
Apparent Predation by a White Shark *Carcharodon carcharias* on a Pygmy Sperm Whale *Kogia breviceps*

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The white shark *Carcharodon carcharias* is one of the largest predatory fishes in the world's oceans, and is an important apex predator in coastal waters. The diet of the white shark is quite diverse, including bony fishes, sharks, sea turtles, birds, and various invertebrates (Compagno 1984). Adults prey frequently on marine mammals. In the northeast Pacific, white sharks kill and eat sea lions *Zalophus californianus* and *Eumetopias jubatus*, elephant seals *Mirounga angustirostris*, and harbor seals *Phoca vitulina* (Ainley et al. 1981 and 1985, Le Boeuf et al. 1982, McCosker 1985), and are known to kill sea otters *Enhydra lutris*, although none have been found in the stomachs of the sharks (Ames and Morejohn 1980). In other oceans, there are several records of white shark predation on cetaceans, specifically on the harbor porpoise *Phocoena phocoena* and the bottlenose dolphin *Tursiops truncatus* (Arnold 1972, Corkeron et al. 1987), but the majority of accounts are largely anecdotal. There are few published records of white sharks attacking larger cetaceans, and no published records of white sharks in the northeast Pacific attacking cetaceans. Of over 100 white sharks collected in California waters between 1935 and 1984, the ones whose stomach contents were examined were not known to have the remains of any cetacean (Klimley 1985).

However, many authors (Randall 1973, Ellis 1975, Carey et al. 1982, Pratt et al. 1982, McCosker 1985)

observed or documented white sharks scavenging on large whale carcasses off Australia and the eastern United States, and Castro (1983) suggested that whale carcasses may be a primary food resource for these sharks in some areas. To date, there is no documentation of white sharks preying or attempting to prey on a live cetacean other than a porpoise or dolphin. This study reports such predation and provides new information on the diet and predatory behavior of white sharks.

On 31 August 1989, a live pygmy sperm whale *Kogia breviceps* stranded at Pajaro Dunes beach north of Monterey near Watsonville in northern California. The whale, a 1.8 m, 82 kg male, was taken to the Long Marine Laboratory at the University of California, Santa Cruz, where it was kept alive for several weeks. I was able to examine and photograph the whale 18 days after the initial stranding, and noticed a pair of crescentic rows of gashes and punctures on the dorsal and ventral surfaces of the whale's body anterior to the caudal peduncle (Fig. 1). On the dorsal surface, the scars were narrow, parallel grooves that punctured the dermal layer and cut down into the muscles in several spots. The scars cut much deeper on the ventral surface: the anterior scars were deep puncture wounds, and the posterior scars were vertically-oriented parallel gashes that penetrated well into the muscle mass. The dorsal surface was penetrated by 12 teeth and the ventral surface by 9 teeth.

The shape and orientation of these scars strongly suggests that they were inflicted by a large predator in an attempt to capture the pygmy sperm whale. The size, shape, width, spacing, and orientation of these scars indicated that they were caused by a medium-to-large white shark, and the bite marks on the *Kogia* are different than those that could be made by other large sharks from northern Californian coastal waters such as the blue shark *Prionace glauca*, the short fin mako shark *Isurus oxyrinchus*, or the salmon shark *Lamna ditropis*. The only other sharks known to prey upon cetaceans are the tiger shark *Galeocerdo cuvieri* and large individuals of the genus *Carcharhinus* (Compagno 1984, Corkeron et al. 1987). These species are almost never seen in northern California waters (Compagno 1984), and the bite marks on the *Kogia* do not appear to have been made by these sharks. These conclusions are supported by comparisons with similar marks and injuries attributed to white sharks on pinnipeds and dolphins, and by comparisons with *C. carcharias* and jaws of other large predatory sharks examined by the author. Lastly, white sharks are frequently sighted and caught in the Monterey Bay area (Klimley 1985).

Observations on and documentation of white shark attack behavior by Tricas and McCosker (1984) also implicate *C. carcharias* as the attacker. First, white sharks usually attack their prey in a swift initial bite from below, behind, or from the side; the bite marks on the pygmy sperm whale are on the left, rear side of the body. Next, in the initial attack the shark opens its mouth by raising the head, dropping the lower jaw, and then thrusting it up into the prey while the upper jaw closes down. The shark will roll or shake

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Figure 1

Left lateral view of bite scars from a white shark *Carcharodon carcharias* on the anterior caudal peduncle of a live 1.8m juvenile male pygmy sperm whale *Kogia breviceps*. Dorsal scars correspond to the upper jaw of the shark, and ventral scars correspond to the lower jaw.

violently to inflict a fatal initial bite. The bite marks on the ventral surface of the whale were deeper than the dorsal set of scars, and the deepest scars were on the upper left and lower right, indicating initial penetration with the lower teeth, biting down of the upper jaw, and a roll to the left as the shark attacked the whale. The initial bite was relatively superficial and apparently unsuccessful, since the whale survived the attack. The bite-and-spit attack behavior of the white shark (McCosker 1985, Tricas and McCosker 1984) may have allowed the whale to escape any further injury by the same shark.

Many white shark attacks are made while the prey is floating or swimming at the surface, and the shark usually attacks from below or behind (McCosker 1985). Pygmy sperm whales have been observed floating quietly on the surface of the ocean with the tail hanging low in the water (Caldwell and Caldwell 1989). This 'basking' behavior seen in *Kogia* may facilitate easier attack by predators.

Although shark predation on smaller odontocetes is apparently rare, white sharks are known to attack and eat living dolphins (Arnold 1972, Corkeron et al. 1987). White sharks are also known to eat marine mammals as large as adult male elephant seals. Le Boeuf et al. (1982), documented remains of a 3m-long male ele-

phant seal that may have weighed over 600kg taken from the stomach of a 4.7m white shark. Thus, a 1.8m, 82kg whale is within the size range of white shark prey.

Based on calculations by Randall (1973), the width of the bite marks on the pygmy sperm whale (roughly 25cm wide) and the relative spacing between individual tooth scars indicate a 4–5m shark made them. Pratt et al. (1982) recorded white sharks 4–5m-long feeding on the carcass of a dead fin whale *Balaenoptera physalus*, and Le Boeuf et al. (1982) examined seven white sharks ranging in length from 2.4 to 5.5m and recorded pinniped remains in each of their stomachs. Therefore, medium and large white sharks attack and consume marine mammals their size or smaller, and scavenge on cetacean carcasses larger than themselves (Klimley 1985, McCosker 1985, Pratt et al. 1982).

This is the first report of an attack on a *Kogia*, and on any cetacean in the northeast Pacific by a white shark. It is one of the few records of a shark attack on a live cetacean, other than a porpoise or dolphin. In a recent review, Caldwell and Caldwell (1989) list no known predators for *Kogia*; this observation implicates white sharks as a predator.

Although such predation has not previously been reported, the ranges of white sharks and *Kogia* overlap in the coastal areas of eastern and western North

America, southeastern and southwestern South America, northwestern Europe, northwestern and southern Africa, southern Australia and New Zealand, and northeast Asia and Japan (Caldwell and Caldwell 1989, Compagno 1984). Therefore, other incidents of predation may be observed in these areas.

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