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Short Note

Brachygnathia Superior Observed in a Juvenile Common Bottlenose Dolphin (*Tursiops truncatus*)

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Brachygnathism is a congenital malformation involving an abnormal truncation of the maxillae (brachygnathia superior) or mandibles (brachygnathia inferior), which can lead to a severe malocclusion (Barker et al., 1993). This condition is commonly seen in species such as cattle (Kene & Uwagie-Ero, 2001; Čítek et al., 2009; Hoy et al., 2011), dogs (Fox, 1963; Borissov et al., 2004), wild ungulates (Hoy et al., 2011), and humans (Mackay et al., 1992; Ariji et al., 2000). The few descriptions of brachygnathism in cetaceans have resulted from examinations of stranded dolphins. Elorriaga-Verplancken et al. (2015) reported a live stranded common bottlenose dolphin (*Tursiops truncatus*; hereafter bottlenose dolphin), which presented with both brachygnathia superior and a severe oral infestation of rabbit-ear barnacles (*Conchoderma auritum*). In this case, the distal halves of the maxillae were abnormally truncated, measuring approximately one half the length of the mandible. Traumatic injury could not be ruled out as the cause of this particular deformity, perhaps in part due to the damage incurred from the described barnacle infestation. However, the authors posited that the barnacle growth was facilitated by the presence of exposed teeth caused by the rostral deformity. In this case, the animal presented with a healthy overall body condition, suggesting that the deformity did not significantly affect the animal's ability to hunt. Similar observations of brachygnathia inferior were observed by Van Bressem et al. (2006) in a long-beaked common dolphin (*Delphinus delphis* [originally reported as *D. capensis*]) taken as fisheries bycatch in Peru. In this case, the distal halves of the maxillae and mandible were curved upwards, and the mandible was observed to be shorter than both the maxillaries and premaxillaries; however, a similar barnacle infestation was not observed. This animal also presented with a healthy body condition, indicating that the animal was able to forage effectively.

A juvenile bottlenose dolphin exhibiting significant brachygnathia superior was observed during a routine boat-based photo-identification survey on 26 October 2012 near Petit Bois Island in the Mississippi Sound (MSS; Figure 1). This is the first known report of such a deformity in this stock. This case is presented with the intent that it provides a basis of comparison for future observations and for reference to management officials when evaluating the likelihood of post-release survival for stranded animals suffering from rostral deformities and comparable injuries.

The MSS is a shallow embayment approximately 2,100 km^2 in size that extends from Mobile Bay, Alabama, to Lake Borgne, Louisiana (Eleuterius, 1978a, 1978b; Figure 1). It is home to the Mississippi Sound, Lake Borgne, Bay Boudreaux bottlenose dolphin stock, known to be one of the largest and best studied estuarine populations in U.S. territorial waters (Hayes et al., 2018). Dolphin abundance in the MSS is known to fluctuate seasonally from approximately 738 in the winter to over 3,000 in the summer, likely resulting from seasonal emigration/immigration. Dolphins' movements within the MSS are characterized by an east-west ranging pattern that appears to be related to salinity (Pitchford et al., 2016).

The survey platform was a 6.4-m vessel powered by a single 150-hp Evinrude E-Tech outboard engine travelling at a maximum speed of 40 km/h while on survey. The vessel carried four observers who recorded behavioral states, group size, group composition, and environmental data such as water quality and sightability. The location was recorded using a handheld Garmin GPSmap76 global positioning system (GPS), and photographs of individual dorsal fins were collected using a Canon EOS 30D digital camera with a Canon 400-mm zoom lens. The speed of the vessel was reduced to the pace of the

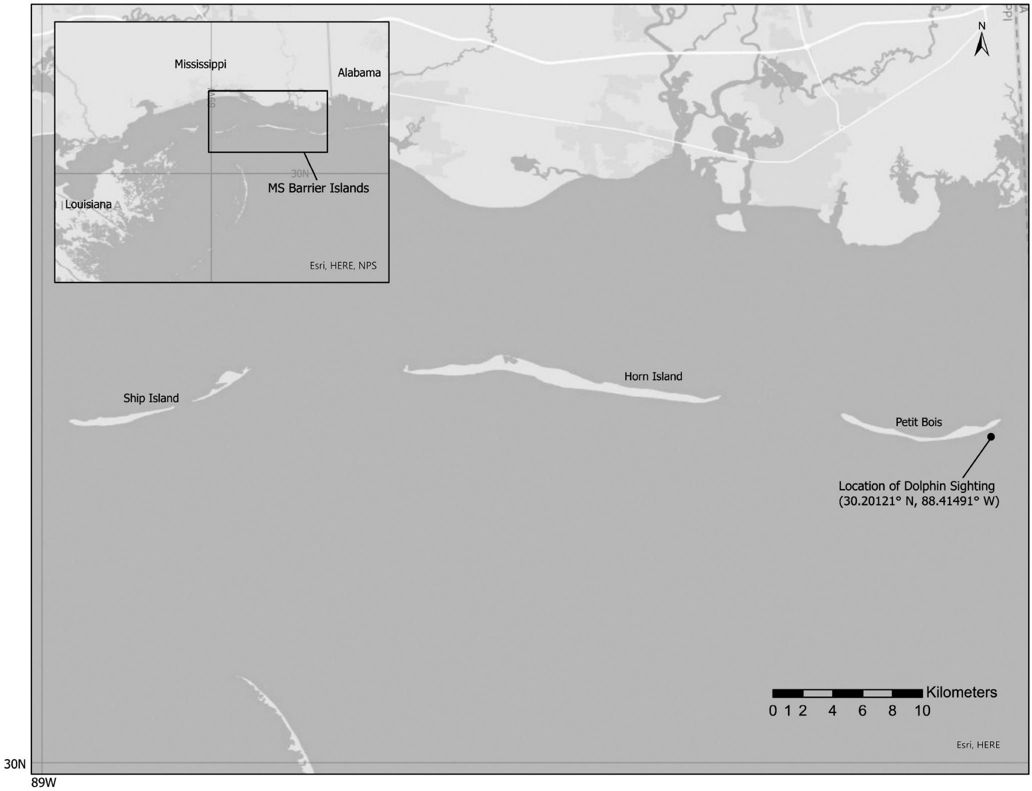

Figure 1. Map of the study area and location of the encounter

dolphins when sighted. Sightings were limited to 30 min during which time researchers endeavored to avoid influencing the animals' behavior by moving parallel to the dolphins and keeping as much distance as possible (as per Permit GA LOC #13549). During this effort, observers obtained photographs of the individual's facial deformity for later analysis. All of the resulting sighting data was entered into *FinBase*, and sighting location coordinates were imported into *ArcMAP*, Version 9.3 (ESRI, Redlands, CA, USA). Each individual's dorsal fin, photographed during the sighting, was traced and compared against the Institute for Marine Mammal Studies (IMMS) database using *Darwin*, Version 2.22.

The individual of interest was observed primarily milling in a group of seven bottlenose dolphins near Petit Bois Island in the eastern MSS. The group, including the individual, consisted of adults ($n = 2$), juveniles ($n = 3$), and calves ($n = 2$). The observed animal was inferred to be a juvenile as it measured approximately two-thirds the length of an adult and presented with a lighter coloration in comparison with adult dolphins (Bearzi et al., 1997). Sex was not able to be determined due to the animal's body position throughout the duration of the sighting. The animal had not been previously observed in the IMMS database and has not been sighted since that observation. Thus, the animal's disposition following this observation remains unknown.

In evaluating the photographs resulting from this field observation, it is clear that this animal's skeletal architecture and associated anatomical lips, fascia, and associated blood and nerve supply to the upper jaw were truncated. In addition, the rostral-most end of the mandible extended beyond the maxillae and deviated dorsally (Figure 2C). The epidermal and dermal layers of the external right lateral rostral lip appeared raised or nodular in shape and presented with a lighter color in comparison to the rest of the mandible. Approximately half of the dental arcade of the visible maxillary teeth could be distinguished in the photographs collected (Figure 2A). In this case, the individual's half maxillary dental formula appeared to range from 11 to 14, which is less than the 18 to 26 considered typical of this species.

The individual's cranium, melon, and overall body condition appeared to be robust, indicating that this individual was otherwise healthy and, thus, able to forage effectively. This finding is consistent with conclusions from Elorriaga-Verplancken et al. (2015) and Van Bressem et al. (2006, 2007), which suggested that brachygnathia is unlikely to impact the foraging capabilities of cetaceans.

In other species, behavioral adaptations enable individuals to compensate for these malocclusions to hunt or forage effectively (Hoy et al., 2011). In this case, of course, it is unknown what behavioral adaptations, if any, would contribute to foraging success in a delphinid with a rostral deformity. Additionally, it is unknown if alternate communicative and foraging strategies are required to compensate for mandibular deformities that may inhibit the reception of the broadband sounds associated with echolocation, the reception of which has been shown to be facilitated by the mandible. Though studies have shown acoustic sensitivity at a number of locations on a dolphin's head and lower jaw, the best sensitivity, in some studies, was found to be the most distal point of the mandible (Møhl et al., 1999; Brill et al., 2001).

Figure 2. Photographs of a juvenile bottlenose dolphin (*Tursiops truncatus*) encountered in the Mississippi Sound exhibiting rostral brachygnathia superior: (A) right lateral view, (B) left lateral view, and (C) caudal view.

While traumatic injury has been implicated as a potential cause of brachygnathia superior (Elorriaga-Verplancken et al., 2015), it is more commonly linked to autosomal recessive traits, as in Jersey cattle (Barker et al., 1993), or exposure to pesticides (Hoy et al., 2015). In this case, a hands-on examination of the animal was not possible; however, photographic assessment suggests that traumatic injury is unlikely to be the cause of this particular abnormality. This is evidenced by the lack of scarring on the individual's rostrum, suggesting that this is likely a congenital deformity (Figure 2B). Thus, we posit that the likely cause of this particular individual's abnormality is either a genetic condition and/or exposure to environmental pollutants.

The MSS was impacted by the *Deepwater Horizon* (DWH) oil spill in 2010 and is continually impacted by runoff from the Mississippi, Pascagoula, and Pearl Rivers which carry a variety of pollutants into the northern Gulf of Mexico. Thus, it is not surprising to find that surface waters in the region have been shown to exhibit a high concentration of pollutants such as chlorobenzilate, polychlorinated biphenyls (PCBs), organochlorine pesticides, bisphenol A, and estrogenic compounds (Wang et al., 2012). These, and other, pollutants are known to impact marine mammals disproportionately through the process of bioaccumulation, as well as the eventual storage of such pollutants in the blubber. These pollutants are destined to be released at a later time when fat reserves are depleted during times of stress, pregnancy, depleted food supply, disease, and lactation. The release of these chemicals can result in any number of conditions, including immunosuppression, decreased reproductive efficiency, developmental disorders in calves (Reddy et al., 1998; Watanabe et al., 2000), and impaired endocrine function such as the development of hypoadrenocorticism (Schwacke et al., 2013; Venn-Watson et al., 2015). Hypoadrenocorticism, in particular, has been linked to the development of brachygnathia superior in ruminants (Hoy et al., 2011).

Concern related to the impact of pollutants on this population is underscored by findings presented by Schwacke et al. (2013) and Venn-Watson et al. (2015), which directly link the aforementioned conditions to the DWH oil spill.

Persistent organic pollutants (POPs) are of a particularly high concern for MSS dolphins which exhibit site fidelity to the barrier islands of the MSS, such as Petit Bois Island, as these animals tend to present with higher levels of these pollutants in their blubber (Balmer et al., 2015). Given the size of the individual relative to group members, it was determined that this animal is a juvenile and, thus, likely to have either been born or conceived in 2010. As such, it is possible that effects from the DWH oil spill may have contributed to the development of this condition in this case.

Van Bressem et al. (2007) found, from looking at stranded animals and museum specimens, the apparent prevalence (AP) of congenital malformations among populations of small cetaceans in South America, including bottlenose dolphins, to be less than 10%. Similar observations of congenital spinal malformations in the MSS have estimated an AP of 0.037% (Ambert et al., 2017). In this case, when compared to the existing photo-identification catalog (n = 3,542 at present), the AP was found to be approximately 0.030%.

While the exact cause of this individual's condition is unknown, reporting such cases is critical to the detection and tracking of health trends within and across populations. Continued monitoring of this population is crucial for assessing possible congenital malformations and their likely linkages.

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