecutter shark bites are tuna, billfish, and other large bycatch fishes at the offshore and open-ocean fisheries. For this work, the studied cobia was caught by artisanal fishery, at low depth (30 m) and at the littoral zone. The presence of the bite wounds by a cookiecutter shark on a prey in a low depth zone is evidence of their vertical migration diel behaviour. The cookiecutter shark, maybe *I. brasiliensis*, swim to the coastal zone in order to forage, and recently found a new prey, the cobia, on the continental shelf of southeastern Mexico. Because cobia along with other potential prey are important in the catches of small-scale coastal fisheries, it is necessary to establish a monitoring program to determine the diversity of prey of this type of shark in the coastal zone of the Gulf of Mexico.

Table II. List of cookiecutter shark *Isistius brasiliensis* identified fish prey species. Mesopelagic (MP), epipelagic (EP) and vertically emigrant fish species (VEF). The superscript letter in species column corresponding to: a, Carlisle et al. (2021); b, Hoyos-Padilla et al. (2013); c, Jones (1971); d, Nakano & Tabuchi (1990); e, Niella et al. (2018); f, Papastamatiou et al. (2010); g, this study.

Family	Species	Common name	Type
Lamnidae	*Carcharadon carcharias*[b]	White shark	VEF
Lampridae	*Lampris guttatus*[f]	Opah	MP
Ariommatidae	*Ariomma* sp.[a]	Driftfish	MP
Bramidae	*Taractichthys steindachneri*[f]	Sickle pomfret	MP
	Brama japonica[d]	Pacific pomfret	MP
Gempylidae	*Ruvettus pretiosus*[f]	Oil fish	MP
Scombridae	*Acanthocybium solandri*[f]	Wahoo	VEF
	Thunnus obesus[f]	Bigeye tuna	VEF
	Thunnus albacares[c]	Yellow fin tuna	VEF
	Katsuwonus pelamis[f]	Skipjack tuna	VEF
	Euthynnus affinis[c]	Kawakawa	VEF
	Euthynnus alletteratus[e]	Little tunny	VEF
	Sarda sarda[e]	Atlantic bonito	VEF
Carangidae	*Caranx* spp.[c]	Large jacks	VEF
	Elagatis sp.[c]	Rainbow runners	VEF
Coryphaenidae	*Coryphaena hippurus*[c]	Dolphinfish	VEF
Istiophoridae	*Makaira mazara*[f]	Pacific blue marlin	VEF
	Tetrapturus audax[f]	Striped marlin	VEF
	Tetrapturus angustirostris[f]	Shortbill sailfish	VEF
Rachycentridae	*Rachycentron canadum*[g]	Cobia	VEF
Xiphiidae	*Xiphias gladius*[f]	Swordfish	VEF
Scomberesocidae	*Cololabis saira*[a]	Pacific saury	EP

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