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Interactions between bottlenose dolphins and sharks in Moreton Bay, Queensland

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Abstract

Details concerning the frequency and occurrence of large wounds on bottlenose dolphins resident in Moreton bay are presented. These wounds appear to result from interactions between the dolphins and sharks, particularly great white and tiger sharks. The results are discussed in relation to what is known about shark distribution in the area and the factors which are believed to affect social behaviour in bottlenose dolphins.

Introduction

Studies of free ranging delphinids have cast light on the way some dolphin and shark species interact. Norris and Dohl (1980), in a study of Hawaiian spinner dolphins (*Stenella longirostris*), reported that they 'seem to be attacked with some frequency' (p. 846). Norris *et al.* (1985) noted a school of spinner dolphins 'in obvious agitation' when a 'medium sized shark' (p. 180) was viewed by an underwater observer. Wells *et al.* (1980), noted a movement of bottlenose dolphins (*Tursiops truncatus*), into shallow water at times when bull sharks (*Carcharhinus leucas*), were most common in their study area.

Ross (1977), in a study of dead bottlenose dolphins (reported as *Tursiops aduncus*) in South Africa, noted that while 'the incidence of shark attack is unknown . . .(it) appears to be low on the basis of scarred animals'. (p. 178). From South Africa also comes an account of humpback dolphins (*Sousa chinensis*) attacking a shark known to be a dolphin predator. Saayman and Tayler (1979) describe a group of these dolphins apparently chasing a four to five metre shark, thought to be a *Carcharadon carcharias*, the great white shark. While no physical contact was observed between dolphins and shark, the shark was chased towards the open sea. Humpback dolphins also were observed to apparently avoid a four to five metre hammerhead shark (*Sphyrna* sp.).

A few shark species have been reported to attack a variety of species of delphinids. Compagno (1984) listed great white, tiger (*Galaeocerdo cuvieri*) and bull sharks as dolphin predators. Wood *et al.* (1970) in their review of the literature on dolphin—shark interaction reported dolphin remains in tiger, bull and dusky (*Carcharhinus obscurus*) sharks. Paterson (1986) noted that, of the shark species taken by beach protection measures (netting and drumlining) in Queensland waters, dolphin remains were only found in great white sharks.

Stevens (1984), in a study of sharks caught by sportsfishermen off the coast of New South Wales, Australia, found delphinid and unidentified mammal remains in tiger sharks, and cetacean remains in the stomachs of blue sharks (*Prionace glauca*), shortfin makos (*Isurus oxyrhynchus*), and oceanic whitetip sharks (*Carcharhinus longimanus*). One great white shark investigated in this study was reported to have regurgitated cetacean remains. It is possible that some sharks feed on cetacean carrion (e.g. Pratt *et al.*, 1982) rather than actively hunting cetaceans.

Little is known of the annual patterning of shark attacks on any dolphin population, nor of age or sex related differences in rates of attack. This paper describes observed interactions between bottlenose dolphins in Moreton Bay, and presents evidence, in the form of fresh and healed wounds, of interactions between sharks and these dolphins.

Materials and Methods

Bottlenose dolphins were identified using naturally occurring marks found on their dorsal fins and surfaces (Würsig and Würsig, 1977). Identified individual bottlenose dolphins were photographed during a study on the behavioural ecology of inshore dolphins in Moreton Bay, Queensland, Australia undertaken from May 1984 until February 1987. From photographs and noted observations, fresh wounds inflicted by sharks (defined as those either still bleeding or with large areas of flesh still visible) were recorded. The number of fresh bites seen per month was divided by the number of data-collecting trips made per month, to ensure that a large number of bites seen in one particular month did not simply reflect a large number of trips made in that month.

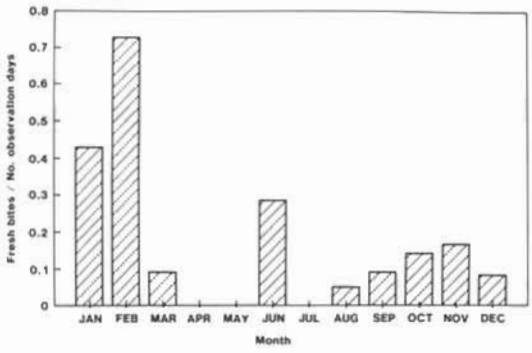

Figure 1. The incidence of fresh shark bites on dolphins in each month of the year (corrected for the number of observation days in any one month).

Photographs of dolphins identified in Moreton Bay were examined for evidence of healed wounds caused by shark attack. Only scars which were considered to show definite evidence of shark bites were counted. Therefore, many 'possible' healed bites were not counted as evidence of attack.

In an attempt to ascertain the species of shark responsible for attacks, clear photographs of seven dolphins with either fresh or healed wounds were shown to ichthyologists at the Queensland Museum, who examined the conformation of wounds, marks of tooth cusps and spacing between teeth to posit possible shark species responsible for the wounds.

Specific names are given for sharks, however the identification to species of several of the whaler sharks seen is dubious, and further study of the shark fauna of Moreton Bay may reveal incorrect specific assignments presented here.

Results

The monthly incidence of fresh scars, plotted against the number of bites seen per month/the number of observation days made per month, is presented in Fig. 1. A peak of fresh wounds was apparent in February. However, there are no significant differences in the mean value of the index presented above over seasons of the year (paired T tests $p > 0.05$ in all cases).

Fresh wounds were seen on two animals in June. While these wounds fitted the definition provided above, it is thought that they were not inflicted in that month. Both animals showed evidence of healing of wounds considered to have been at the same time as the 'fresh' wounds (see Fig. 2 for an example). These wounds were probably at least two months old at the time of their first sighting.

Overall, of 334 bottlenose dolphins identified in Moreton Bay, 36·6% showed definite evidence of shark attack. Evidence of attack on the 106 animals of known sex was investigated. Twenty males and 31 females showed signs of bites, while 15 males and 40 females did not. There was no significant difference between sexes in evidence of attack ($x^2_1 = 1.706$, $p > 0.05$).

Results from this study were compared with those from Wood *et al.* (1970, p. 267). These authors reported that, in a population of captive dolphins, five were determined to have definite evidence of shark attack prior to their capture and 17 either showed no sign of bites or may have been bitten. These rates of attack were not significantly different from those recorded here ($x^2_1 = 1.738$, $p > 0.05$).

In the present work, of five dolphins where a shark species possibly responsible for the wound could be suggested, all were either tiger or great white sharks (R. Mackay, pers. comm.). Some of the largest wounds seen during this study are shown in Figs. 2–9 and include examples of both tiger and great white attacks.

Discussion

The results of this research indicate that tiger and great white sharks attack bottlenose dolphins in Moreton Bay. Most of the major wounds shown in the figures presented here seem to be caused by great white sharks. There appears to be a peak of attacks in the summer months, although analysis of the present data found no statistically significant seasonal variation in incidence (possibly due to the small sample size). It is interesting to note that attacks apparently due to great white sharks occurred in the summer months. While tiger sharks are known to occur in the tropics, the great white is commonest in cold and warm temperate water (Compagno, 1984). The maximum water temperature recorded in Moreton Bay in the summer is 29°C while the coldest recorded winter temperature is 16°C in August (Newell, 1971). A study of the seasonal distribution and abundance of the shark fauna of Moreton Bay would shed light on the habits and ecology of great white sharks in the area.

Studies of white sharks have generally taken place in areas where the water temperature is far colder than the summer maximum recorded for Moreton Bay. Tricas and McCosker (1984), working in shallow waters off South Australia, found sharks in waters of 20.9°–21.2°C, while Carey *et al.* (1982), in their study of sharks in deeper waters, off the east coast of the USA, found sharks in waters of approximately 5°–19°C. Great white sharks are known to occur in the waters of Moreton Bay, as a 2.9 m specimen was caught in 'late' (austral summer?) 1976 (Grant, 1982).

Paterson (1986) found that most great white sharks caught in coastal oceanic waters off Queensland were found in the southeastern corner, during periods

Figure 2. A large wound on animal B 249.

Figure 3. A large fresh wound on animal B 59 thought to be caused by a great white shark.

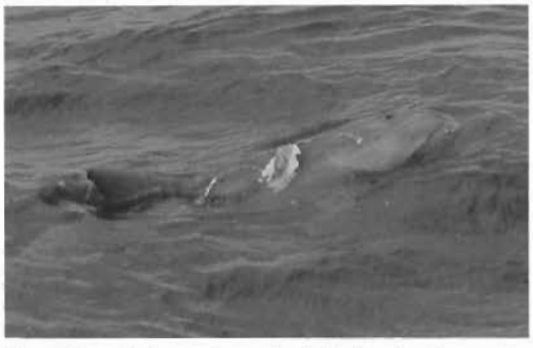

Figure 4. Large fresh wounds on animal B 41 thought to be caused by a great white shark.

Figure 5. A large fresh wound on animal B 28 thought to be caused by a great white shark.

Figure 6. Large healed wounds on animal B 51 thought to be caused by a great white shark.

Figure 7. A large wound on animal B 65 thought to be caused by a tiger shark.

Figure 8. A very large healed wound on the tail of animal B 91.

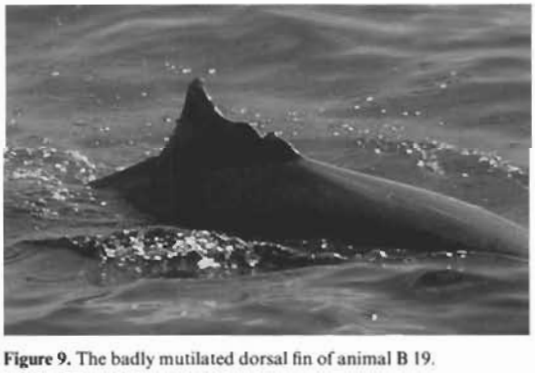

Figure 9. The badly mutilated dorsal fin of animal B 19.

when the water was coldest. However, a few great whites were also caught in the summer, in waters as far north as the Mackay region, where the oceanic water temperature was 26°–28°C, comparable with that of Moreton Bay in summer.

Other shark species may be found around trawlers, and interactions between these sharks and bottlenose dolphins were also observed occasionally. Small whaler sharks, generally black tip (*Carcharhinus brevipinna*) and bronze whalers (*C. brachyurus*) of lengths to approximately 1.5 m were infrequently caught when members of the University of Queensland's trawler crew attempted to catch tuna (*Kishinoella tonggol*) also feeding on trash fish. Underwater observations also demonstrated the presence of these sharks, generally at greater depths than dolphins were seen (i.e. from approximately 7 m). On one occasion, two male dolphins were observed to chase a small shark on the surface for approximately 30 m. The incidence of sharks around the trawler was probably greater than was obvious to underwater observers, as on one occasion analysis of underwater video film revealed the presence of a large whaler shark (2–2.5 m long) that had not been obvious to the observers underwater.

Occasionally, larger whaler sharks (2–2.5 m) were seen by observers on the trawler. In general, it appeared that adult male dolphins remained in the shark's vicinity, while females, calves and juveniles tended to avoid the sharks.

On one occasion, one underwater observer noted the presence of a large (approximately 2.5 m), very robust, whaler shark (probably either a dusky or bull shark), approximately two metres directly underneath him. At this time, the dolphin group present was about 30 m distant, and huddled into a small, circular pack. Females, calves and juveniles made up the group. Underwater observations were abandoned, but recommenced about ten minutes later, when some of the dolphin group returned to near the trawler's stern. There was no sign of the shark on reinvestigation.

While there was no significant differences between the sexes in numbers of animals with healed wounds, five of the 21 instances of animals seen with fresh wounds were females with calves less than eighteen months old. Calves and juveniles were also bitten by sharks, some when less than one year old. Calves are extremely difficult to identify photographically (and are catalogued as 'x's calf') until they gain an injury such as those from shark attack. Therefore, no attempt has been made to quantify the numbers of attacks on juveniles and calves. However, the relatively high proportion of nursing females that have fresh visible sharkbites suggests that these adults, or their calves, are more vulnerable to predation, and may explain their shark avoidance behaviour described above.

Cost—benefit analysis of animal behaviour is an accepted method for considering the development of types of behaviour. However, this form of analysis is difficult to relate to the population of dolphins in this study. Some of the wounds reported here are major, and suggest that the dolphins are placed in life-threatening situations during an attack. However, on one occasion while a working commercial trawler was being followed, one adult female dolphin (B1) was observed to gain a new shark attack wound. This dolphin and others present continued to follow the trawler, so obviously a shark attack is insufficient to drive dolphins away from trawlers on every occasion.

It is clear from the foregoing that dolphins can survive shark attacks. Sharks may utilize a 'bite and spit' method of attack. Tricas and McCosker (1984, p. 229) define this method of attack as 'after attacking a large prey. . . the shark routinely retreats a short distance from the injured (and at least partially immobilized) prey and swims cautiously within the area apparently waiting for the (prey) to bleed to death or to lapse into a state of shock'. If this is correct, it may be that the other dolphins provide assistance to the injured animal (Caldwell and Caldwell, 1966, Conner and Norris, 1982) or chase the shark away. Slight evidence of a group response to shark attack is indicated by the observation of two dolphins (B59 and B100) in the same group that both had fresh wounds at the same time.

Comparisons of rates of attack on other dolphin populations would provide insight into costs and benefits of the behaviour of the dolphins in this study. This may be difficult, as field workers would need to agree on a common definition of what constitutes evidence of shark attack. As predation is considered a major factor in the evolution of group living (Hamilton, 1971, and see van Schaik and van Noordwijk, 1985 for an example of a test of this hypothesis in primates), such comparisons could cast light on factors affecting bottlenose dolphin sociality. This initial work has given some indication of the interactions of sharks and bottlenose dolphins in Moreton Bay. Further study in this area should include continued observation of dolphins, in order to establish a larger data set on rates of interaction (e.g. sufficient numbers of fresh wounds for statistical analysis), and studies of shark biology within the bay.

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