Aquatic Mammals 2003, **29.1,** 84–87

Evidence of predation by a tiger shark (*Galeocerdo cuvier*) on a spotted dolphin (*Stenella attenuata*) off O′ahu, Hawai′i

Daniela Maldini

University of Hawai′i at Manoa, Department of Zoology, Ecology, Evolution and Conservation Biology Program, Edmondson Hall, Honolulu, HI 96722, USA

Abstract

Witness accounts of shark predation on cetaceans are rare. On this occasion, a 3.5–4.0 m tiger shark (*Galeocerdo cuvier*) successfully attacked a juvenile spotted dolphin (*Stenella attenuata*) near Penguin Bank, O′ahu, Hawai′i on 11 March 2000. The event was witnessed by the author from a Partenavia P-68 Observer aircraft during an aerial survey assessing abundance and distribution of odontocetes. The dolphin was swimming in a school of 30–50 individuals heading in a south-easterly direction.

Key words: shark attack, tiger shark, *Galeocerdo cuvier*, spotted dolphin, *Stenella attenuata*, shark predation, predator-prey interactions, Hawai′i.

Introduction

In general, predation pressure on odontocetes is not well documented. However, predation pressure has been advocated as an important factor in shaping the structure and behaviour of dolphin schools (Norris & Dohl, 1980*a*). Yet, the effects of predation on structuring cetacean population dynamics are poorly understood. Dietary studies on sharks which are commonly believed to prey on marine mammals do not show cetaceans to be an important prey item (Heithaus, 2001*a,b*; Simpfendorfer *et al*., 2001). Nonetheless, even an occasional successful feeding on a relatively large dolphin could make it worthwhile for a shark to regularly engage in this predatory practice (Heithaus, 2001*a*).

Heithaus (2001*b*) recently reviewed predator-prey and competitive interactions between sharks and dolphins. Much of the evidence of shark/cetacean interaction relies on stomach content studies (Bell & Nichols, 1921; Cliff & Dudley, 1991; Simpfendorfer *et al*., 2001), on observations of scarring patterns and wounds on live dolphins (Corkeron *et al*., 1987; Cockcroft *et al*., 1989; Cockcroft, 1991; Bearzi *et al*., 1997; Urian *et al*., 1998; Heithaus, 2001*a*) or on carcasses beached or floating at sea, which often bear signs of shark predation. However, in some cases, these animals could have died of other causes and may have been scavenged after death (Carey *et al*., 1982; Long & Jones, 1996; Heithaus, 2001*b*).

There are few published observations of direct attacks by sharks on live cetaceans (Leatherwood *et al*., 1973; Mann & Barnett, 1999). The following report documents an attack by a tiger shark on a juvenile spotted dolphin in Hawaiian waters.

Current Address: Alaska SeaLife Center, P.O. Box 1329, Seward, AK 99664, USA.

Materials and Methods

A predatory attack involving a tiger shark (*Galeocerdo cuvier*) and a juvenile spotted dolphin (*Stenella attenuata*) was witnessed by the author while on board a Partenavia P68 Observer aircraft from an altitude of 150 m during an aerial survey of cetaceans in the coastal waters around the Island of O′ahu, Hawai′i. The plane circled the sighting for its entire duration (approximately 1 min), from the time the dolphin was separated from its school to the time both shark and dolphin disappeared from view. Subsequently, two attempts were made to reposition the plane on the exact location of the initial sighting with no success.

Results

On 11 March 2000, at approximately 12:06 h a tiger shark (*Galeocerdo cuvier*) attacked a juvenile spotted dolphin (*Stenella attenuata*) on Penguin Banks, a shallow water embankment between the islands of O′ahu and Moloka′i, in the main Hawaiian Island Chain (Fig. 1). The species identification for the animals involved in the interaction was made by the author and relied on several characteristics typical of the two species. The tiger shark, estimated to be approximately 3.5–4.0 m in length, was identified by its large square head, its blunt nose, its slender body behind the pectoral fins and

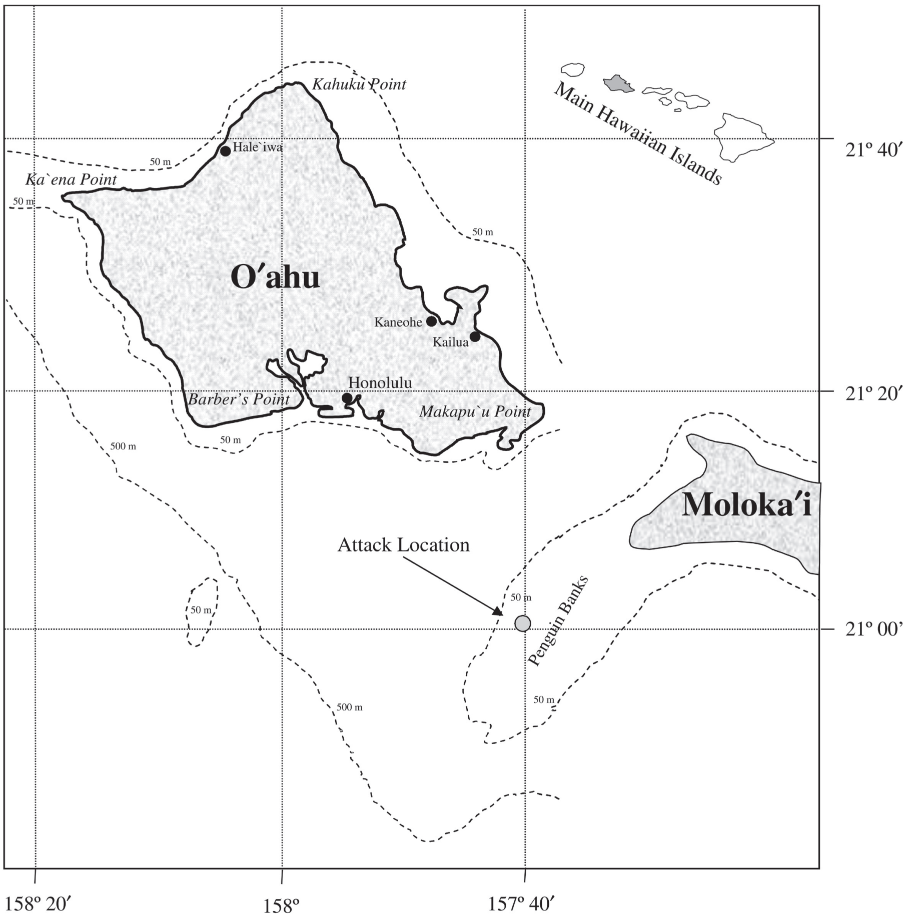

Figure 1. Map of the Penguin Banks area between the Islands of O′ahu and Moloka′i in the Main Hawaiian Islands Chain showing the exact location of a tiger shark attack on a spotted dolphin.

its size. Spotted dolphins in Hawaiian waters can be distinguished from other *Stenella* species for the presence of faint spots on the body and a prominent white lip at the tip of the rostrum. From an aircraft, observers routinely identify spotted dolphins using the latter characteristic since the presence of spots is not noticeable from a distance.

The attack occurred in approximately 50 m of water at a position of 21°00.85′N and 157°40.24′W. The juvenile dolphin was part of a large (approximately 30–50 individuals) school travelling in a south-easterly direction toward the island of Moloka′i. The school was arranged in a diamond-shaped formation. The juvenile spotted dolphin was observed slowly falling behind the school while a tiger shark quickly approached from the rear-left side. While the shark approached the isolated dolphin, the rest of the school continued on its south-easterly course.

The shark's approach was fast and deliberate. The tiger shark bit the spotted dolphin in the middle section of the tailstock and completely severed it. The dolphin was thus left unable to escape and was seen thrashing at the surface for a few seconds, allowing one of the observers (DM) a clear view of its missing tailstock. Later, the two animals disappeared underwater and we lost the location of the sighting. Some blood was present in the water but the sighting location was lost by the aircraft before any of the observers could verify the amount. Given the nature of the injury it was assumed that the dolphin did not survive the attack, which was therefore defined as successful.

Discussion

The strategy used by the tiger shark during the attack seems to confirm previous observations that successful attacks on cetaceans occur more frequently from the side/rear, while the higher incidence of wounds and scars on the back/frontal regions of the body of survivors indicates this is a less effective site of attack (Heithaus, 2001*a*). In the case reported, the severing of the tailstock effectively ensured the immobilization of the victim, which was left unable to escape. Interestingly, another published report of a tiger shark attack on a bottlenose dolphin (*Tursiops truncatus*) calf at Monkey Mia, Australia showed a photograph of the dead calf with a severed tail: witnesses to the attack suspect the tail was severed before the shark took a second fatal bite into the belly of the animal (Mann & Barnett, 1999). Other observations also support the hypothesis that many attacks on odontocetes are directed to the tail (Arnold, 1972; Cockcroft, 1991; Long & Jones, 1996).

If successful attacks are generally as quick and flawless as the one witnessed in Hawaiian waters, it is not surprising they are missed by potential observers. To date, the rate of shark attacks on cetaceans is unknown. Inferences on attack rates can be made from unsuccessful attempts based on wounds and scars (Cockcroft *et al*., 1989; Heithaus, 2001*a*). Nonetheless, lack of scars in a cetacean population is not necessarily an indication of a low rate of predation, but a possible indication of a higher success rate of the predator, since wounded dolphins only represent misses.

Irvine *et al*. (1973) reported that between 20 and 50% of bottlenose dolphins living along the shallow waters of Florida and Texas bear scars inflicted by sharks. In contrast, dolphins living in the open ocean appear to have a lower incidence of scarring (Wood *et al*., 1970). The difference in scarring frequency could be attributed to the differential mortality in shallow versus open waters. While attacks may be frequent in both environments, shallow waters may afford an animal additional protection, because of the lesser number of directions from which an attack could be launched. For example, spinner dolphins (*Stenella longirostris*) may seek the shallow sandy bottom of protected coves over areas of rocks and corals to be able to see the approach of a shark and better respond to it (Norris *et al*., 1994). In the open ocean, the school envelope may provide the only protection to an individual against attacks, which could come from several directions.

In this report, the attacked dolphin appeared to become detached from the orderly diamond-formation of the school before the attack began. Whatever the reason for this tactical error, it reinforces the importance of school cohesion and coordination as a defence mechanism against predation. In response to an attack an individual is safeguarded only within the school envelope where the rapid and coordinated avoidance manoeuvres of the school contribute to 'confuse' the predator's search image and give any individual in the school the advantage of a few precious seconds that may be the difference between life and death. Therefore, some aspects of predator evasion in cetaceans may not be very different than in schooling fish (Norris & Dohl, 1980).

On the other hand, cetaceans have developed very sophisticated sonar systems, which allow them to efficiently scan the water ahead in search of prey and as an early warning signal for predators. Norris & Dohl (1980) described a dolphin school as Sensory Integration System (SIS) where sensory coordination helps each individual 'perceive' at all times the position of all other individuals within the school envelope, and facilitates responses to information gathered outside the envelope (such as the presence of food or of a predator). As part of an SIS each individual depends on the other to contribute information gathered within its sensory distance, and the sum of the information provided by each school member constitutes the framework used to coordinate the movements and reactions of the school as a whole. Without the cooperation of each individual within the school this system would not work. As part of an SIS, a school may become an efficient mechanism for long-range predator detection.

Sharks, on the other hand, rely on chemical, electrical and visual cues to find their prey. Their success in killing a dolphin may depend on opportunity and speed. Norris *et al*. (1994) present a report by Springer, which illustrates a possible cooperative effort by sharks to kill a common dolphin (*Delphinus delphis*) by surrounding a school for several hours and flanking the dolphins until an opportunity is provided. It is common in the open ocean to find multi-species aggregation where sharks and dolphins all follow large schooling fish (Au, 1991). The continued presence of sharks around dolphin schools may provide many opportunities for predation although cetaceans do not appear to be the main staple of any shark species (Heithaus, 2001*b*).

Despite the theoretical framework surrounding the issue of predation on cetaceans, there is still a need to understand its mechanisms. It is therefore important that occurrences such as the one described in this report are divulged to the scientific community.

Acknowledgments

The reported observation was collected under NMFS Permit No. 877–1473 during Daniela Maldini's dissertation work on abundance and distribution patterns of cetaceans around O'ahu's waters. Funding for this work was provided by the National Marine Fisheries Service, the Pacific Marine Life Foundation and by Royal Hawaiian Cruises, Navatech II. I thank the observers onboard the aircraft on that eventful day: John Weiser, Marc Lammers, and Aaron Hepshi. Thanks to all reviewers for ensuring the manuscript complied with scientific standards.

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