First tiger shark Galeocerdo cuvier bite in 75 years in French Polynesia (Eastern Central Pacific)

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CASE REPORT

First tiger shark *Galeocerdo cuvier* bite in 75 years in French Polynesia (Eastern Central Pacific)

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Abstract

We analyzed a tiger shark (estimated 2.8 m total length) bite on a snorkeler. The removal of the terminal part of the leg suggests a predatory motivation for the bite. This is the first documented bite by a tiger shark in French Polynesia waters for the past 75 years.

KEYWORDS

agonistic behavior, bite features, bite motivation, dangerous marine wildlife, feeding behavior, forensic science, problem individual, species identification

1 | INTRODUCTION

Despite a persistent public perception that shark bites result primarily from feeding attempts, a study published in 1974[1] noted that "a significant fraction of shark 'attacks' on man may well be the result of aggressive behavior directed at the victims in an attitude of fighting rather than feeding." This distinction is important because most nonpredatory bites are relatively superficial, whereas those resulting from feeding attempts typically result in massive tissue loss and hemorrhaging.[2] Although some nonpredatory bites may ultimately prove lethal,[3] fatalities are much more like to result from the massive tissue damage associated with predatory bites.[4]

French Polynesia consists of 118 islands spread over an area of 4.5 million km^2 in the central-eastern Pacific with an economy based largely on tourism (especially marine ecotourism). Underwater shark watching is a major activity, generating millions of dollars annually in some islands such as Moorea.[5] Nevertheless, the presence of shark species that are potentially dangerous to humans creates risk management challenges for this type of ecotourism.[6] For example, tiger sharks *Galeocerdo cuvier*, which were the flagship species observed at the Vallée Blanche dive site in Tahiti between 2011 and 2017,[7] bite humans more often than any other shark species except the white shark *Carcharias carcharodon*. However, tiger sharks have never been implicated in a bite on humans in French Polynesia

since written records began in 1940 (E. E. G. Clua, personal observation).

Here we analyze a nonfatal tiger shark bite on a male snorkeler in French Polynesia to determine the likely motivation for the incident. We discuss the shark risk management implications for a country, which is highly economically dependent on marine ecotourism.

2 | CASE HISTORY

2.1 | Data collection

In the course of the investigation, the first author (EEGC)—as an expert at the Court of Papeete—was given access to medical photos of the victim's wounds and interviewed the victim at the hospital 2 days after the incident. Additional relevant information from the remote location of the incident was collected by one of the co-authors (OJ).

2.2 | Incident background

On December 22, 2021, two Polynesian pearl-farm workers visited a site in the Rikitea lagoon in order to install larval collectors. After arriving on site and mooring to a buoy (Figure 1), one worker entered the water wearing a full wetsuit without gloves, 70 cm-long fins (CRESSI brand—Gara model), and a mask and snorkel. Once in the water and while still close to the boat, he visually scanned a 360° area from the surface without noticing anything abnormal. After swimming 20 m away from the boat towards the work site, he noticed a "large" tiger shark approaching him tangentially from a depth of about 10 m. Accustomed to encountering, and being ignored by, large tiger sharks 3–4 times a year, he looked away from the animal. A few seconds later, he instinctively turned around to find the shark near the surface lunging towards him at chest level, with its mouth open. He pushed on the shark's snout to deflect it resulting in it grabbing his right leg, fin first. He then started to scream at his colleague on the boat. The shark then closed its jaws at mid-shin height and shook its head several times while the diver tried to reach the shark's eyes with both hands. During this attempt, his right hand involuntarily entered the shark's mouth, while he managed, with his left hand, to push three digits (including the thumb) into the shark's right eye. As he pushed his fingers in, he felt and heard his shin crack under the shark's teeth, and the shark instantly released him and moved away, swallowing the diver's foot. According to the victim, the contact with the shark lasted <30 s. When the boat arrived at the scene few seconds after, the diver was able to get back on the boat with the help of the pilot. They installed rope tourniquets above and below his knee before transiting to the pier near the medical center where the victim received medical attention within approximately 15 min (Figure 1). When questioned by the emergency doctor, the victim described the shark's behavior as "curious and want-to-play-like."

2.3 | Shark species and size assessment

During treatment, the victim's wounds were photographed along with a metric scale bar. The general and specific characteristics of the bite wounds were analyzed and compared with anatomical data compiled for each species of large shark capable of inflicting such wounds on a human.[4] We used the characteristic tooth marks left by unfinished and superficial bites to assess the size of the animal. The centre of each tooth mark was used to measure the interdental distance (IDD) between two tooth tips; these measurements were averaged and we used a

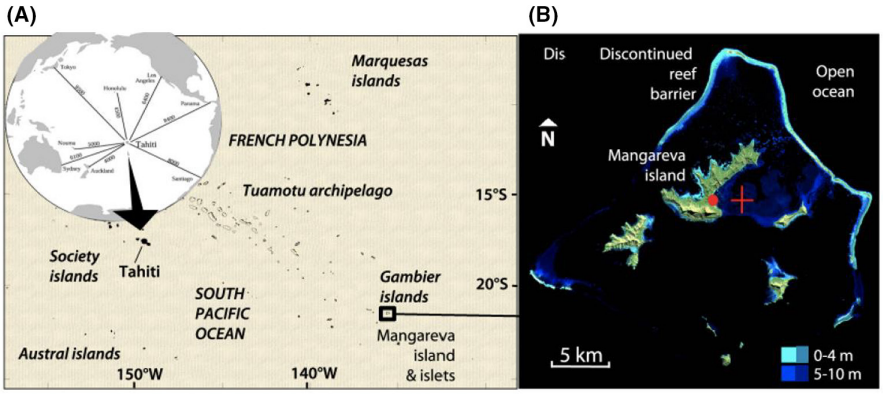

FIGURE 1 (A) Location of the Mangareva island and islets belonging to the Gambier islands (South-East of the Tuamotu archipelago). (B) Close-up view of the very open lagoon showing a strong continuity with the open ocean. The red cross indicates the location of the shark bite, close to the main village Rikitea and medical center (red dot). Basic bathymetry (0–4 and 5–10 m) is indicated.

published total length (TL) to IDD regression algorithm to determine the size of the animal.[8]

2.4 | Fatal shark bites in French Polynesia

Since 2005, CRIOBE has maintained a shark bite incident database for French Polynesia. Data characterizing the victim's profile, their ocean activity, and the circumstances of the incident are collected from press (written and televised) reports and the register of medical evacuations from remote islands compiled by the Central Hospital of the capital Tahiti. This information is further supplemented with onsite interviews by the first author aimed at documenting the history of shark bites at islands throughout French Polynesia, as well as by the existing literature on shark bites in this region.[9-13]

3 | DIFFERENTIAL DIAGNOSIS

3.1 | Description of the wounds and assessment of the shark size

The main wound severed the right leg at the level of the lower third of the tibia (Figure 2A,B). Characteristic shark tooth marks on the lateral-internal portion of this circular wound (Figure 2C) allowed an average interdental distance (IDD) of 19 mm to be estimated (Figure 2D,D′). Based on this average IDD, shark size was estimated to be 2862 mm in total length (TL). The victim's right hand also had three superficial puncture wounds consistent with contiguous tooth marks (Figure 3), which yielded a mean IDD of 18 mm, consistent with the assessment from the main wound. The culprit size (2.8 m TL) is also consistent with the testimony of a local fisherman interviewed by one of the co-authors (OJ) regarding another incident on 18 December about 1 km from the bite site where a young snorkeler was pursued by a tiger shark as he rushed to board the fisherman's boat to escape the animal, which bit the boat instead.

3.2 | Human fatalities and shark bite motivations

Analysis of 125 shark bite cases that occurred in French Polynesia between 1940 and 2022 revealed patterns consistent with those observed in a previous study of 54 shark bites occurring between 1979 and 2001 in this region.[11] Most shark bites were nonfatal and involved either scuba divers feeding sharks or spearfishers, but four bites resulted in the death of the victim (Table 1). Two fatalities resulted from self-defensive bites when spearfishers wounded sharks.[9,13] Another fatality was attributable to dominance/territoriality behavior by gray reef sharks that attacked a turtle fisherman who probably inadvertently entered their idiosphere[10]. The remaining fatality resulted from a deep bite to the thigh of a fisherman who fell overboard and was attacked by an oceanic whitetip shark[9] (Table 1).

4 | DISCUSSION

The tiger shark *G. cuvier* is ubiquitous in French Polynesia, where no <55 different individuals have been observed in under 5 years at the Vallée Blanche site off Tahiti alone.[7] It is an integral part of Polynesian mythology, locally referred to as *Ma'o Tore-Tore* in the Society island and the Austral archipelago, *Mago Tagatukao* in the Tuamotu archipelago, and *Mako Ka'eva'eva* in the Marquesas (E. E. G. Clua, personal observation). Just as the Hawaiian term "niuhi" meaning "man-eater" refers to both white and tiger sharks,[14] the term "parata" in French Polynesia refers to both oceanic whitetip sharks (OWT) *Carcharhinus longimanus*, and tiger sharks.[16] Both terms primarily represent the concept of "a large shark capable of devouring a man" more than any particular species of shark, but both recognize the ability of tiger sharks to prey on humans. It is therefore surprising that, until this recent incident off Rikitea, no tiger shark bites on humans had been documented in French Polynesia since records began in 1940.

The predatory motivation for the Rikitea bite is clearly indicated by (i) the attempted surprise attack, (ii) the lack of preceding agonistic behavior, and (iii) the removal and consumption of the lower leg. The victim survived primarily because of the close presence of the boat and a companion, and the effective first-aid treatment (tourniquets) applied by his companion. The size estimate of around 3 m is consistent with the victim's description of the shark as having a "juvenile" appearance, probably referring to the slender morphology typical of sexually immature tiger sharks (tiger sharks in the Pacific reach sexual maturity at lengths of 2.9–3.4 m TL[17]). Only two previous predatory shark bites have been documented during recorded history in French Polynesia. Both of these cases involved the highly traumatogenic OWT in waters off Moorea, with one fatal incident in 1970 involving a fisherman who fell from a boat in the middle of a feeding frenzy (Table 1) and the other nonfatal bite in 2019 on a whale-watching female snorkeler.[18] With only two predatory and four fatal bites in over 70 years (Table 1), the likelihood of a shark bite fatality remains extremely low in French Polynesia, and this is the first time in recorded history that a tiger

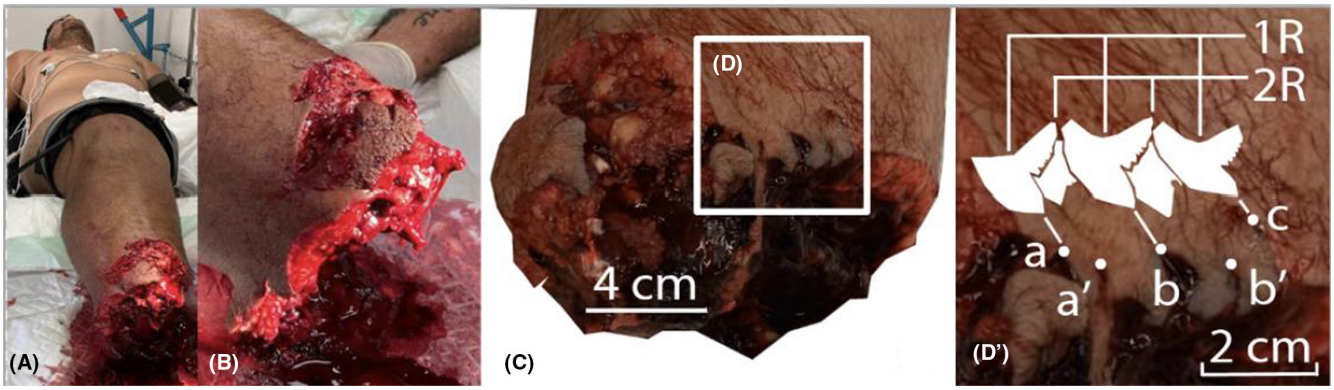

FIGURE 2 (A) General view of the victim's right leg severed at the lower third of the tibia. (B) Close-up showing (top) the imprint of the first unfinished bite corresponding to a supporting bite that was released for a downward shift of the jaw for the completed bite that broke the tibia. (C) Left lateral view of the section showing an area (D) suitable for measuring interdental distances (IDD). (D′) Close-up showing the impact points (a, b, and c) of three contiguous teeth belonging to the first row of the shark jaw (1R) and the impacts (a′ and b′) of two contiguous teeth belonging to the second inside row of teeth (2R), slightly shifted downwards due to the spacing between the two rows. The measurement of the IDDs [ab] and [bc] gave an identical result of 19 mm.

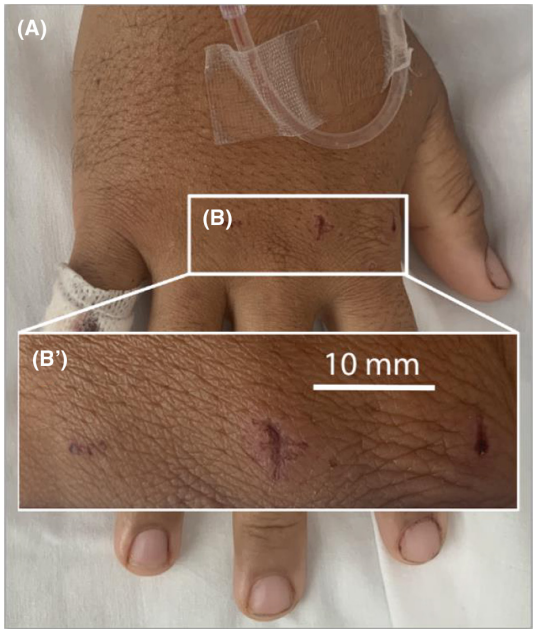

FIGURE 3 (A) Impacts ($n = 3$) of contiguous teeth on the back of the victim's right hand. (B, B′) Close-up of the impacts corresponding to the tips of three contiguous teeth and allowing the assessment of two similar interdental distances (IDD) of 18 mm.

shark has been identified as the perpetrator of a bite on humans in this region (although there is still the chance that tiger sharks were involved in previous bites without being identified). This is particularly surprising given that tiger sharks are a chronic danger to humans in the Hawaiian Islands,[19] which have many similar habitat and anthropogenic use characteristics (e.g., practice of numerous water sports, including surfing) to French Polynesia. This stark contrast between Hawaii and French Polynesia, both regions where tiger sharks are common, shows that shark abundance[20] and external environmental factors alone[21-23] cannot fully explain observed patterns of shark bites. In recent years there has been a growing recognition that sharks have individual personalities (e.g., some individuals are inherently bolder and more prone to risk-taking than others).[24] Genetic mediation of these behavioral traits[25] could potentially explain the differences in the frequencies of shark bites between Hawaii and French Polynesia. Simply stated, the tiger sharks in Hawaii may be genetically more inclined than those in French Polynesia to bite humans. However, the recent incident off Rikitea shows that this behavioral trait also exists in the French Polynesian tiger shark population and the fact that it was preceded by an aggressive encounter with a similar tiger shark in a nearby location 4 days before the bite (see 3-1 section) also supports it.

5 | CONCLUSION

This incident clearly highlights the importance of prompt and effective first-aid treatment in the successful management of serious shark bites. The sudden emergence of previously undocumented aggressive behavior by a tiger shark towards humans in French Polynesia demonstrates that countries where tiger sharks occur[26] should conduct risk assessments of in-water activities that may bring humans into contact with this species. Future environmentally responsible shark risk management could combine individual genetic profiling with photoidentification,[27] and leverage existing shark photo-ID databases.[7]

TABLE 1 Description of human fatalities resulting from shark bites in French Polynesia from 1940 to 2022.

Year	Gender	Age	Island	Species involved	Activity	Death cause	Bite motivation	Source
1942	Male	U	Arutua	Gray reef shark *Carcharhinus amblyrhynchos*	Spear-fishing	Bite to the neck with the section of the carotid by a shark previously wounded by a fisherman	Self-defense	Lagraulet et al.[9]
1962	Male	42	Puka-Puka	Gray reef shark *Carcharhinus amblyrhynchos*	Turtle-fishing	Multiple bites by two sharks on the swimmer at the surface with heavy exsanguination	Dominance/territoriality	Bagnis[10]
1969	Male	35	Moorea	Oceanic whitetip shark *Carcharhinus longimanus*	Fishing from a boat	Massive bite on the thigh of the victim who fell off the boat into a feeding frenzy	Indirect predation	Lagraulet et al.[9]
1977	Male	U	Tepoto Nord	Sicklefin lemon shark *Negaprion acutidens*	Spear-fishing	Multiple bites with heavy exsanguination by a shark previously wounded by a fisherman	Self-defense	Clua and Haguenauer[13]

Note: The 1969 case study is the only one that could be classified as "predation" because the victim inadvertently became part of a feeding frenzy involving oceanic whitetip sharks (a highly traumatogenic species). The feeding purpose of the bite is highly probable, but the predation is qualified here as "indirect" in that it is very difficult to distinguish a deliberate choice by the shark to consider humans as potential prey from a reflex bite exacerbated by competition with other sharks for food.

Abbreviation: U, unknown.

AUTHOR CONTRIBUTIONS

Eric E. G. Clua: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; supervision; writing – original draft. **Michel Bègue:** Conceptualization; data curation; writing – review and editing. **Olivier Jam:** Data curation; resources; writing – review and editing. **Raphaël Lambillon:** Data curation; resources; validation; writing – review and editing. **Carl G. Meyer:** Conceptualization; formal analysis; methodology; supervision; writing – review and editing.

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CONFLICT OF INTEREST

All authors declare they have no conflict of interest.

DATA AVAILABILITY STATEMENT

Data available on request due to privacy/ethical restrictions.

CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

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