

RAY ENCOUNTERS AS A MORTALITY FACTOR
IN ATLANTIC BOTTLENOSE DOLPHINS
(*TURSIOPS TRUNCATUS*)

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ABSTRACT

Ray spines were found associated with various tissues on necropsy of seven Atlantic bottlenose dolphins (*Tursiops truncatus*). In at least six cases they were considered a major factor in the death of the animal. Three mature *Tursiops* had ray spines located in the lung parenchyma. In two other dolphins the ray spine punctured the lateral chest wall without entering the lung tissue. A sixth *Tursiops* contained a ray spine located in the liver tissue, while a seventh animal had a ray spine lodged in the pancreas. Five of the dolphins were wild individuals and two had been in captivity for more than one year. These findings indicate that beached dolphins and dolphins in captivity with a chronic history of illness should be examined for the presence of ray spines. Caution should be used in maintaining mixed exhibits of dolphins with stingray species.

Key words: *Tursiops truncatus*, dolphin, ray spine, stingray.

The causes of cetacean strandings have long been a source of interest by scientists and the general public. A great deal of effort is expended by state and

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federal agencies, as well as by marine zoological parks, and other private institutions in assisting those animals found alive (stranded) and to gain information from those animals which are found dead (beached).

Cetaceans such as the bottlenose dolphin (*Tursiops truncatus*) are faced with many potential disease problems including interspecific interactions that may result in injury or death of the individuals involved. It is apparent from observations of dolphins in the field that they interact with members of the ray family which can inflict serious injury to the dolphins (Jones 1985). Jenkins and Cardeilhac (1982) gave a preliminary report on the death of a beached bottlenose dolphin which apparently died from the perforation of the small intestine by a 11.5-cm sting ray spine. The following is a review of additional cases where spines from stingrays were found associated with pathology in the Atlantic bottlenose dolphin.

MATERIALS AND METHODS

Dolphin necropsies were performed by members of the Southeastern United States Marine Mammal Stranding Network. The condition of the animals varied greatly from case to case. Full necropsy examinations were performed on those animals which had not undergone extensive decomposition. The freshness of the tissues was limited by environmental conditions such as high ambient temperatures and sun exposure. Animals which were considered to be in fresh condition were examined grossly with representative histologic sections taken from each major organ for routine histopathology. Aerobic and anaerobic bacteria cultures were taken at the discretion of the individual performing the examination.

Ray spines were identified based on species-specific anatomic variations which have been partially cataloged by Halstead (1970), and by researchers at the University of Central Florida (T. Schmid).

RESULTS

Case 1—A mature female *T. truncatus* which had beached on Florida's east coast in December of 1978 was recovered and taken to Sea World of Florida for necropsy. Examination of the exterior of the animal revealed a small puncture wound, 0.25 cm in diameter, on the right thorax between ribs 6 and 7. Dissection along the wound tract revealed a 7-cm ray spine extending from the dermis through the intercostal musculature and protruding into the thorax. The right hemithorax was filled with an exudate and the pleura was covered with fibrin tags. Although the ray spine tip had penetrated the costal pleura there was no evidence of damage to the lung parenchyma. No gross abnormalities were present in the other organs and histology was not available for review. The ray spine was not available for identification.

Case 2—An adult female *T. truncatus* was found stranded near Fort Lauderdale, Broward County, Florida and transported to Ocean World for treatment. The animal died approximately 3 h later and a necropsy was performed.

The dolphin was thin with ribs and peduncular vertebrae apparent through

the skin. Numerous superficial lacerations were present over the dorsolateral skin surfaces. The abdominal cavity contained approximately 1.5 liters of a yellow-brown viscous, non-aromatic fluid with numerous associated fibrin-like tags. The pancreas was edematous, hemorrhagic, and irregularly fibrotic on cut surface. Serial sectioning of the pancreas revealed an embedded ray spine approximately 6.0 cm in length and 0.5 cm in diameter at the widest point. The ray spine was not available for identification. There were large, irregular, firm, white to tan adhesions associated with the pancreas, the small intestine and the serosa of the first and second stomach compartments. The lungs were heavy and wet with multiple, soft to moderately firm, light brown to yellow, 0.3- to 4.0-cm foci scattered throughout on cut section. The first and second stomach compartments had multifocal mucosal ulcerations. Some of these ulcers were characterized by fibrotic borders with small central craters. The remaining organs examined appeared grossly normal. Representative tissues were fixed in neutral 10% buffered formalin, processed routinely and examined microscopically.

Histological evaluation of the pancreas revealed extensive multifocal necrosis involving both exocrine and endocrine cells. In addition there was associated multifocal hemorrhage, edema, and mild to moderate infiltrates of neutrophils, plasma cells and macrophages. There was also moderate, multifocal, pancreatic fibrosis and mild focal hemosiderosis. In multiple foci, peripancreatic mesenteric fat was necrotic. There was an associated focally extensive acute necrotizing fibrinous peritonitis.

The first and second stomach compartments were characterized by multifocal chronic-active fibrosing ulcerative inflammation with extensive inflammatory cell infiltration. The lungs were characterized by extensive multifocal broncho-alveolar suppuration with an admixture of inflammatory cell infiltrates including neutrophils, eosinophils, plasma cells, and macrophages. There were also moderate multifocal alveolar edema and hemorrhage. Other histologic changes included moderate to extensive lymphoid depletion of the spleen and mesenteric lymph nodes as well as adrenocortical lipid depletion.

Case 3—An adult female *T. truncatus* maintained on exhibit in Tampa, Florida had a chronic history of appetite fluctuation mixed with periods of depression. Physical examination and clinical pathology evaluations involving complete blood counts and clinical chemistries were not diagnostic. In August 1984 the animal expired.

Gross pathological findings revealed a 7.5-cm ray spine embedded in the posterior portion of the left liver lobe. The tip of the spine protruded posteriorly through the serosa of the liver and extended into the wall of the 1st stomach compartment. Examination of the stomach suggested that the spine tip did not enter the stomach lumen. The ray spine could not be located for identification. No other gross abnormalities were noted. Tissues were not available for histologic review.

Case 4—A 241-cm male *T. tursiops* which had originally been seen floundering at the surface of the Indian River lagoon in Brevard County on the east coast of Florida in January of 1986, was found dead and taken to Sea World of Florida for postmortem examination. Externally the animal was in good flesh

and there were four parallel lacerations (5 cm in length and 1 cm deep) resembling tooth rake marks located caudal to the right eye. No other superficial abnormalities were found. The lungs appeared congested and remained distended upon opening the thorax. Small 1–4-mm yellow areas of discoloration were visible through the lung pleura and resembled abscesses on cut section. The left lateral lung pleura was adhered to the costal pleura at three locations by organized scar tissue. The hilar lymph nodes of the chest appeared enlarged. Bacterial samples taken from the lung parenchyma yielded a pure growth of *Edwardsiella tarda* upon aerobic culture. Serial sectioning of the lung tissue revealed a 7.25-cm ray spine 0.4 cm in width lying longitudinally in the anterior portion of the left lung. The barbs of the spine were directed cranially. The spine was identified as originating from *Dasyatis sabina* (Fig. 1), a species found in the western North Atlantic and reaching a maximum width of 20 cm (Halstead 1970). The abdomen of the dolphin contained approximately 1.0 liter of a clear transudate. The intestinal tract was partially distended with gas and the mediastinal lymph nodes were grossly enlarged. There were no gross lesions noted in the remaining tissues. Representative tissue samples were fixed in 10% neutral buffered formalin and processed routinely.

On histologic examination the lungs showed multiple bronchial and alveolar lumens containing inflammatory cell infiltrates. The pulmonary interstitium was characterized by fibrosis with infiltrates consisting primarily of chronic inflammatory cells. Coccoid bacterial colonies were present in the involved areas. Similar chronic inflammation was also present in multiple foci in the pleura. The lesion in the lung parenchyma which surrounded the embedded spine was composed of fibrous connective tissue with a large focus of necrosis containing neutrophils, plasma cells and macrophages.

The hilar lymph nodes had severe often necrotizing chronic active inflammation as well as lymphoid depletion. A section of large intestine had lymphoid necrosis associated with infiltrates of acute and chronic inflammatory cells in the submucosa and lamina propria. There was a mild to moderate chronic active meningitis and mild focal gliosis in the brain. The tissue of the liver was characterized by a mild chronic cholangitis and moderate biliary fibrosis.

Case 5—During an aerial survey of the lower Caloosahatchee River in Lee County in 1981, a beached 236-cm male *T. truncatus* was spotted near Fort Myers, Florida. Though mildly decomposed a necropsy examination was performed on site. The right hemithorax contained approximately 10 liters of a yellowish exudate and an incomplete 10 × 0.8 cm anterior section of a ray spine from *Dasyatis americana*. There were numerous fibrin tags present on the pleural surface and multiple adhesions between the lung and the costal pleura. The caudal portion of the spine could not be located. The parenchyma of the right lung did not appear to be involved. No other gross lesions were noted in the other organs.

Case 6—A 215-cm female *T. truncatus* was found beached on Anna Maria Island in Manatee County on the west coast of Florida. There was some early decomposition of the epidermis externally and bruising on both the right side of the melon area and right axilla. Gross examination of the right pleural cavity

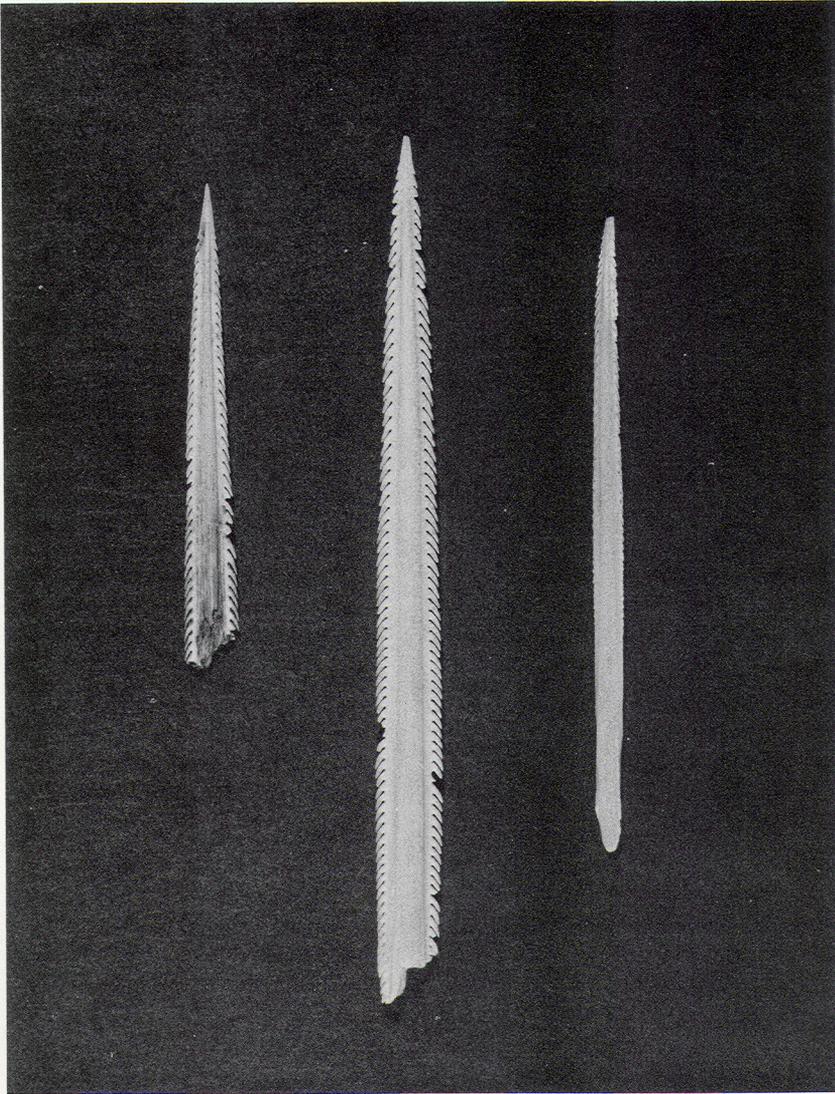


Figure 1. Remnants of three ray spines involved in Cases 4 (*Dasyatis sabina*, right), 5 (*Dasyatis americana*, middle), and 6 (*Dasyatis americana*, left).

revealed a raised 14-cm circular hematoma on the lateral surface of the right lung beneath the visceral pleura. A smaller lesion was present on the opposite parietal pleura between the fifth and sixth ribs. This corresponded to a small external scar in the epidermis externally. Dissection of the lung lesion revealed a 4.5-cm long section of a stingray spine oriented ventromedially. The caudal edge of the barb indicated that a portion of the spine was absent. The spine fragment recovered grossly resembles the spine from Case 5 and is probably from *Dasyatis americana*.

Examination of the abdominal contents revealed two cestode parasites in the intestinal tract and hemorrhage in the caudal portion of the ileum. Histopathologic examination of the lungs showed severe diffuse bronchoalveolar suppuration with infiltrates of neutrophils, plasma cells, alveolar macrophages, and occasional lymphocytes. The pleura had moderate to heavy infiltration with chronic inflammatory cells admixed with occasional neutrophils. Other tissues were within normal limits. Aerobic cultures of the lung tissue yielded *Vibrio damsela* and *Pseudomonas putrefaciens*.

Case 7—An adult female *T. truncatus* with a history of chronic regurgitation was maintained in an aquarium in New York. In 1987 the animal expired. Upon external examination the animal appeared thin. Skeletal landmarks such as the peduncular vertebrae and scapulae were visually prominent.

Gross examination of the pleural cavity revealed multiple white, firm, pleural adhesions. The pericardium also contained multiple firm white adhesions. On sectioning, the cranial lung tissue exuded a frothy serous liquid, while the caudal portions were more consolidated and soft in nature. In the middle portion of the right lung there was a stingray spine measuring $8.5 \times 0.5 \times 0.2$ cm. The spine was identified as originating from *Dasyatis americana*. There was no local gross pathology surrounding the barb.

The serosa of the abdominal cavity had multiple green to brown foci 1–2 mm in diameter. Associated with a section of omental discoloration in the area of the pancreas was a large tan to white irregular fibrous mass approximately $15 \times 10 \times 7$ cm. This mass appeared to involve the pancreas, duodenal ampulla, and third stomach compartment. Sectioning of the mass revealed an irregular lobular pattern of dense tan tissue resulting in a partial stricture of the duodenum spanning 14 cm of its length. The mucosa of the third stomach compartment was friable and brown to black in color.

Microscopic examination showed numerous inflammatory changes. The caudoventral lung fields were characterized by bronchoalveolar suppuration with associated infiltrates of neutrophils, eosinophils, plasma cells and alveolar macrophages. There was also edema and hemorrhage. The pericardium had multifocal infiltrates of lymphocytes, plasma cells, and histocytes also associated with fibrosis. Similar changes were present in the myocardium along with occasional myocardial antischow cells.

The gastrointestinal mass was made up of multiple histologic components which included the pancreas. Normal pancreatic tissue was largely replaced by fibrous connective tissue associated with multifocal infiltrates of lymphocytes and macrophages and areas of mineralization. In one focus there were three football shaped, golden brown shelled trematode eggs characteristic of *Braunina* spp.

The omental tissue associated with the mass was characterized by deposition of fibrinoid-like material containing infiltrates of plasma cells and neutrophils. Colonies of coccoid bacteria were present in this material.

There was mucosal necrosis associated with the third stomach compartment together with submucosal infiltrates of chronic inflammatory cells. Similar inflammatory infiltrates were present in the esophagus and intestinal tract.

The meninges of this dolphin had moderate diffuse infiltrates of lymphocytes without suppuration. The brain had mild multifocal congestion and gliosis.

DISCUSSION

There are seven families of so called "stingrays" in the Suborder Myliobatoidea. The damage from these rays may result from: (1) direct physical trauma from the barb (sting/spine), (2) injection of bacteria into the wound resulting in infection, and (3) toxicosis from venom released into the wound site. The sting apparatus of rays consists of a bilaterally retroserrated spine and its sheath. The spine is composed of a thin outer layer of enamel and an inner core of vasodentine. The dorsal surface of the spine may have one or more longitudinal grooves while ventrolaterally there are grooves which contain the toxic glandular tissue (Halstead 1970). When the spine penetrates, the outer tissue sheath is torn as the edges of the apparatus are exposed and the venom is released.

The bottlenose dolphin is well known as an accomplished swimmer with a strong sense of curiosity. Dolphins have in fact been observed chasing and apparently "teasing" rays (Jones 1985). Jones' crew filmed a group of 4-6 dolphins pursuing small stingrays along the ocean floor in the Bahamas. Individuals involved appeared to take turns diving at fleeing rays, often turning on their sides when closing on the animal being chased. This behavior would explain the location of lateral chest wounds involved in Cases 1, 5, and 6. A spine embedded in the chest wall could eventually migrate forward into the chest cavity or proceed into or through the lung tissue as in Cases 4, 5, 6, and 7. The injection of the spine more caudally could result in contact with the liver and eventual migration through the liver tissue as in Cases 2 and 3. Similar ray spine puncture wounds of the chest and abdomen have been seen in humans (Ronka and Roe 1945, Russell *et al.* 1958, Cadzow 1960, Barss 1984).

A major complication of any wound, especially the puncture type, is the possibility of bacterial contamination and subsequent sepsis. The time to examination of many beached animals is uncontrollable so that they present in all stages of decomposition. As a result, bacterial cultures of tissue specimens examined are often not attempted. Case 4, visually a very fresh specimen, yielded a pure culture of *Edwardsiella tarda* from the lung aerobically. Found associated with visible abscessation, it should be considered a primary pathogen. Bacteria cultured from Case 6 yielded *Vibrio* and *Pseudomonas* which may both be primary pathogens though the state of decomposition makes their origins questionable.

The effects of the toxin injected with the spine are not well understood. In man, it appears that there are some systemic effects on the cardiovascular and nervous systems (Russell and Lewis 1956, Russell *et al.* 1958, Russell 1965). There may also be local damage from the toxins resulting in tissue compromise. This may allow a bacterial contaminant to set up a nidus of infection eventually resulting in sepsis (Russell 1953, Barss 1984).

Ingestion should be considered as a possible origin of ray spines in some instances where the spine is found in the liver and pancreas or when deep abdominal lesions such as the large mass surrounding the duodenum of the

animal in Case 7 are present. It is possible that dolphins could ingest members of the smaller ray species or swallow a spine they have found. Reynosa and Hugentobler (1986) reported a case of a dolphin which died with a dorsal spine of a catfish perforating the cardiac stomach and diaphragm.

The morbidity and mortality resulting from ray spine injury in wild dolphin populations is unknown since the exact numbers of dolphins which are injured or die can not be accurately determined. It is apparent that it is a factor which should be considered when examining beached animals and when dealing with animals originally obtained from the wild which show signs of chronic disease. Care should be taken when exhibiting both dolphins and rays together in community tanks. Removal of the barb from rays in communal tanks is recommended.

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