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Asphyxiation in a Bottlenose Dolphin (*Tursiops truncatus*) from Puerto Rico Due to Choking on a Black Margate (*Anisotremus surinamensis*)

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Abstract

Bottlenose dolphins (*Tursiops truncatus*) are found in the coastal and offshore waters of Puerto Rico. However, little is known about causes of their mortality in the Caribbean. On 18 February 2002, a female bottlenose dolphin was found dead in Bahía de San Juan, Puerto Rico. Remarkably, a black margate (*Anisotremus surinamensis*) was firmly lodged in the dolphin's oral cavity and the pharynx. The throat of the dolphin was markedly swollen; the larynx was dislocated; and signs of agonal death were evident. Grossly, the cause of death was determined to be asphyxiation due to choking. Fifty strandings of bottlenose dolphins have been reported between 1937 and 2006 in Puerto Rico and the Virgin Islands. In those for which a cause of death was determined, four were human related and 11 died of natural causes (including this case). The present case study fits the definitions of "choking" and "asphyxiation." The evolved respiratory anatomy of cetaceans in which the larynx is inserted into the nasal passages leading to the blowhole makes asphyxiation due to choking unlikely in odontocetes. However, if the larynx is irreversibly dislodged from its normal position during swallowing, this may cause the dolphin to stop breathing or even drown. Thus, respiratory blockage from a natural prey item represents an uncommon mortality factor associated with piscivorous cetaceans and is the first record of such marine mammal mortality in the Caribbean.

Key Words: asphyxia, choking, mortality, Caribbean, bottlenose dolphin, *Tursiops truncatus*, black margate, *Anisotremus surinamensis*

Introduction

Bottlenose dolphins (*Tursiops truncatus*) are commonly found in the coastal and offshore waters of Puerto Rico (Mignucci-Giannoni, 1998; Roden & Mullin, 2000; Rodríguez-Ferrer, 2001; Swartz et al., 2001). Most of our knowledge about this species comes from surveys, sightings at sea, and strandings. Bottlenose dolphins are the second most commonly stranded marine mammal species in Puerto Rico (Mignucci-Giannoni et al., 1999). However, little is known about their mortality factors in the Caribbean. Therefore, we describe a previously unreported non-anthropogenic mortality factor for this species in the Caribbean.

Materials and Methods

As part of a study by the Caribbean Stranding Network to document and analyze marine mammal strandings and mortality in Puerto Rico and the Virgin Islands (Mignucci-Giannoni, 1996; Mignucci-Giannoni et al., 1999), carcasses and alpha-level information (Geraci & Lounsbury, 2005) were collected for bottlenose dolphins reported stranded or dead on shore. More detailed data were gathered opportunistically. Necropsies following the protocol of Geraci & Lounsbury were conducted on fresh and moderately decomposed carcasses (codes 2 and 3) in an attempt to determine the cause of death and obtain life history data in terms of morphometrics, sex, age, diet, disease signs, and parasitic fauna associated with each event. Tissue sections from the lung, heart, liver, spleen, multiple lymph nodes, thymus

(if present), gastrointestinal tract, pancreas, kidney, adrenal gland, skeletal muscle, and skin were collected and fixed in 10% neutral buffered formalin for histologic examination. The tissue samples were sectioned at 4 to 5 μm and stained with hematoxylin and eosin prior to microscopic examination.

Results

On 18 February 2002, a dead bottlenose dolphin was found floating off La Puntilla in Bahía de San Juan, on the north-central coast of Puerto Rico (18° 27' 30" N, 66° 06' 59" W). The carcass was recovered for examination and a full necropsy.

The animal was in an early stage of decomposition (code 2) as described by Geraci & Lounsbury (2005). The dolphin was a lactating female in good body condition with no evidence of significant external injuries, measuring 259 cm in total length and weighing 188 kg. A large fish, a black margate (*Anisotremus surinamensis*), measuring 49.2 cm in length, was observed occupying the mouth and pharyngeal cavity of the dolphin, extending from the tip of the dolphin's rostrum into its throat (Figure 1). Only the tail and posterior portion of the body of the fish were clearly visible through the open gape of the dolphin's mouth. The fish was firmly lodged into the oral and pharyngeal mucosa by its opposing dorsal and anal fin spines. The fish's dorsal spines were lodged in the ventral aspect of the oral cavity, and the anal fin spine was lodged in the dorsal aspect of the oral cavity as the fish was swallowed head first but dorsal-side down. The throat of the dolphin was swollen; the larynx was dislodged ventrolaterally into the surface of the pharyngeal wall; and signs of agonal death (blood and froth) were evident in the larynx and nasal passages. No other significant lesions were observed in any organs after thorough internal examination. Stomach contents included additional black margates of smaller size, striped mojarra (*Eugerres plumieri*), yellow fin mojarra (*Gerres cinereus*), and squid (*Loligo* sp.). Histopathologic analysis of organ tissues revealed that the dolphin had underlying chronic and active disease processes involving the lungs, liver, and possibly the pancreas, which may have been parasitic in origin, an incidental finding in a wild dolphin unrelated to its fatal choking event. Both lungs floated in water, and this taken together with histopathology of the lung tissues submitted, excluded drowning as part of the cause of death. No other significant lesions were noted. Grossly, the cause of death was determined to be asphyxiation due to choking.

Discussion

The present case report agrees with the definition of "choking" ("partial or complete obstruction that interferes with swallowing and/or respiration"; Shiel & Conrad-Stöppler, 2008, p. 81). Furthermore, the result of choking as it relates to interfering with respiration is "asphyxiation" (extreme decrease in the concentration of oxygen

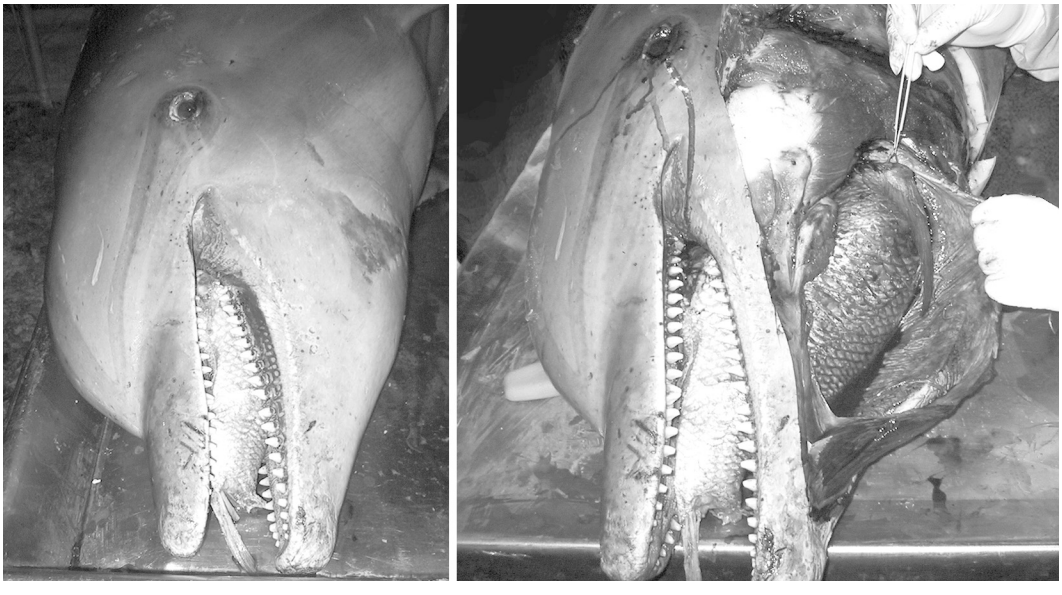

Figure 1. Black margate (*Anisotremus surinamensis*) visibly lodged in the throat of a bottlenose dolphin (*Tursiops truncatus*) from Puerto Rico

in the body or hypoxia) and ultimately "apnea" (no breathing). Cetaceans have evolved a unique respiratory anatomy in which the larynx (epiglottis and the paired corniculate cartilages) is normally interlocked by an encircling palatopharyngeal sphincter into the nasal passages leading to the blowhole (nares) (Reidenberg & Laitman, 1987). This intranarial laryngeal position completely separates the respiratory and digestive pathways, and makes asphyxiation due to choking very unlikely in odontocetes.

The dolphin in this case attempted to swallow a very large prey item. The prey was apparently larger than the maximum height of the piriform sinus (lateral food channel) and thus became lodged in this location. Dolphins have asymmetrical piriform sinuses (MacLeod et al., 2007), This fish was swallowed along the smaller left side, which may have contributed to it becoming entrapped. The dolphin's likely response to this blockage was to try to either force the obstructive fish out or struggle to swallow it. An attempt to enlarge the height of the piriform sinus to accommodate the girth of the fish may have caused the larynx to become uncoupled from the palatopharyngeal sphincter. Attempting to expel the fish may have further dislodged the larynx from a midline position under the palatopharyngeal sphincter, pushing it laterally against the pharyngeal wall. Displacing the larynx away from the nasal passageway exposes it to the digestive tract and may have caused the dolphin to stop breathing or even drown (see Reidenberg & Laitman, 2007). Further attempts to expel the fish likely resulted in forcing the dorsal and anal spines of the fish into the pharyngeal mucosa, thus locking the fish in position.

Asphyxiation by indirect blockage from ingested food superficially resembles the café coronary syndrome of humans (Mittleman & Wetli, 1982; Byard et al., 2003; Wick et al., 2006) but with one major difference. In the human condition, the blockage is located at the entrance of the larynx, with the food item often trapped between the vocal folds. In this dolphin, however, the obstruction remained in the oropharynx. The glottal opening of the dolphin's larynx, while not physically obstructed by the prey, was compromised due to its aberrant position in the digestive tract. Malpositioning of the larynx likely prevented normal inspiration, resulting in asphyxiation.

Both external and internal injuries from interactions between dolphins and fish are common. Walsh et al. (1988) reported several cases of bottlenose dolphins with injuries caused by stingrays (*Dasyatis americana*, *D. sabina*). A bottlenose dolphin was reported in Puerto Rico to have died from pneumonia and pleuritis as a consequence of an agujon needlefish (*Tylosurus acus acus*) beak penetrating the esophagus and migrating to the lung (Carrasquillo-Casado et al., 2002).

While choking and asphyxiation associated with the ingestion of fish in marine mammals appears to be common, it is infrequently reported. Harmer (1927) reported that a bottlenose dolphin in Britain was found dead after attempting to swallow a 1.2 m shark. A harbor porpoise (*Phocoena phocoena*) was reported to have choked to death on a gray smooth-hound (*Mustelus californicus*) in California (Orr, 1937), and two harbor porpoises fatally choked on American shad (*Alosa sapidissima*) in Washington State (Scheffer & Slipp, 1948; Scheffer, 1953). Houck (1961) reported a Pacific whiteside dolphin (*Lagenorhynchus obliquidens*) and Johnson & Ridgway (1969) reported on a bottlenose dolphin, both off the coast of California, choking to death on prey items. Stroud & Roffe (1979) reported on a northern elephant seal (*Mirounga angustirostris*) in Oregon choking to death on a Pacific Ocean perch (*Sebastes alutus*) lodged in its pharynx. A shortbeak common dolphin (*Delphinus delphis*) in the Black Sea was reported to have died due to asphyxiation after the aspiration of a fish (Krivokhizhin & Birkun, 1991). Barros & Odell (1995) indicated that at least 16 *Tursiops* deaths in Florida were associated with the ingestion of typical prey species. An Atlantic spotted dolphin (*Stenella frontalis*) from Puerto Rico was also found dead with a sand diver (*Synodus intermedius*) lodged in the esophagus (Mignucci-Giannoni, 1996), although it was not determined if this was related to the dolphin's cause of death or if it was being regurgitated just before death. Berrow & Rogan (1997) reported that a bottlenose dolphin stranded on Ards Peninsula, Northern Ireland, had apparently choked to death on a small-spotted catshark (*Scyliorhinus canícula*). Another bottlenose dolphin was found floating in Lake Pontchartrain, Louisiana, which upon necropsy was found to have died from asphyxiation due to larynx displacement by two fish in the esophagus ("Recent Strandings," 1997). Thinkquest Team (1998) reported the death of a bottlenose dolphin from choking on a leopard shark (*Triakis semifasciata*). A juvenile whitebeak dolphin (*L. albirostris*) in Scotland attempted to swallow a ballan wrasse (*Labrus bergylta*), which resulted in the fish being lodged in the pharynx, displacing the larynx from the nasal recess, and, thus, its death (Scottish Agricultural College, 2000). A minke whale (*Balaenoptera acutorostrata*) in Chesapeake Bay, Maryland, was found dead, and upon necropsy, it was found to have choked on a 45-cm fish lodged in its airway (Knowles, 2000). In South Australia, an Indo-Pacific bottlenose dolphin

Table 1. Stranding cases of bottlenose dolphins (*Tursiops truncatus*) from Puerto Rico and the Virgin Islands

Field number	Date	Locality	Coordinates	Sex	Total length (cm)	Code	Cause of death
NEPST020	30 March 1937	Bahía de San Juan, San Juan, PR	18°27.0' N, 66°07.0' W	F	215	2	U
NEPST048	1950	Off Cayo Margarita, La Parguera, Lajas, PR	17°55.3' N, 67°06.3' W	U	--	1	HR entanglement
NEPST006	April 1963	Isla Cueva, La Parguera, Lajas, PR	17°57.8' N, 67°04.7' W	M	250	U	U
NEPST022	1978	Ponce, PR	17°58.5' N, 66°37.5' W	U	--	U	U
NEPST023	1979	La Poza de las Mujeres, Manatí, PR	18°28.7' N, 66°30.5' W	U	--	2	U
NEPST027	3 May 1979	Off Joyuda, Cabo Rojo, PR	18°07.2' N, 67°11.9' W	M	165	1	HR capture
NEPST024	3 April 1981	Arecibo, PR	18°29.0' N, 66.42.0' W	U	--	2	U*
NEPST025	3 May 1981	John's Folly, St. John, USVI	18°19.0' N, 64°42.0' W	U	250	4	U
NEPST016	20 Aug 1981	Jack's Bay, St. Croix, USVI	17°44.8' N, 64°35.5' W	F	245	2	U
NEPST361	12 Oct 1981	Zootenvale, Coral Bay, St. John, USVI	18°20.2' N, 64°41.9' W	U	170	5	N dependent calf
NEPST062	1983	Punta Arenas, Joyuda, Cabo Rojo, PR	18°08.2' N, 67°11.2' W	M	--	3	U
NEPST083	Winter 1986	Main Harbor, Charlotte Amalie, St. Thomas, USVI	18°20.2' N, 64°55.5' W	U	--	1	U
NEPST089	8 Sept 1987	Playa de Arecibo, Arecibo, PR	18°28.5' N, 66°44.5' W	M	180	2	N dependent calf
NEPST191	27 June 1992	Las Croabas, Fajardo, PR	18°21.8' N, 65°37.5' W	M	270	4	U
NEPST314	23 Jan 1994	E of Mattei Island, La Parguera, Lajas, PR	17°57.7' N, 67°00.0' W	F	135	3	N dependent calf
NEPST454	Dec 1994	Ensenada Dakity, Isla de Culebra, PR	18°17.2' N, 65°17.0' W	M	--	4	U
NEPST372	24 Nov 1994	Playa Ballenas, Yauco, PR	17°57.3' N, 66°51.2' W	F	233	3	U
NEPST373	14 Feb 1995	Isla de Cabra, Bahía de San Juan, Toa Baja, PR	18°27.9' N, 66°08.3' W	M	262	2	U
NEPST486	9 Jan 1996	Playa Jobos, Guayama, PR	17°56.2' N, 66°10.4' W	M	138	2	HR shot/harpooned
NEPST511	8 May 1996	Little Princess Beach, Christiansted, St. Croix, USVI	17°45.3' N, 64°43.1' W	F	262	U	U
NEPST522	17 Oct 1996	SW of Isla Magueyes, Lajas, PR	17°58.1' N, 67°02.8' W	U	226	4	U
NEPST383	16 July 1998	Playa Santa Cruz, Ponce, PR	17°57.1' N, 66°36.1' W	F	248	3	N illness
NEPST375	29 July 1998	Playa Larga, Caja de Muertos, Ponce, PR	17°53.1' N, 66°31.6' W	M	197	2	U
NEPST381	29 July 1998	Playa Los Tubos, Manatí, PR	18°28.4' N, 66°29.0' W	M	251	2	N illness
NEPST415	9 Aug 1998	SE of Peñoncillo, Peñuelas, PR	17°59.0' N, 66°43.0' W	M	170	2	U
NEPST549	10 June 1999	La Puntilla, Bahía de San Juan, San Juan, PR	18°27.7' N, 66°07.2' W	M	192	4	U
NEPST550	4 July 1999	Playa de Ocean Park, San Juan, PR	18°27.9' N, 66°03.1' W	F	273	2	N illness
NEPST555	21 July 1999	Punta Melones, Cabo Rojo, PR	17°59.5' N, 67°12.8' W	F	186	3	U
NEPST558	23 Aug 1999	Club Nautico, Vega Baja, PR	18°29.1' N, 66°23.0' W	M	193	3	U
NEPST554	25 Aug 1999	Crash Boat, Aguadilla, PR	18°26.7' N, 67°09.6' W	F	246	3	U
NEPST596	3 Jan 2000	Bahía de Boquerón, Cabo Rojo, PR	18°00.5' N, 67°10.5' W	M	220	2	HR entanglement
NEPST603	16 May 2000	Off Cayo Santiago and Batata, Humacao, PR	18°08.2' N, 65°46.3' W	M	162	4	U
NEPST604	21 June 2000	Sector Verdum, Barceloneta, PR	18°29.1' N, 66°34.8' W	F	147	4	U
NEPST608	17 Aug 2000	Playa Grande, Isla de Vieques, PR	18°05.5' N, 65°30.4' W	U	--	4	U

Table 1 (cont.)

Field number	Date	Locality	Coordinates	Sex	Total length (cm)	Code	Cause of death
NEPST610	20 Sept 2000	W of Punta Las Marías, San Juan, PR	18°27.2' N, 66°03.0' W	F	214	3	U
NEPST613	1 Nov 2000	Isabel Segunda, Isla de Vieques, PR	18°09.5' N, 65°26.0' W	F	130	3	N dependent calf
NEPST616	15 March 2001	Bahía Los Negrones, Lajas, PR	17°58.3' N, 67°04.3' W	F	147	2	U
NEPST618	17 April 2001	Playa Subibaja, La Perla, San Juan, PR	18°28.2' N, 66°07.1' W	M	220	2	U
NEPST622	3 June 2001	W of Rio Blanco, Humacao, PR	18°10.3' N, 65°44.4' W	F	148	4	U
NEPST641	5 Jan 2002	SW of Punta Salinas, Salinas, PR	17°57.5' N, 66°17.9' W	M	230	U	U
NEPST833	5 Feb 2002	Playa Los Pozos, Boquerón, Cabo Rojo, PR	18°00.0' N, 67°12.2' W	F	210	3	U
NEPST834	18 Feb 2002	La Puntilla, Bahía de San Juan, San Juan, PR	18°27.5' N, 66°06.9' W	F	259	2	N choking & asphyxiation
NEPST835	4 March 2002	Playa Los Pozos, Cabo Rojo, PR	18°00.3' N, 67°11.5' W	M	250	2	U
NEPST849	13 Sept 2002	Punta Puerca, Ceiba, PR	18°13.5' N, 65°35.5' W	U	130	4	U
NEPST869	1 Sept 2003	Cayo Enrique, La Parguera, Lajas, PR	17°57.4' N, 67°02.5' W	F	111	3	N dependent calf
NEPST870	8 Oct 2003	E of Long Pt., St. Croix, USVI	17°41.2' N, 64°49.3' W	M	113	2	N dependent calf
NEPST874	19 Nov 2003	Cayo de Tierra, Isla de Vieques, PR	18°05.5' N, 65°28.0' W	M	226	4	U
NEPST898	13 Dec 2004	Off Punta Cataño, Bahía de San Juan, Cataño, PR	18°26.5' N, 66°07.5' W	F	250	3	N illness
NEPST903	18 April 2005	S of Palo Seco, Bahía de San Juan, Cataño, PR	18°27.8' N, 66°08.4' W	M	--	4	U
NEPST931	7 Dec 2006	El Morro, Bahía de San Juan, San Juan, PR	18°28.0' N, 66°07.4' W	M	200	2	U

Locality: PR = Puerto Rico, USVI = U.S. Virgin Islands; Sex: F = female, M = male, U = undetermined; Codes: 1 = alive, 2 = fresh, 3 = moderately decomposed, 4 = advanced decomposition, 5 = mummified carcass; Cause of death: HR = human related, N = natural, U = undetermined, * = two animals stranded

(*T. aduncus*) was found dead with a cobbler carpetshark (*Sutorectus tentaculatus*) obstructing its upper aerodigestive tract (Byard et al., 2003; Kemper et al., 2005). In Florida, two bottlenose dolphins died of asphyxiation due to an esophageal obstruction—one with a striped mojarra and the second with a non-native blackchin tilapia (*Sarotherodon melanotheron*) (Bossart et al., 2003; Mazzoil et al., 2008). Another bottlenose dolphin in Galveston, Texas, died from complete laryngeal displacement and asphyxiation as it was trying to swallow a large beheaded sheepshead (*Archosargus probatocephalus*) (Watson & Gee, 2005). A bottlenose dolphin was also found dead with a great barracuda (*Sphyraena barracuda*) halfway in its throat in Belize (C. W. Potter, pers. comm.), but it was not concluded if the lodged fish was the actual cause of death or contributed to the demise of the animal.

Incidental ingestion of anthropogenic debris may also cause mortality involving choking and asphyxia. Two bottlenose dolphins in Florida were reported to have died from asphyxiation due to laryngeal entrapment (monofilament line tightly wrapped around the larynx) (Gorzelany, 1998). Đuras Gomerčić et al. (in press) reported a gillnet ingestion by a bottlenose dolphin in the Adriatic Sea that resulted in larynx strangulation, and therefore death by asphyxiation.

Fifty strandings of bottlenose dolphins have been reported between 1937 and 2006 in Puerto Rico and the Virgin Islands (see Table 1). Accuracy in determining the cause of death depends upon the degree of decomposition when the carcass is examined. For those specimens in which a cause of death was determined, four were human related (e.g., accidental entanglement, deliberate hunting) and 11 died of natural causes. Natural death causes for bottlenose dolphins in Puerto Rico included six dependent calves, pulmonary carcinoma in one adult (Ewing & Mignucci-Giannoni, 2003), severe pneumonia in two adults (Carrasquillo-Casado et al., 2002), and choking in one adult (the case report presented here). No similar cases of choking or asphyxia have been observed in over 150 marine mammal strandings documented in Puerto Rico and the Virgin Islands since 1985 (Mignucci-Giannoni et al., 1999, 2000). Asphyxiation by choking on a natural prey item represents an uncommon mortality factor in the Caribbean associated with piscivorous cetaceans that needs to be considered and reported when conducting postmortem examinations in these tropical waters.

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