Ingestion of stingrays (*Dasyatis spp.*) by a common bottlenose dolphin (*Tursiops truncatus*)

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Common bottlenose dolphins (*Tursiops truncatus*) and sting rays (*Dasyatis spp.)* both inhabit shallow, coastal waters of the southeastern United States and interactions between the two species are common (Walsh *et al*. 1988; McFee *et al*. 1997). Dolphins have been observed chasing and teasing stingrays (Jones 1985); however, interactions can result in injury or even mortality from penetration of the stingray spine into soft tissue (McClellan *et al.* 1996). Walsh *et al*. (1988) describes seven cases where ray spines found during necropsy of bottlenose dolphins were a contributing factor for mortality. In one case, a stingray spine was observed in the middle portion of the right lung. In addition, there was a large, irregular fibrous mass found in the abdominal cavity involving the pancreas, duodenal ampulla and pyloric chamber of the stomach. The author suggested that in those cases where stingray spines were present in conjunction with abdominal lesions, ingestion should be considered as a possible origin. We report the first documented case of ingestion of stingrays by a common bottlenose dolphin from the Atlantic Ocean.

On June 8, 2015, a 257 cm male bottlenose dolphin was reported dead, floating in the Cooper River in Charleston County, South Carolina (32° 47' 27.75"N, -79° 55' 29.19"W). The dolphin was transported to the marine mammal necropsy laboratory at the National Centers for Coastal Ocean Science, Center for Coastal Environmental Health and Biomolecular Research facility at Fort Johnson (James Island, South Carolina) for necropsy. At the time of examination, the dolphin was moderately decomposed. The trailing edge of the dorsal fin had unique notches but when searched against the Charleston bottlenose dolphin dorsal fin catalogue using *Finbase* software (Adams *et al.,* 2006), it did not result in a match. A standard necropsy was performed on June 9, 2015 resulting in an inconclusive cause of death. Externally, there were several raised, partially healed lacerations to the left lateral body, suggestive of shark bites. All organs were examined both externally and internally for lesions, color and texture. Upon examining the abdominal viscera, the fore chamber of the stomach appeared fully expanded. A small incision was made to open the stomach. Two stingrays were first pulled from the fore chamber. Species were identified as a Southern stingray (*Dasyatis americana*) and an Atlantic stingray (*Dasyatis sabina*) using field guide measurements and observations from the Florida Museum of Natural History stingray I.D. guide (https://www.flmnh.ufl.edu/fish/discover/rays-skates/stingray-id-guide/). The Southern stingray had a wingspan of 20.6 cm and the Atlantic stingray had a wingspan of 16.6 cm (Figure 1). Both rays were partially digested with the tail spines still attached, but lacking tissue on the spines. Upon further investigation, it was concluded that no puncture wounds had been made to either the esophagus or stomach lining, evidence that the stingrays may have been dead when ingested. Other fore-chamber contents included: 12 shrimp, two crawfish, two squid, two fish, five cephalopod beaks and 1,435 fish otoliths. Seventy-two otoliths were also found in the fundic and pyloric chambers, collectively. The total number of otoliths represented 471 individual fish from 10 different species, predominately star drum (*S. lanceolatus*) and croaker (*M. undulates*). Several parasitic cysts ranging from 0.3 cm to 0.6 cm in diameter were present along the interior lining of the pyloric chamber.

Given the abundance and diversity of prey items in the stomach in addition to the shark bite wounds, it is suggested that the dolphin may have been foraging near or in association with a shrimp trawler. Dolphins have been known to forage in association with trawlers by feeding on caught fish or discarded bycatch (Greenman and McFee 2014). In a study by Kovacs and Cox (2014), it was determined that dolphins near Savannah, Georgia approached commercial fishing vessels or actively begged more frequently when fisherman were cleaning or manipulating the nets. During this process, fishermen often discard their bycatch over the side of the boat. The dolphin presented in this case might have been feeding during this time and could have encountered the stingrays and other prey items after they had been caught and released. The dolphin may also have encountered the rays while foraging behind an active trawl, when benthic species become stirred up as the net passes along the seafloor. During predation, sting rays are likely to display self-defense measures against animals trying to feed upon them by thrusting their tail and stinging upward (Findlay 1953). The lack of thoracic wounds, multiple species of stingray and diversity of prey items found in the stomach provide evidence that the stingrays may have been ingested dead or injured as part of a commercial bycatch foraging event.

It is unclear as to what extent venom from the soft tissues surrounding the spines may have contributed to the demise of the dolphin. Stingray venom in marine species is located in protein secretory cells located in the ventrolateral grooves of the spine (Pedroso *et al.* 2007). Since in this case the epidermis of the spines was gone, either the skin was gone prior to ingestion or removed through mechanical digestion in the fore chamber of the stomach where they were observed. If the latter, then venom could have been released into the stomach but likely wasn't absorbed since the fore chamber in dolphins is only used for breaking down food remains and is devoid of glands (Berta *et al*. 2015; Cozzi *et al*. 2016;). Venom proteins can be denatured in an environment with a pH < 3 (Sweeney and Reddy 2001), therefore it is likely they would have been denatured as the result of the acidic environment of the dolphin stomach in which pH has been reported to be between 1.5 and 3 (Sweeney and Reddy 2001; Mitchell *et al.* 2008), and would not have caused ill-effects to the dolphin.

The presented findings are unusual given that stingray associations with bottlenose dolphins are more frequently related to mortality than a source of prey. It is unclear whether this dolphin ingested the stingrays intentionally or if it occurred inadvertently through opportunistic feeding of bycatch; nevertheless it highlights the importance of analyzing stomach contents and changes in diet. Long-term studies of the bottlenose dolphin diet in the southeastern United States have found a variety of fish and other species as prey items (Barros and Odell 1990; Gannon and Waples 2004; Pate and McFee 2012); however, this is the first documented case of stingrays being ingested by a common bottlenose dolphin. Documenting unusual prey items and changes in a dolphin's diet can increase knowledge of feeding strategies and may be helpful in elucidating changes due to environmental factors and stressors. Resident dolphin populations along the southeast United States coast tend to display strong site fidelity, making them particularly vulnerable to the consequences of environmental stressors such as climate change (Gubbins 2002; Simmonds and Eliott 2009). Temperature shifts associated with climate change may indirectly affect bottlenose dolphins by limiting prey availability (Simmonds and Eliott 2009). The response to these shifts in prey could be reflected in the changes of dolphin's diets. Monitoring changes in dolphin stomach contents could also provide insight into changes in fish distribution, abundance and top-down cascading effects. For example, if apex predators such as sharks become overfished, mesopredators like stingrays will become more abundant (Baum and Worm 2009). This may result in dolphins interacting with or ingesting stingrays more frequently, increasing the likelihood of fatality due to stingray spine perforation.

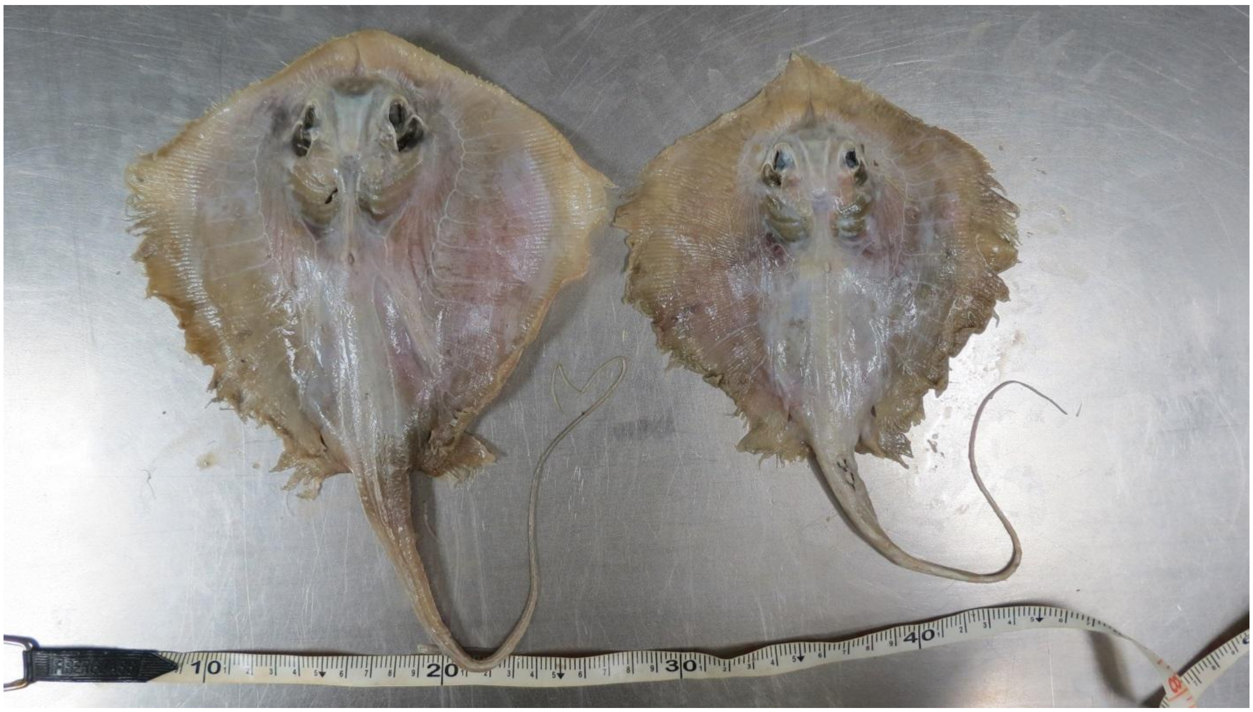

Figure 1. Southern stingray (left) and Atlantic stingray (right) found inside the fore chamber of a bottlenose dolphin stomach.

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Literature Cited

Adams, J., Speakman, T., Zolman, E. and Schwacke, L.H. 2006. Automating image matching, cataloguing and analysis for photo-identification research. Aquatic Mammals 32(2): 374–84.

Barros, N. and Odell, D. 1990. Food habits of bottlenose dolphins in the southeastern United States. Pages 309-328 in S. Leatherwood and R. R. Reeves, eds. The bottlenose dolphin. Academic Press, San Diego, CA.

Baum, Julia K., and Boris Worm. 2009. Cascading top-down effects of changing oceanic predator abundances. Journal of Animal Ecology, 78(4): 699-714.

Berta, A., Sumich, J.L. and Kovacs, K.M. 2015. Marine Mammals: Evolutionary biology, Third edition. Academic Press, London 725 pp.

Cozzi, B., Huggenberger, S. and H. Oelschalger. 2016. Anatomy of Dolphins: Insights into body structure and function, First edition. Academic Press, London 438 pp.

Gannon, D. and Waples, D. 2004. Diets of coastal bottlenose dolphins from the U.S. mid-Atlantic coast differ by habitat. Marine Mammal Science, 20(3): 527-545.

Greenman, J., & McFee, W. (2014) A characterization of common bottlenose dolphins (Tursiops truncatus) interactions with the commercial shrimp trawl fishery of South Carolina, USA. Journal of Cetacean Research and Managemetn, 14(1), 69-79

Gubbins, C. 2002. Use of home ranges by resident bottlenose dolphins (Tursiops truncatus) in a South Carolina estuary. Journal of Mammalogy, 83(1): 178-187.

Findlay, R. 1953. Stingray injuries: A review and discussion of their treatment. American Journal of the Medical Sciences, 226(6): 611-622.

Jones, H. 1985. Kingom of the dolphin. KQED Television Productions, San Francisco, California.

Kovacs, C. and Cox, T. 2014. Quantification of interactions between common bottlenose dolphins (Tursiops truncatus) and a commercial shrimp trawler near Savannah, Georgia. Aquatic Mammals, 40(1): 81-94.

McClellan, W.A., Thayer, V.G.. Pabst, A.D. 1996. Stingray spine mortality in a bottlenose dolphin, Tursiops truncatus, from North Carolina waters. The Journal of the Elisha Mitchell Scientific Society, 112(2): 98-101.

McFee, W., Root, H., Friedman, R., Zolman, E. 1997. A stingray spine in the scapula of a bottlenose dolphin. Journal of Wildlife Diseases, 33(4): 921-924.

Mitchell, M. A., Solangi, M. A., Clemons-Chevis, C. L., Vanderpool, D., Romagnoli, M., Huffland, T. and P. Juwett. 2008. Relationship between plasma iron concentration and gastric pH in captive adult bottlenose dolphins (Tursiops truncatus). American Journal of Veterinary Research, 69(7): 900-903.

Pate, M. and McFee, W. 2012. Prey species of bottlenose dolphins (Tursiops truncatus) from South Carolina waters. Southeastern Naturalist, 11(1): 1-22.

Pedroso, C. M., Jared, C., Charvet-Almeida, P., Almeida, M. P., Neto, D. G., Lira, M.S., Haddad Jr., V., Barbaro, K. C. and M. M. Antoniazzi. 2007. Morphological characterization of the venom secretory cells in the stinger of marine and freshwater stingrays. Toxicon, 50(5): 688-697.

Simmonds, M.P. and Eliott, W.J. 2009. Climate change and cetaceans: concerns and recent developments. Journal of the Marine Biological Association of the United Kingdom, 89(1): 203-210.

Slaughter, R. J., Beasley, D. M., Lambie, B. S. and Schep L. J. 2009. New Zealand's venomous creatures. New Zealand Medical Journal, 122: 83-97.

Sweeney, J. C. and M. L. Reddy. 2001. Cetacean cytology. In CRC Handbook of Marine Mammal Medicine, Second edition (L. A. Dierauf and M. D. Gulland, eds.). CRC Press, New York. 444 pp.

Walsh, M. T., Beusse, D., Bossart, G. D., Young, G. W., Odell, D. K., and Patton, G. W. 1988. Ray encounters as a mortality factor in Atlantic bottlenose dolphins (Tursiops truncatus). Marine Mammal Science, 4(2): 154-162.

Wells, R. S., McHugh, K. A., Douglas, D. C., Shippee, S., McCabe, E. B., Barros, N. B. and G. T. Phillips. 2013. Evaluation and potential protective factors against metabolic syndrome in bottlenose dolphins: feeding and activity patterns of dolphins in Sarasota Bay, Florida. Frontiers in Endocrinology, 4(139): 1-16.