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NON-LETHAL SHARK ATTACK ON A BOTTLENOSE DOLPHIN (*TURSIOPS* SP.) CALF

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The risk of predation by sharks is considered to have a strong influence on dolphin behavior, especially group formation and habitat use (Heithaus 2001*a*). Although evidence of shark attacks on dolphins abounds (in the form of shark bite scars, shark stomach contents, *etc*.), there have been no published reports in which researchers have directly observed a shark attack on a dolphin in the wild. There are, however, several reports of calves that have died from shark-induced wounds and cases in which researchers have been able to obtain statements from witnesses following a lethal shark attack (*e.g.*, Wood *et al.* 1970, Mann and Barnett 1999). Here, I document the response of a group of bottlenose dolphins (*Tursiops* sp.), containing adult and juvenile females and calves, to the attack of one of its group members (a 3.5-mo-old calf) by an unidentified shark. Because the attack occurred during a focal follow of one of the mother-calf pairs in the group, I present a detailed description (derived from systematic observational data) of the behavior of the focal mother-calf pair, in addition to a description (based on *ad libitum* sampling) of other group members' behavior prior to and following the attack.

The observations occurred offshore of Monkey Mia in Shark Bay, Western Australia (25°47′S, 113°43′E). The study population consists of over 600 individually recognized bottlenose dolphins (*Tursiops* sp.). The three mother-calf pairs present during the described attack are part of a longitudinal study in which focal follows have been conducted on individual mother-calf pairs each year since 1988 (Mann and Smuts 1998, Mann and Watson-Capps 2005). During follows, systematic data collection is achieved using a combination of point, continuous, scan, and *ad libitum* sampling (see Altmann 1974). Information recorded includes focal mother and calf activity, mother-calf distance, group composition, and other information. Group membership

Table 1. Sex and age information for dolphin group members on the day of the attack. Approximate ages of the adult females FAT and JFR have been estimated using a combination of body size, degree of ventral speckling, and the birthdates of their first observed calves (see Smolker *et al.* 1992 and Mann *et al.* 2000).

Dolphin ID	Sex	Age (in yr)
FAT	Female	~31
JFR	Female	~25
PEG	Female	14.3
MOU	Female	12.4
LAU	Female	9.2
RHO	Female	6.4
BSS	Female	5.2
GRT	Male	1.3
STA	Male	1.2
MIG	Unknown	0.3

is defined as including any animal within 10 m of another group member (see Smolker *et al.* 1992).

On 29 February 2004 the mother-calf pair PEG and STA were focal subjects from 0815 to 1735. MOU and MIG (the attacked mother-calf pair) were present in the focal mother and calf's group from 1238 to 1451. All of the group members, except the three calves, were predominantly resting throughout this time period with occasional brief periods of slow travel (see Table 1 for sex and age information on group members). A 2-m hammerhead shark (*Sphyrna* sp.) was sighted near the dolphin group several times throughout the follow. In addition, numerous small (~0.9 m) carcharhinid sharks (*Carcharhinus* sp.) were repeatedly seen following the dolphin group. A summary of all shark related events is presented in Table 2. Because of poor water clarity, depth and visibility on the day of observation, some sharks may not have been noticed by the observer.

The first shark encounter of the follow occurred at 1144 when a 2-m-long hammerhead shark passed between the focal mother and calf, PEG and STA, who were >5 m apart at the time. There appeared to be no reaction by either the mother or calf. The mother continued resting while the calf foraged. STA increased the separation distance from his mother following the shark sighting. However, between 1213 and 1217 STA was alone (>100 m from his mother) and being followed by several small (~0.9 m) carcharhinid sharks. At 1217 STA leapt twice in the direction of his mother and upon rejoining her immediately went into infant position (swimming under the mother, in contact). These leaps are interpreted as an evasive response, as opposed to play or social behavior, because the calf leapt directly towards the mother and went into infant position immediately upon rejoining her (which is a common response when calves are startled);[1] there were no other dolphins (besides the mother) within 50 m with which the calf could have been interacting. In contrast to this evasive

[1] Personal communication from J. Mann, Biology Department, Georgetown University, 406 Reiss Science, Washington, DC 20057, 15 December 2004.

Table 2. Summary of shark related events and subsequent dolphin reactions.

Time	Event	Dolphin reaction	Depth	Group composition
1144	2-m long hammerhead shark passed between focal mother (PEG) and calf (STA)	No reaction	6.1 m	PEG STA
1213	Small (~0.9 m) carcharhinid shark following STA	No reaction	6.4 m	STA
1215	Two small (~0.9 m) carcharhinid sharks near STA	No reaction	6.4 m	STA
1217	STA followed by several small (~0.9 m) carcharhinid sharks	STA leapt twice in the direction of his mother (PEG) and upon rejoining her immediately went into infant position	6.4 m	STA
1243	Small (~0.9 m) carcharhinid shark sighted 5–10 m from STA	No reaction	6.7 m	PEG STA JFR GRT MOU MIG BSS LAU RHO FAT
~1309	At least two small (~0.9 m) carcharhinid sharks following dolphin group; approximate time of shark attack on MIG	No reaction	6.7 m	PEG STA JFR GRT MOU MIG BSS LAU RHO FAT
1314	Lots of small (~0.9 m) carcharhinid sharks sighted near MIG	MIG leapt once	6.7 m	MIG GRT RHO
1322	2-m long hammerhead within 1-m of STA	No reaction	6.7 m	STA
1408	Two large splashes (presumably due to thrashing with tail flukes) were observed in the center of the resting dolphin group	Abrupt, large splashes	6.7 m	PEG STA JFR GRT MOU MIG BSS LAU RHO FAT
1415	Several small (~0.9 m) carcharhinid sharks still near dolphin group	No reaction	6.7 m	PEG STA JFR GRT MOU MIG BSS LAU RHO FAT

Figure 1. MIG's intact tail fluke prior to the attack. This [hotograph was taken with a Canon EOS-1D digital camera at 1304 on 29 February 2004.

response, STA later showed no reaction when a small (~0.9 m) carcharhinid shark passed within 5–10 m of him while he was in a group with his mother and eight other dolphins (see Table 2 for group composition).

The actual shark attack, which resulted in the left half of MIG's tail fluke being bitten off, occurred between 1304 and 1310. However, due to poor visibility and no obvious reaction by the dolphins in the group, I was unaware of the attack at the time. The time frame of the attack can be approximated using time-coded photographs of the group in which MIG is visible with tail flukes intact and then with half the tail fluke missing (Fig. 1, 2). I was within 15 m of the dolphins and observing their surface behaviors continuously throughout this period. Although I did not actually

Figure 2. MIG's wounded tail fluke. This photograph wastaken with a Canon EOS-1D digital camera at 1311 on 29 February 2004. The size and shape of this wound is consistent with a bite from a small carcharhinid shark (see text for source).

witness the shark bite MIG, it was noted that at least two small (~0.9 m) carcharhinid sharks were following the dolphin group at 1309. Between 1314 and 1315 at least six small (~0.9 m) carcharhinid sharks were sighted near MIG, who at the time was on a separation (approximately 20 m from MOU) and in association with a 6-yr-old female (RHO) and a 15-mo-old male calf (GRT). Figure 2 illustrates that MIG's wound is of size and shape to have been inflicted by a small carcharhinid shark and not another dolphin or a larger, unseen shark. The size and shape of shark and dolphin bite marks differ greatly. In particular, dolphin bites result in "superficial, thin parallel" rake marks (*Scott et al.* 2005, p. 7), rendering it unlikely that this wound was dolphin induced. It is equally unlikely that a larger shark could have caused this wound because the larger shark species found in Shark Bay (*e.g.*, tiger, *Galeocerdo cuvier* and white, *Carcharhodon carcharias*) typically leave ragged or coarsely serrated bite marks (Long and Jones 1996, Heithaus 2001*a*). Thus, the observed wound on MIG's tail fluke is most consistent with a bite from a small carcharhinid shark, which are known to leave small, clean-cut bite marks on cetaceans (Long and Jones 1996, Heithaus 2001*a*).

The next notable event involving this resting group of dolphins occurred when two distinct large splashes (presumably due to thrashing with the tail flukes) were observed in the center of the group at 1408. The two splashes occurred abruptly and the entire group returned to rest mode immediately following the disturbance. At 14:11 I noted that the left half of MIG's tail fluke was missing. Blood was still visible on the fluke, but not in the water. If the splashing event was in response to a shark threat (several small carcharhinid sharks were noted to still be near the dolphin group at 1415), no subsequent evasive response was observed. As mentioned above, the adults and juveniles in the group immediately returned to rest mode after the two splashes and remained in the same area. The three calves had varied reactions. STA, the focal calf, went into infant position. GRT, who already bears multiple shark bite scars, left the group and ventured off alone for a few minutes. MIG, the wounded 3.5-mo-old calf, did not show any obvious signs of distress and continued swimming with the group of dolphins a few meters from MOU. Several minutes after the shark sightings and splashing incident, MIG initiated play with a juvenile female in the group and then proceeded to socialize with the other two calves. MIG did not appear hindered by the absence of half of the tail fluke and appeared to be swimming and behaving normally.

Due to their small size and decreased defenses, dolphin calves should be at high risk of predation by sharks, especially while on separations from their mothers. Although none of the 22 sampled calves in Sarasota bore shark bite scars (Wells *et al.* 1987), the low incidence of scars on young dolphins at that site and elsewhere is purported to be due to a greater proportion of fatal attacks (Cockcroft *et al.* 1989). However, in Shark Bay, 34% of focal calves (Mann and Barnett 1999) and 74% of non-calves (Heithaus 2001*a*) have shark bite scars. Heithaus (2001*a*) reports that, based on scar frequencies and attack rates, dolphins in Shark Bay are at a greater risk of predation by sharks than bottlenose dolphins elsewhere. The presence of tiger sharks (*Galeocerdo cuvier*), a known predator of dolphins, has been found to increase significantly in Shark Bay during the warmer months (September–May) (Heithaus 2001*b*, Heithaus and Dill 2002). While tiger sharks are found in shallow water more often than expected (Heithaus and Dill 2002), smaller species (*e.g.*, *Carcharhinus* sp.) tend to be sighted more often in deeper water (Mann and Watson-Capps 2005). Studies show that dolphins in the bay tend to spend more time in deeper water (Heithaus 2001*a*, Mann and Watson-Capps 2005) and form larger resting groups (Heithaus and Dill 2002) during the warm months when predation risk is high. In addition, Mann & Watson-Capps (2005) suggest that maternal vigilance increases during the warmer months since mothers spend less time resting in deep water during this time. However, even with these precautions, calves are still highly vulnerable to attack. The shark attack on MIG occurred while the dolphin group was resting in deep water (6.7 m).

Sharks and dolphins are commonly observed in close proximity, but reactions vary depending on the species of shark and the context of the encounter. Simple avoidance is the most commonly reported response, although dolphins have been known to herd or even mob sharks (Wood *et al.* 1970, Mann and Watson-Capps 2005). While a captive Atlantic bottlenose dolphin (*Tursiops truncatus*) was successfully conditioned to attack sandbar (*Carcharhinus milberti*), lemon (*Negaprion brevirostris*), and nurse sharks (*Ginglymostoma cirratum*), the same dolphin refused to respond to commands when presented with a bull shark (*Carcharhinus leucas*; Irvine *et al.* 1973). Connor and Heithaus (1996) reported an extreme evasive response to a white shark (C*archarodon carcharias*) by a surprised group of resting females and calves in Shark Bay. Yet in other instances there seemed to be no reaction by either the dolphins or the shark (*e.g.*, Wood *et al.* 1970, Leatherwood 1977). The dolphin–shark encounters described herein illustrate several types of reactions, including avoidance and the apparent lack of a reaction if they are aware of the shark's presence. However, an extreme evasive response (as reported by Connor and Heithaus 1996) was not observed, despite a successful shark attack on one of the group's calves. STA, the focal calf, did not exhibit an avoidance response when in close proximity to a 2-m hammerhead, either when with his mother or alone. This lack of a reaction to the presence of a hammerhead shark is expected given that the location of its mouth would make it difficult to attack a dolphin (Heithaus 2001*c*). STA did, however, exhibit avoidance (by leaping towards his mother) when followed by a group of small (~0.9 m) carcharhinid sharks. Similarly, MIG, the attacked calf, responded to the presence of numerous carcharhinid sharks by leaping. Since MIG's fluke had already been bitten and was bleeding, blood may have attracted these small sharks. MIG's leap was most likely an attempt to evade the schooling sharks. While small carcharhinid sharks may pose little predation threat to bottlenose dolphins, Heithaus (2001*a*) reports that 6.2% of surveyed dolphins in Shark Bay bore crescent-shaped bite marks from small (<1.5 m) carcharhinid sharks and in several cases these bite marks were out of the pectoral fins. The ability of these carcharhinid sharks to inflict such wounds renders it likely that dolphins will perceive them as a threat despite their small size. Thus, the varied responses reported herein, as well as those described in the literature, suggest that the species and size of shark, as well as the context, determine the response elicited by the presence of a shark.

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LITERATURE CITED

ALTMANN, J. 1974. Observational study of behaviour: Sampling methods. Behaviour 49:227–267.

COCKCROFT, V. G., G. CLIFF AND G. J. B. ROSS. 1989. Shark predation on Indian Ocean bottlenose dolphins *Tursiops truncatus* off Natal, South Africa. South African Journal of Zoology 24:305–310.

CONNOR, R. C., AND M. R. HEITHAUS. 1996. Approach by Great White shark elicits flight response in bottlenose dolphins. Marine Mammal Science 12:602–606.

HEITHAUS, M. R. 2001*a*. Shark attacks on bottlenose dolphins (*Tursiops aduncus*) in Shark Bay, Western Australia: Attack rate, bite scar frequencies, and attack seasonality. Marine Mammal Science 17:526–539.

HEITHAUS, M. R. 2001*b*. The biology of tiger sharks (*Galeocerdo cuvier*) in Shark Bay, Western Australia: Sex ratio, size distribution, diet, and seasonal changes in catch rates. Environmental Biology of Fishes 61:25–36.

HEITHAUS, M. R. 2001*c*. Predator-prey and competitive interactions between sharks (order Selachii) and dolphins (suborder Ondontoceti): A review. Journal of Zoology (London) 253:53–68.

HEITHAUS, M. R., AND L. M. DILL. 2002. Food availability and tiger shark predation risk influence bottlenose dolphin habitat use. Ecology 83:480–491.

IRVINE, B., R. S. WELLS AND P. W. GILBERT. 1973. Conditioning an Atlantic bottlenose dolphin, *Tursiops truncatus*, to repel various species of sharks. Journal of Mammalogy 54:503–505.

LEATHERWOOD, S. 1977. Some preliminary impressions on the numbers and social behavior of free-swimming bottlenose dolphin calves (*Tursiops truncatus*) in the northern Gulf of Mexico. Pages 143–167 *in* S. H. Ridgway and K. Benirschke, eds. Breeding dolphins: Present status, suggestions for the future. Marine Mammal Commission Report #MMC-76/77 (unpublished). 308 pp. Available from MMC, 4340 East-West Hwy., Rm 905, Bethesda, MD 20814.

LONG, D. J., AND R. E. JONES. 1996. White shark predation and scavenging on cetaceans in the eastern north Pacific Ocean. Pages 293–307 *in* A. P. Klimley and D. G. Ainley, eds. Great white sharks: The biology of *Carcharodon carcharias*. Academic Press, New York, NY.

MANN, J., AND H. BARNETT. 1999. Lethal tiger shark (*Galeocerdo cuvier*) attack on bottlenose dolphin (*Tursiops* sp.) calf: Defense and reactions by the mother. Marine Mammal Science 15:568–575.

MANN, J., AND B. B. SMUTS. 1998. Natal attraction: Allomaternal care and mother-infant separations in wild bottlenose dolphins. Animal Behaviour 55:1097–1113.

MANN, J., AND J. WATSON-CAPPS. 2005. Surviving at sea: Ecological and behavioral predictors of calf mortality in Indian Ocean bottlenose dolphins (*Tursiops* sp.). Animal Behaviour 69:899–909.

MANN, J., R. C. CONNOR, L. M. BARRE AND M. R. HEITHUS. 2000. Female reproductive success in bottlenose dolphins (*Tursiops* sp.): Life history, habitat, provisioning, and group-size effects. Behavioral Ecology 11:210–219.

SCOTT, E., J. MANN, J. J. WATSON-CAPPS, B. L. SARGEANT AND R. C. CONNOR. 2005. Aggression in bottlenose dolphins: Evidence for sexual coercion, male-male competition, and female tolerance through analysis of tooth-rake marks and behaviour. Behaviour 142:21–44.

SMOLKER, R. A., A. F. RICHARDS, R. C. CONNOR AND J. W. PEPPER. 1992. Sex differences in patterns of association among Indian Ocean bottlenose dolphins. Behaviour 123:38–69.

WELLS, R. S., M. D. SCOTT AND A. B. IRVINE. 1987. The social structure of free-ranging bottlenose dolphins. Pages 247–305 *in* H. H. Genoways, ed. Current mammalogy. Volume 1. Plenum Press, New York, NY.

WOOD, F. G. JR., D. K. CALDWELL AND M. C. CALDWELL. 1970. Behavioral interactions between porpoises and sharks. Investigations on Cetacea 2:264–277.

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