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Short Note

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Mandibular osteomyelitis in the bottlenose dolphin *Tursiops truncatus* (Montagu, 1821) (Odontoceti: Cetacea): first case in the Mexican Caribbean

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Abstract: Oral pathological conditions are common in mammals and have been relatively well documented for some wild groups, but are rarely reported in marine mammals. Here, we report for the Mexican Caribbean the first case of mandibular osteomyelitis in a free-ranging dolphin. A bottlenose dolphin *Tursiops truncatus* adult male (256.5 cm total length) was found stranded dead in the west coast of the State Reserve "Chetumal Bay Manatee Sanctuary". Herein, we discuss some plausible explanations about the origin of this lesion to improve the knowledge about the species biology.

Keywords: cetacean; infectious disease; marine mammals; Mexican Caribbean; oral pathology; osteomyelitis; stranding.

Oral affections caused by pathological conditions are common in mammals (Fagan et al. 2005) and relatively well documented in some groups, especially in terrestrial animals (Hoefs and Bunch 2001). Despite this, it is believed that osteomyelitis (spine, peripheral bones and mandibular osteomyelitis) is a common infection in dolphins (Sweeney and Ridgway 1975), there are few reports of this disease in this group (De Smet 1977, Brooks and Anderson 1998, Ramos et al. 2001, Montes et al. 2004, Van Bressem et al. 2006, 2007a,b, Loch et al. 2011, Fettuccia et al. 2013). Due to the lack of information available about oral/dental lesions in cetaceans, Brooks and Anderson (1998) recommended to be alert and report any related case. Nevertheless, since that publication, few reports have been added.

The bottlenose dolphin *Tursiops truncatus* (Montagu, 1821) is the most common dolphin worldwide (Leatherwood and Reeves 1983). The species has a cosmopolitan distribution occurring principally in temperate and tropical waters, and is considered the most common cetacean in the Mexican Caribbean (Navarro 1992, Zacarías 1992, Niño-Torres et al. 2015). Despite its current categorization as Low Concern (LC) by the International Union for Conservation of Nature (IUCN) (Hammond et al. 2018), it has been suggested that several local populations/groups should be classified into the Data Deficient (DD) category. Mexican laws catalogued the bottlenose dolphin as subject to special protection (NOM-059-SEMARNAT 2010). Additionally, the species is listed in the Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2018).

The disease (mandibular osteomyelitis) is characterized by a severe deep bone infection (Antiabong et al. 2013), and its etiologic agents involve bacteria (culturable and non-culturable) established in the oral cavity (Moore and Moore 1994, Soto et al. 2014). Typically, the infection begins with gum damage and the entry of bacteria in the tooth socket that eventually spreads into the soft tissues reaching the jaw bone (Lang et al. 2009). Following the inflammatory process, necrotic tissues and pus fill the bone, and the infection gradually destroys the jaw (Sundqvist et al. 1979).

As part of the duties of the Marine Mammal Stranding Network of the State of Quintana Roo, a dead adult male

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Tursiops truncatus was recovered in the west coast of the State Reserve "Chetumal Bay Manatee Sanctuary" (UTM: 370609.4; 2057430.2) on July 9th, 2017. The individual was a 256.5-cm (in length) male and arrived in a decomposition code 3 (moderately decomposed) according to the categorization of Pugliares et al. (2007). The carcass underwent a necropsy resulting in a comprehensive report including external measurements and tissue sampling (muscle, skin and some internal organs) for future analysis. The carcass was not collapsed; bloating was evident (tongue and penis protruded) and it presented damage from scavengers, likely a shark. No external evidence of infection/disease was observed. The carcass was buried at 80-cm depth at the Chetumal Campus of the University of Quintana Roo. Seven months later, the bones were recovered, cleaned and labeled (UQROO-Tt-09072017) for deposit in the Vertebrate Collection (SEMARNAT register code: DF-CC-295-15).

During cleaning, we noted that the right mandibular ramus (RMR) had severe pathology/condition (Figure 1),

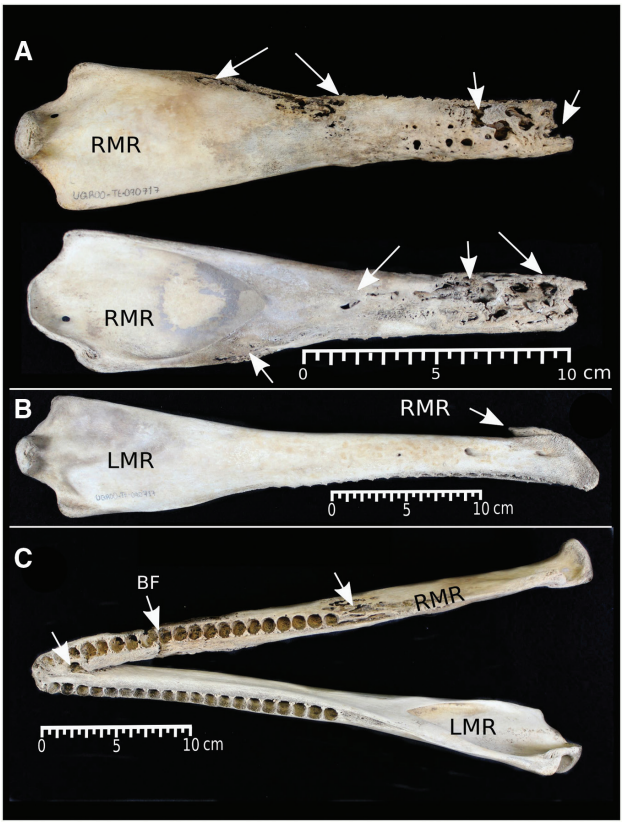

Figure 1: Mandible of *Tursiops truncatus* showing mandibular osteomyelitis.
(A) Lateral (upper) and medial (lower) view of the right mandibular ramus (RMR). (B) Lateral view of the left mandibular ramus (LMR). (C) Dorsal view of the mandible. Arrows indicate areas where the lesion is evident. Note the bone fracture (BF) caused by the infection in the RMR and the lesion reaching the LMR.

presenting a cavernous bone lesion (bone loss/osteolysis) possibly associated with a necrotic, inflammatory and, maybe, chronic bone infection, which affected the trabecular and cortical bone. The lesion comprised approximately 70% of the RMR (Figure 1), even reaching the most anterior portion of the left mandibular ramus (LMR) (Figure 1C).

These chronic, expansive, bony lesions have been difficult to treat in domestic animals (Fagan et al. 2005), and infections occurring in the oral cavity may have an association with general health (Mattila et al. 1989). According to the kind and size of the lesion observed in this dolphin, we hypothesize that the infection originated in this ramus could have compromised the health of the animal and possibly caused its death.

Jaw pathology has been relatively well-documented in mammals including sheep (Hoefs and Bunch 2001), bovines (Masand et al. 2015), macropods (Sotohira et al. 2017), cats (Soto et al. 2014) and humans (Valour et al. 2015). Whereas oral/dental abnormalities such as mineralized deposits, caries, tooth erosion, root resorption and shape anomalies have been studied in wild cetaceans (Brooks and Anderson 1998, Loch and Simoes-Lopes 2013), mandibular osteomyelitis has been documented less.

The case presented here represents the second report of mandibular osteomyelitis for bottlenose dolphins (De Smet 1977, Brooks and Anderson 1998) and the first record for the Mexican Caribbean. Mandibular osteomyelitis has been previously reported in the tucuxi species *Sotalia fluviatilis* (Gervais and Deville in Gervais, 1853) (Fettuccia et al. 2013), the Burmeister's porpoise *Phocoena spinipinnis* (Burmeister, 1865) (Reyes and Van Waerebeek 1995, Van Bressem et al. 2007a,b) and long-beaked common dolphins *Delphinus capensis* (G. Cuvier, 1829) (Van Bressem et al. 2006). Spine and peripheral bone osteomyelitis has been presented in bottlenose dolphins (De Smet 1977, Alexander et al. 1989), both the tucuxi species *S. fluviatilis* (Ramos et al. 2001, Fettuccia et al. 2013) and *Sotalia guianensis* (Van Beneden, 1864) (Van Bressem et al. 2007a, Simões-Lopes et al. 2008), and in long-beaked common dolphins (Van Bressem et al. 2007a,b, Loch et al. 2011), Peale's dolphin *Lagenorhynchus australis* (Peale, 1848) (San Martín et al. 2016), *Lagenorhynchus albirostris* (Gray, 1846) (Kompanje 1995a), the killer whale *Orcinus orca* (Linnaeus, 1758) (Kompanje 1995b), the long-finned pilot whale *Globicephala melas* (Traill, 1809) (Sweeny et al. 2005), Franciscana *Pontoporia blainvillei* (Fraser in Norman & Fraser, 1938) (Gerholdt 2006), Dall's porpoises *Phocoenoides dalli* (True, 1885) (Sweeney and Ridgway 1975), the Burmeister's porpoise (Reyes and Van Waerebeek 1995, Montes et al. 2004) and the humpback whale

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Megaptera novaeangliae (Borowski, 1781) (Félix et al. 2007, Groch et al. 2012).

Severe skeletal disorders are usually attributed to hunting/foraging animal activities, infectious diseases and environmental pollution (Martinez and Stockin 2013, Eissa and Abu-Seida 2015). Fetuccia et al. (2013) and Kompanje (1995b) suggest dental injuries caused by penetrating wounds and fractures act as the in-door gate for infectious organisms; even normal wear and tear of the teeth can expose the pulp tooth creating an access way to infection agents. We propose the following four possible causes of the jaw infection origin in this case:

1. Dental wear: Pulp cavity can be exposed during severe cases of dental wear (Loch and Simoes-Lopes 2013), a common phenomenon in cetaceans (Loch et al. 2011, 2013, Loch and Simoes-Lopes 2013); in some severe abrasion cases, pulp cavity may be exposed, allowing access to infection agents, followed by osteomyelitis (Kompanje 1995b). We believe, this is the most likely scenario because the specimen showed a significant dental wear (Figure 2).
2. Caries-like disease (CLD): CLD is a destructive process starting with the enamel erosion and penetrating into the dentine and its underlying layers causing softening and loss of dentinal tissue. From this point, the infection could reach the nerve canal and move into the jaw bone. CLD has been previously reported for wild *Tursiops truncatus*, *Delphinus capensis*, *Sotalia guianensis*, *Stenella coeruleoalba* (Meyen, 1833), *Sotalia frontalis* (Cuvier, 1829) and *Steno bredanensis* (G. Cuvier in Lesson, 1828) (Brooks and Anderson 1998, Loch et al. 2011). Also, CLD has been associated with bone lysis in *D. capensis* and *Phocoena spinipinnis*.
3. Boat collisions: Injury from vessel collision is implicated in severe skeletal conditions in wild dolphins, including scoliosis, lordosis, lumpy dorsal masses and many other skeletal deformities such as vertebral fractures (Martinez and Stockin 2013, Eissa and Abu-Seida 2015). Sanfelice and Ferigolo (2012) inferred that a large hematoma caused by boat collisions' trauma get infected and resulted in the loss of the mandibular bone in a *Balaenoptera edeni* Anderson, 1878 whale. Likewise, in the case reported here, a boat bump could have fractured the bone, with the consequent infection caused by the putrefaction of death tissue.
4. Inter- or intra-species agonistic interactions: Animals living in a group social structure, such as cetaceans, tend to have a high occurrence of fractured teeth caused by fighting (Glatt et al. 2008). Minor or major wounds originated during strong agonistic interactions can infect (Finkelstein and Oren 2011) and eventually develop into an osteomyelitis condition.

To conclude, the report on mandibular osteomyelitis presented here is the second in a free-ranging bottlenose dolphin, and the first case record in the Mexican Caribbean. Our finding contributes to the general knowledge of diseases occurring in wild cetaceans. It is important to continue reporting cases of this kind and investigating potential bacterial pathogens that can produce this disease in dolphins.

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Figure 2: Teeth of the *Tursiops truncatus* showing acute wear. Arrows indicate the principal tooth wear. Note in some cases, the severe wear (more than 50% of loss of the crown area).

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