Concurrent scavenging off a whale carcass by great white sharks, *Carcharodon carcharias,* and tiger sharks, *Galeocerdo cuvier*

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The great white shark, *Carcharodon carcharias* (Lamnidae), and the tiger shark, *Galeocerdo cuvier* (Carcharhinidae), are two of the largest species of macropredatory sharks. Both are known to prey on dolphins (Delphinidae) off KwaZulu-Natal, South Africa (Cockcroft et al., 1989). Although scavenging off whale carcasses by white sharks (Carey et al., 1982; Pratt et al., 1982; McCosker, 1985; Long and Jones, 1996) and tiger sharks (Compagno et al., 1998) has been documented, the two species have not been recorded feeding concurrently on the same carcass. In August 1993, Natal Sharks Board (NSB) observers saw both species feeding on the carcass of a humpback whale, *Megaptera novaeangliae,* off Durban, but they were not seen scavenging concurrently (NSB[1]). In September 1997, elsewhere in the southwest Indian Ocean, tiger sharks were filmed feeding on a humpback whale carcass off the southern tip of Madagascar, but no white sharks were present. Compagno[2] subsequently viewed the footage and verified the identification of the tiger sharks.

This paper presents observations of white and tiger sharks scavenging off the floating carcass of a Bryde's whale, *Balaenoptera edeni*, off the coast of KwaZulu-Natal, South Africa. These observations are of a single event and hence should not be attributed more significance than they can support.

Methods

The National Sea Rescue Institute (NSRI) reported the presence of a Bryde's whale carcass to the NSB at midday on 26 April 1998. The NSRI, which had responded to a call reporting the carcass as a capsized yacht, found it floating 4 km east of the Durban harbor entrance (29°52′S, 31°24′E) with large sharks in its vicinity. The following day various reports were received that the carcass had drifted 25 km to the north and was several kilometers off the mouth of the Umdloti River (29°38′S, 31°07′E). Large sharks were reported to be feeding on it.

On 28 April, three of the authors launched a 5.5-m open-deck boat, equipped with photographic equipment and a shark cage, from the beach at Umhlanga Rocks (29°43′S, 31°05′E). The carcass was located 6 km offshore of the launch site and 10 km south of its position on the previous day. It was observed for 5 h. Conditions were excellent, with a glassy sea, light wind, little current, an estimated water temperature of 23°C and clarity of 15 m.

This account was written by S. F. J. Dudley (who did not witness the event) on the basis of separate interviews with the remaining authors and on viewing 27 min of video footage filmed by M. D. Anderson-Reade and an additional 4 min of footage filmed from another boat. All distances, times, and shark lengths (precaudal length, PCL) are approximate. The carcass was identified to species from the video footage, by the presence of prominent head ridges (Peddemors[3]).

Results

A white shark of 5 m was encountered 500 m from the carcass. The shark made numerous passes within 2 m of the stationary boat and just below the surface. This behavior continued for 15 min before the boat continued towards the carcass. This animal was not seen again.

Immediately upon reaching the carcass, two tiger sharks of 3.5 m were seen cruising 3 m below the surface. Two white sharks were present as well, one of about 4 m and the other a larger animal with a distinctive bite scar on the right side, located dorsolaterally and posterior to the first dorsal fin. A second boat was present and both shark species made approaches to each boat. The shark cage was deployed and occupied by two divers. A number of tiger sharks with distended abdomens were seen feeding on the carcass, usually singly but sometimes in groups of two or more. Their approaches to the carcass were leisurely and gave no evidence of intraspecific aggression. The white sharks, which were not seen feeding during this period, moved off soon after the cage was deployed and the animal with the bite scar was not seen again.

For 20 min the boat and cage were maneuvered around the carcass in an attempt to film the feeding process. Large quantities of organic debris reduced water clarity and because visibility was better from the surface, the divers returned to the boat and the cage was retrieved.

A 4-m female white shark, possibly the smaller animal seen at the carcass

[1] NSB (Natal Sharks Board). 1993. Unpubl. data. Natal Sharks Board, P. Bag 2, Umhlanga Rocks 4320, South Africa.

[2] Compagno, L. J. V. 1999. Personal commun. South African Museum, P.O. Box 61, Cape Town 8000, South Africa.

[3] Peddemors, V. M. 1998. Personal commun. Natal Sharks Board, P. Bag 2, Umhlanga Rocks 4320, South Africa.

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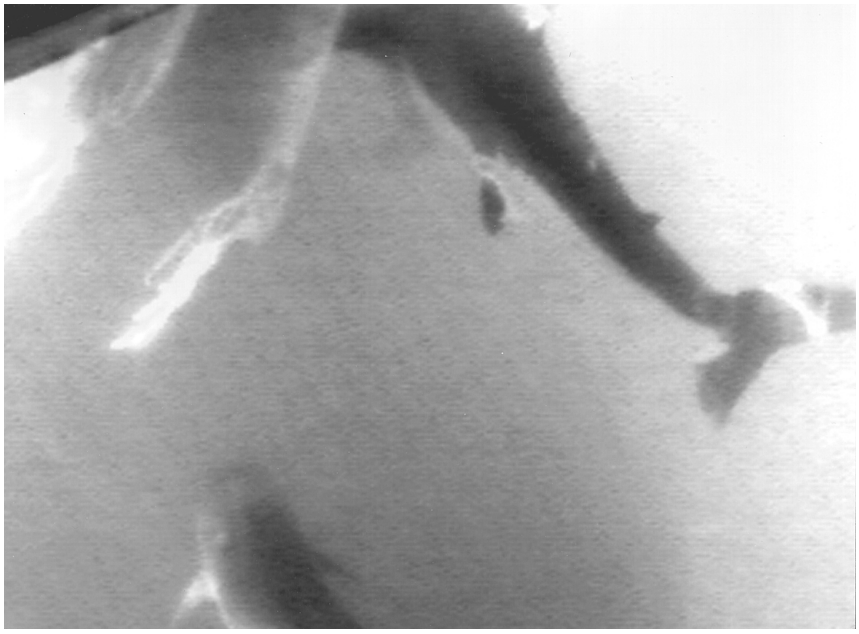

Figure 1

A 4-m PCL white shark feeding on the carcass of a Bryde's whale, and a 3.5-m tiger shark swimming below it. The head of the white shark, out of picture, is above water. The boat hull is at upper left, and strands of whale tissue are hanging beneath it. (Frame from Hi8 videotape).

initially, was observed surfacing 100 m from the carcass and regurgitating its stomach contents. It then circled the floating matter. While being approached by the boat, it began to feed on the regurgitated material. This was the only time that regurgitation was observed but, on other occasions, clouds of what appeared to be regurgitated matter were seen in the water near the carcass, indicating that regurgitation may have occurred more frequently.

Subsurface filming of the white shark was conducted over the gunwale. On five or six occasions the shark approached the camera (which was enclosed in a yellow housing) such that the cameraman was forced to lift the camera out of the water just prior to the shark's snout making contact. The shark would then mouth (lightly and briefly grasp) the boat or motors before moving off. On one occasion it damaged its head on the motor and the resulting laceration, immediately anterior to the right eye, was used subsequently as an identification mark.

A small (3–3.5 m), red, semirigid, inflatable boat arrived and the white shark immediately showed interest in it, approaching it from the rear several times and mouthing the motor.

After 40 min, the observers (coauthors) returned to close proximity of the carcass, where there now appeared to be between 7 and 10 tiger sharks, all 3.5 m. Feeding on the carcass continued, but the animals showed more interest in the boat than previously. Typically, a shark would leave the boat, feed on the whale and then return slowly to the vicinity of the boat. The motors were bumped three times and a propeller was mouthed once. As with the white shark, the tiger sharks approached the camera directly, and on several occasions the cameraman depended upon warnings from his co-observers to ensure timely evasion. Only one interaction between individual tiger sharks was observed. Two animals, swimming one above the other, converged slowly to within 1 m, at which point they diverged rapidly. Immediately prior to this event, one of the animals had been investigating the camera and it is possible that it had been unaware of the other shark's presence.

Soon after returning to the carcass, the observers noted the arrival of the white shark with the wounded snout. There appeared to be a slight increase in the swimming speed of the tiger sharks but no other reaction was observed. The white shark fed on three occasions and on each occasion one or more tiger sharks fed at the same time. On one occasion two tiger sharks swam within 3 m of the feeding white shark—one of these was captured on videotape, together with the white shark (Fig. 1). The white shark removed a piece from the carcass, then abandoned the piece and returned to the carcass. A tiger shark then fed on the piece but moved off when the white shark came back to it.

Both species fed on the carcass at the water line, but the tiger sharks fed below the water line as well. Tiger sharks were observed to thrust their heads out of the water to feed (Fig. 2) as has been observed previously (Gilbert, 1963;

Figure 2

A 3.5-m PCL tiger shark feeding on a Bryde's whale carcass at the water line. The shark's eye is covered by the nictitating membrane.

Moss, 1972; Strong, 1991). One approach behavior exhibited by the white shark and captured on film conformed with that described by Tricas (1985) as an underwater approach, in which the shark approached the carcass just below the surface until approximately 1 m away and then attacked by deflecting the head upward, emerging out of the water to bite. When feeding above the water line, both species tended to bite twice in quick succession, apparently gaining better purchase with the second bite. This procedure was followed by slow and deliberate shaking, twisting, and turning to cut away the mouthful. The tiger sharks demonstrated more thrashing than the white shark, sometimes rolling onto their backs while biting. The white shark behavior described by Pratt et al. (1982), in which the shark bit a whale carcass ventral-surface-up before rolling upright to cut a mouthful, was not seen.

When tiger sharks fed below the surface, the carcass was penetrated vertically and a swaying motion of the body, rather than twisting, followed the bite. As many as five individual tiger sharks fed on the carcass at one time, some hanging below the carcass and some biting at the waterline.

The tiger sharks tended to remain at or near the carcass at all times, whereas the wounded white shark approached the carcass to feed and then moved off again, sometimes out of sight of the observers. A white shark of 3.5–4 m, believed to have been an individual not previously observed, made a brief appearance near the carcass during this period. The tiger sharks were generally more active than the wounded white shark, although both species were unhurried and deliberate. The white shark increased swimming speed only when investigating the camera.

The red inflatable boat which had been present earlier, returned, and the wounded white shark again showed particular interest in it. On one occasion the shark held the rear of the starboard pontoon in its mouth and kept the boat stationary despite the crew of the boat engaging gear and running the 40-hp motor at speed. After 10 sec the shark released the pontoon, the only damage to which was a single, small puncture, perhaps the result of exploratory mouthing behavior.

Discussion

White sharks feeding on whale carcasses appear to feed until satiated (McCosker, 1985). The observed regurgitation of food suggests that feeding may continue even after satiation.

Observations suggest agonistic encounters amongst white sharks when feeding on a whale carcass. Observers saw at least four and possibly up to nine different white sharks in the vicinity of a fin whale carcass, *Balaenoptera physalus*, over a 30-h period but never more than two together (Pratt et al., 1982). When two did co-occur their behavior appeared agonistic, and some of the sharks had tooth cuts and slashes (some previous wounds, some freshly inflicted). Similarly, Long and Jones (1996) reported that about five different white sharks fed on the carcass of a blue whale, *Balaenoptera musculus*, but only one fed at a time. McCosker (1985) observed an agonistic encounter between two white sharks feeding on horsemeat bait; the smaller shark was forced to depart after receiving a minor bite. Strong et al. (unpubl. data in Strong [1996]), also

noted that feeding attempts by individual white sharks may be thwarted by larger conspecifics. In our study, although three, possibly four, white sharks were seen at or near the carcass, only one was seen feeding. Although the observation period was brief, this type of behavior is consistent with the existence of intraspecific competitive exclusion. The animal seen feeding was smaller than at least two of its conspecifics, and it is possible that the larger individuals had fed previously.

The tiger sharks exhibited no evidence of intraspecific competition, despite the presence of up to 10 individuals in the vicinity of the carcass and up to five feeding concurrently. The abundance of food or the similarity in size of the sharks may have prevented the establishment of the size-dependent hierarchy discussed by Bres (1993).

Interspecific competition for food amongst reef-dwelling, carcharhinid species has been recorded (Nelson and Johnson, 1980), as have apparent interspecific hierarchies comprising 1) the silvertip shark, *Carcharhinus albimarginatus*, the Galapagos shark, *C. galapagensis*, and the blacktip shark, *C. limbatus*, (Limbaugh, 1963); 2) the oceanic whitetip shark, *C. longimanus*, and the silky shark, *C. falciformis*; and 3) hammerhead sharks (Sphyrnidae) and various other species (Springer, 1967). Pratt et al. (1982) noted that the locally abundant blue shark, *Prionace glauca*, and shortfin mako, *Isurus oxyrinchus*, were conspicuously absent from the vicinity of the fin whale carcass, and a fish spotter pilot observed no blue sharks within a 3.2-km radius. These authors suggested that this was a consequence of territorial exclusion by white sharks. Similarly, Long and Jones (1996) suggested that white sharks excluded blue sharks, a species known to scavenge on whale carcasses, from the blue whale carcass. McCosker (1985) observed a single white shark feeding on the carcass of a grey whale, *Eschrichtius robustus*, and saw no other shark species nearby. The white and tiger sharks, however, did not appear to compete at the Bryde's whale carcass. Springer (1967) noted that mixed-species feeding aggregations tend to consist of sharks of similar sizes. If it is hypothesized, therefore, that the single 4-m white shark would have competitively excluded a single 3.5-m tiger shark, the presence of several tiger sharks may have prevented this from occurring. McKibben and Nelson (1986) speculated that juvenile gray reef sharks grouping in a loose aggregation or as a polarized pack may obtain protection from larger sharks. The tiger sharks, attracted by a single stimulus, may have derived an incidental defensive benefit.

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