

Dental Anomaly Causing Severe Maxillary Lesions in a Male Sowerby's Beaked Whale (*Mesoplodon bidens* Sowerby, 1804)

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Abstract

Sowerby's beaked whale (*Mesoplodon bidens*) is a poorly known cetacean species, and much of our current information comes from stranded animals. Herein, we describe a dental anomaly in an adult male stranded in 2019 in the Moray Firth, Scotland. The mandibular teeth (tusks) had erupted so their tips converged towards the median plane, and they did not protrude over the lips laterally as is normal in adult male *M. bidens*. As a result, the tusks were causing severe damage to the palate by continual mechanical stimulus. The symmetrical nature of the pair of tusks suggests a developmental abnormality. This malignment of the teeth and damage to the soft tissue and underlying bone of the rostrum likely negatively impacted the health of the animal, increasing the risk of infection.

Key Words: beaked whale, *Mesoplodon bidens*, dental anomaly, maxillary lesions, pathology

Introduction

The Family Ziphiidae comprises 23 known species and six genera of medium-sized to large, deep-diving toothed whales (Jefferson et al., 2015; Yamada et al., 2019). The most speciose of these genera is the genus *Mesoplodon*, which currently includes 15 species. Owing to long dive times, beaked whales are infrequently observed in the wild (Pitman, 2009), and very little is known about their behaviour and ecology (MacLeod, 2018). Beaked whales are suction feeders (Heyning & Mead, 1996) that prey primarily on cephalopods and fishes (Ostrom et al., 1993; Pereira et al., 2011). *Mesoplodon* whales are extreme divers. Blainville's beaked whales (*M. densirostris*) forage at average depths of 800 to 1,000 m (Tyack et al., 2006; Arranz et al., 2011), with a maximum recorded dive of 1,408 m (Baird et al., 2006).

Mesoplodon whales typically congregate around the edges of continental shelves and deep-sea canyons where they forage at depth (Hooker & Baird, 1999; Berrow et al., 2018). Definitive sightings in the wild are rare, and strandings offer important opportunities to improve our understanding of their anatomy, pathology, and diet.

A phylogenetic tree based on mitochondrial genomes suggests that Sowerby's beaked whale (*Mesoplodon bidens*) is the basal species of the genus *Mesoplodon* (Einfeldt et al., 2019). Sowerby's beaked whale occurs throughout the North Atlantic (Moore, 1966; Reiner et al., 1993; Carlström et al., 1997; Hooker & Baird, 1999; Wenzel et al., 2013; Waller, 2014; Berrow et al., 2018) and is characterised by two teeth (tusks) situated midway along the mandible. Both sexes possess mandibular tusks, although these teeth typically only erupt above the gumline in adult males. Tusks are used in aggressive male–male encounters (Mead, 1989), resulting in scars which can aid in individual animal identification. In healthy animals, the two teeth erupt vertically and are visible externally when the jaws are closed.

The majority of Sowerby's beaked whale stranding events occur in Britain, Ireland, and northern Europe, although cases have also been reported from northeastern Canada and the United States, the Faroe Islands, and the Azores (Wojtek et al., 2014). It is hypothesized that breeding and calving grounds occur off the west coast of Ireland (Berrow et al., 2018). In Scotland, Sowerby's stranding events are rare in comparison with other marine mammals (average of three cases per year for the past decade), occurring predominantly in the Western Isles, Orkney, and Shetland Islands (Brownlow & Davison, 2013; Brownlow et al., 2014, 2015b, 2016, 2017, 2018b; Davison et al., 2019). Reported causes of death for Sowerby's beaked whales in Scotland include entanglement, ship strike, and live stranding due to infectious pathogens (particularly neurobrucellosis), although

parasite burden and disorientation, resulting in decompression sickness due to nearby use of mid-frequency-range sonar, are also contributing factors (Brownlow, 2011; Brownlow et al., 2015a, 2018a).

In this article, we describe a dental anomaly in an adult male Sowerby's beaked whale which caused chronic injury to the rostrum.

Methods

Specimen: *Mesoplodon bidens*
 Stranding location: Moray Firth, Scotland
 Latitude: 57.802172° N
 Longitude: 3.8380426° W
 UK grid reference: NH 908 806
 Stranding date: 2 July 2019

This adult male Sowerby's beaked whale (CSIP Stranding No. SW2019/318) was stranded on 2 July 2019 below Geanies House (2.6 km south of Tarrel) on the Moray Firth, Highland, Scotland (Figure 1). The animal was 457 cm long. Its body was in a state of advanced decomposition, and a full necropsy was not possible. The skeleton was recovered for the collections of National Museums Scotland (Register No. NMS.Z.2020.9.30). During the processing of the specimen, the anomalous mandibular teeth were seen to have caused trauma to the rostrum, and this anomaly was further investigated.

The stomach was empty except for a small quantity of fish eye lenses and otoliths. Liquid content was found along the intestine. Overall, it appeared that the animal had not fed recently. Lateral blubber depth on the non-exposed side of the stranded animal was ~28 mm, but it is unclear if this is representative of the pre-mortem depth of the blubber owing to its state of decomposition.

Results

The mandibular tusks were fully erupted, confirming this was an adult male, with evidence of crown wear on both. The roots of both teeth curved towards the midline, creating a C-shape (Figures 2-4). As a result of this curvature, the teeth were not externally visible when the mouth was closed as is normal for an adult male *M. bidens* (Figure 3). Tooth measurements and dimensions are provided in Table 1 and Figure 2. Radiographs of the teeth are provided in Figure 4. Comparison images with a non-pathological tooth from an adult male *M. bidens* specimen are provided in Figure 5.

The inward curvature of the mandibular teeth brought them in direct contact with the upper jaw. There was tissue proliferation of the left caudal and lateral part of the hard palate (Figure 6); and the osteological specimen showed damaged palatine processes of both maxillae (Figures 7-10). The sites of the lesions were 146 mm from the tip of the left maxilla and 148 mm from the tip of the

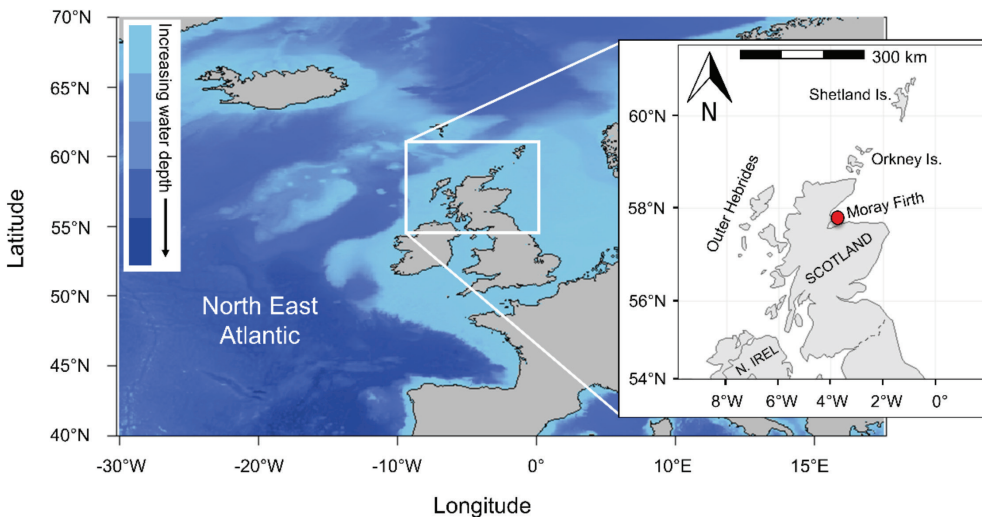


Figure 1. Stranding location of *Mesoplodon bidens* (NMS.Z.2020.9.30). The specimen was collected below Geanies House (~2.6 km south of Tarrel) on the Moray Firth, Highland, Scotland (stranding site marked with a red dot). Map figures created in R, Version 3.6.0, using 'ggplot' package.

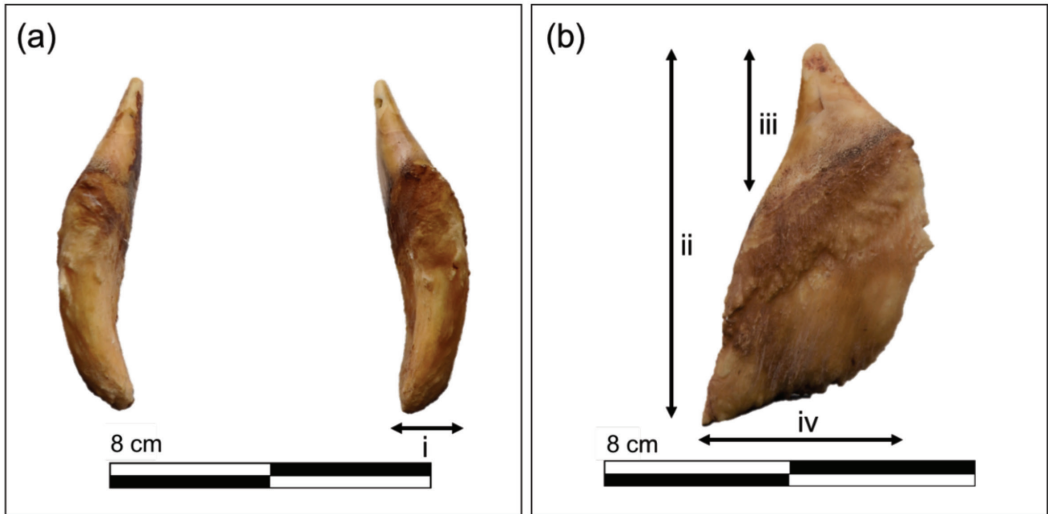


Figure 2. (a) Posterior view of the mandibular teeth—note the curved C-shape of the tooth roots; and (b) labial surface of left mandibular tooth. Tooth measurements are provided in Table 1: i = tooth breadth, ii = total height of tooth, iii = height of tooth crown, and iv = antero-posterior width of tooth.



Figure 3. (a) Right view of the lower jaw with both teeth *in situ*; and (b) dorsal view of the lower jaw with both mandibular teeth *in situ*. Note how the teeth converge medially instead of protruding vertically.

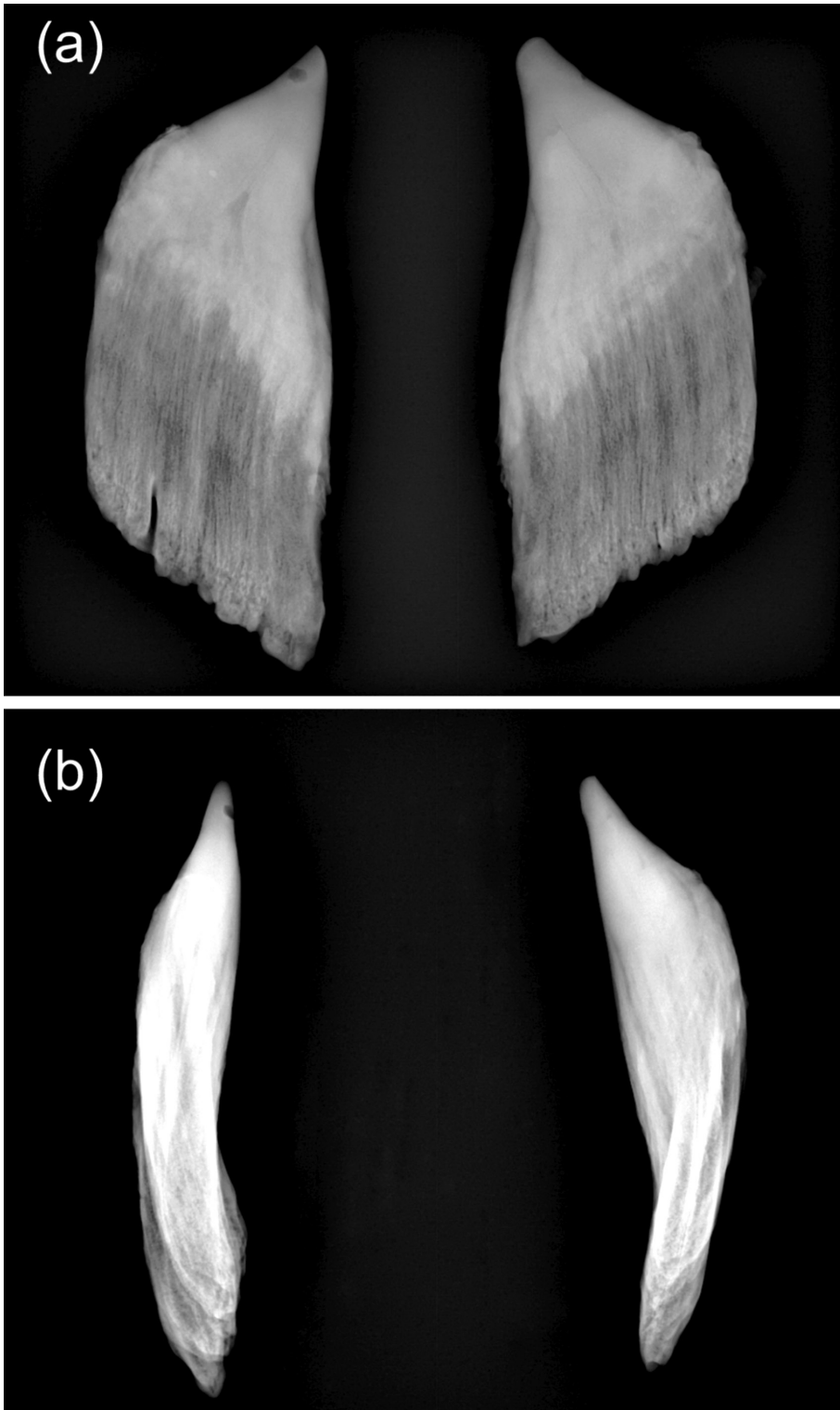
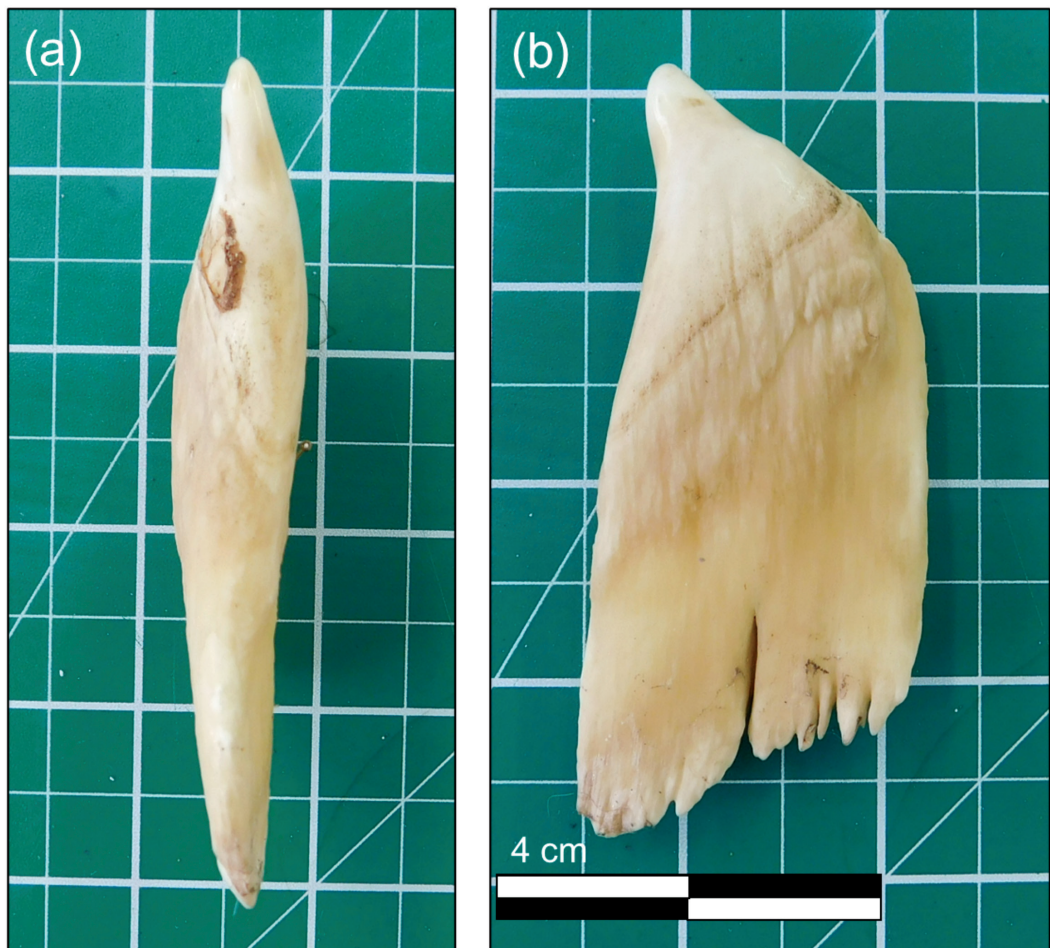


Figure 4. Radiographs displaying the (a) mediolateral and (b) mesiodistal planes of the malformed teeth

Table 1. Measurements of the anomalous tusks of a male *Mesoplodon bidens* (NMS.Z.2020.9.30)

Measurement	Left mandibular tooth (mm)	Right mandibular tooth (mm)
Total tooth height	87.2	84.7
Crown height	28.0	33.8
Antero-posterior width of tooth	38.0	36.5
Tooth breadth	14.5	13.1

**Figure 5.** For comparison with the malformed tusks of specimen NMS.Z.2020.9.30, the (a) anterior surface and (b) lingual surface of a “healthy” tooth from an adult male *M. bidens* that stranded in Scotland in 2020 are presented here.

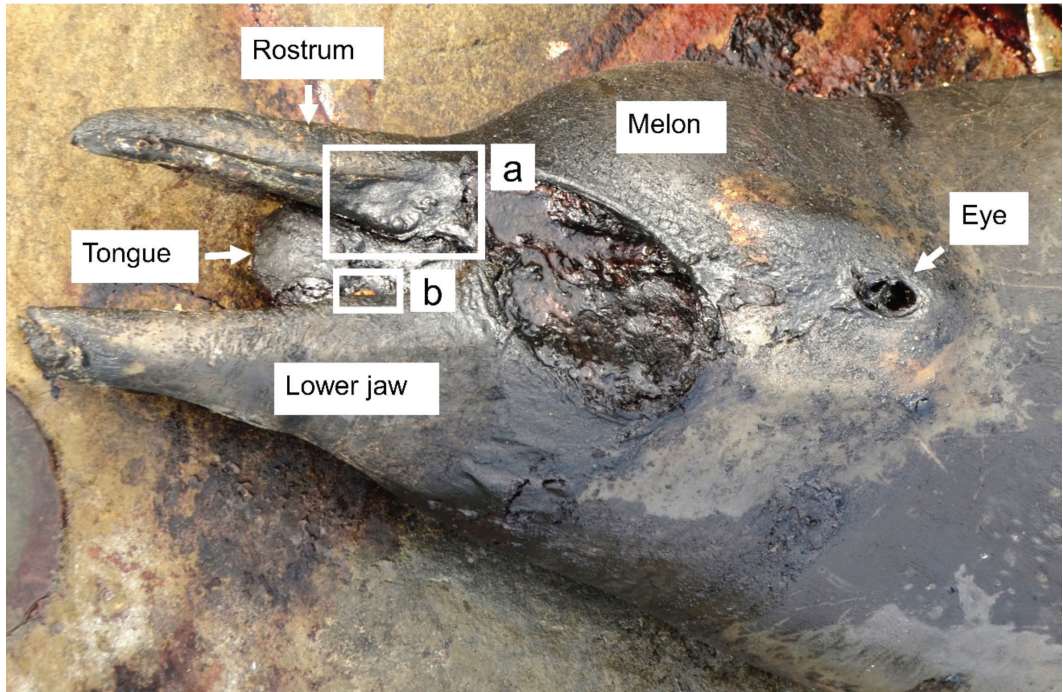


Figure 6. Left side of the head of the stranded adult male *M. bidens* (NMS.Z.2020.9.30). The body was in an advanced stage of decomposition at the time of collection. Palatal soft tissue proliferation in response to injury is visible in box “a”; and the erupted mandibular tooth is visible in box “b.” (Photo credit: G. Hantke, National Museums Scotland, 2019)

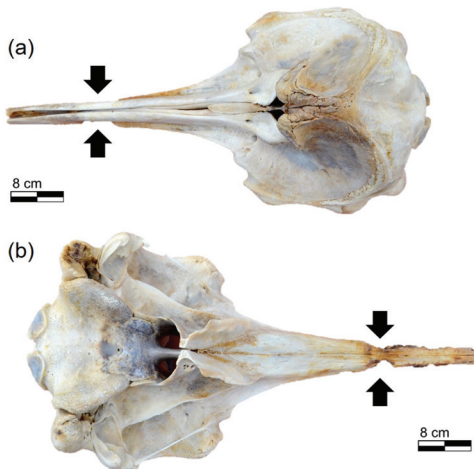


Figure 7. Dorsal (a) and ventral (b) views of the skull. Black arrows indicate the sites of maxillary lesions.

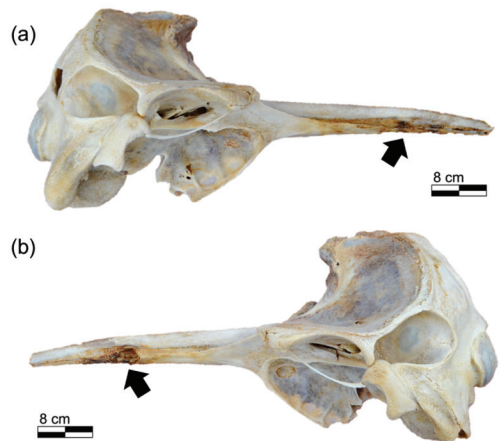


Figure 8. Right (a) and left (b) side views of the skull. Black arrows indicate the sites of maxillary lesions.

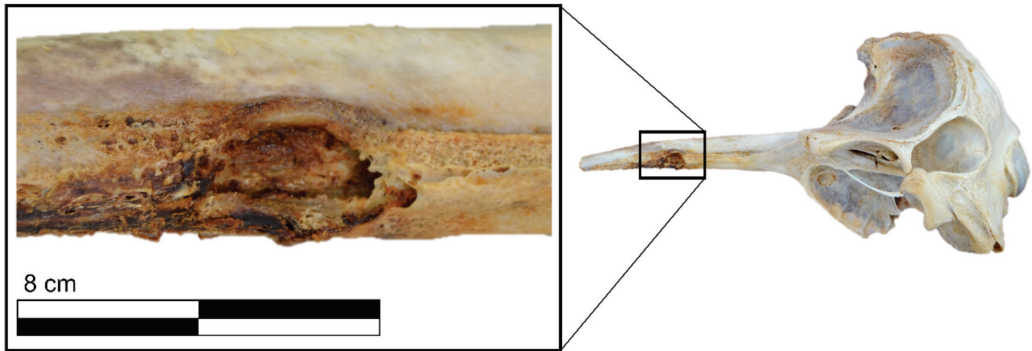


Figure 9. Close-up of a maxillary lesion (left side)

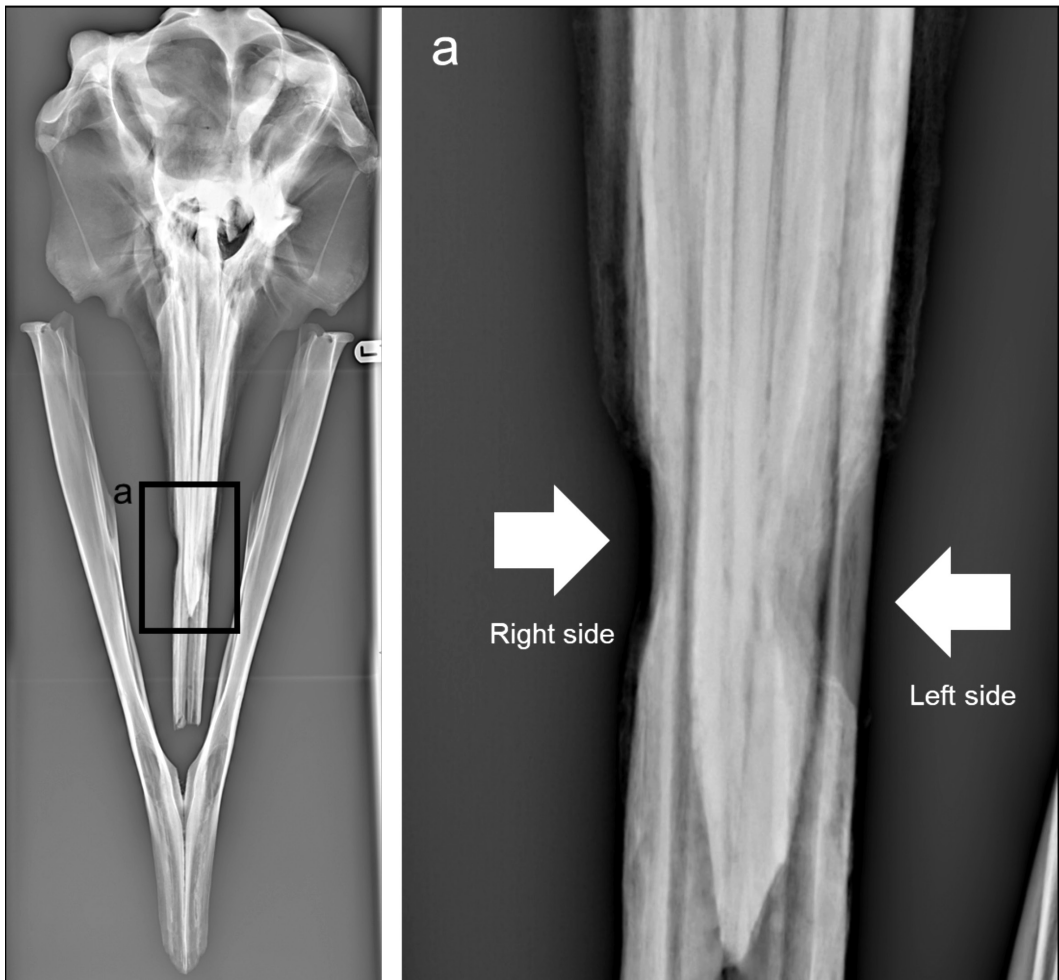


Figure 10. Radiograph dorsal view of the cranium and mandible of the adult male *M. bidens* (NMS.Z.2020.9.30). Box “a” (left panel) indicates the site of injury to the maxilla. The white arrows in the right panel indicate the sites of the bone lesions. Note the more extensive osteological damage to the left maxilla than to the right.

right maxilla. Lesions were both approximately 40 mm in length (rostral-caudal). More severe damage occurred on the left maxilla than the right. The sites of lesion on the skull show evidence of bone remodelling (Figure 9).

Discussion

Malformation and a low angle of tusk eruption in male *Mesoplodon* whales has been previously reported in the literature. Moore (1960) and Varona (1970) reported tusks that raised the upper lips or fitted into depressions on the sides of the upper lips in male Gervais' beaked whales (*Mesoplodon europaeus*). Severe trauma to the soft tissue of the upper lips (resulting in haemorrhagic lesions) was reported in an adult male *M. bidens* stranded in the Canary Islands (Martín et al., 2011), although no osteological lesions were reported in the specimen.

This appears to be the first record of osteological lesions caused by this kind of dental anomaly in Sowerby's beaked whale. The dimensions of the anomalous teeth were highly similar to those reported for the male *M. bidens* stranded case in the Canary Islands with reported haemorrhagic lesions of the soft tissue (Martín et al., 2011).

Sowerby's beaked whales catch their prey (primarily cephalopods) by suction feeding (Heyning & Mead, 1996), which is dependent on a normal healthy rostrum for successful foraging (Dinis et al., 2017). It is unknown if the converging tusks partially blocked the mouth, possibly interfering with prey capture, limiting prey size or ingestion rates.

For comparison, two subadult male *M. bidens* (total body lengths: 444 and 456 cm, respectively), stranded in East Lothian in 2020, had lateral blubber depths of 32 and 35 mm, respectively (G. Hantke, pers. obs.). These animals were fresh and in good condition when post-mortem examinations and blubber measurements were conducted. The blubber thickness (~28 mm) in the specimen with anomalous teeth was less than in these two subadult males in good condition given that blubber thickness is expected to be greater in adults than in subadults. This suggests that the male with malformed teeth may not have fed for some time, although the effects of decomposition may have also reduced blubber thickness.

The symmetrical nature of the curved tusks suggests a developmental abnormality wherein genetic and/or environmental factors influenced both teeth as they formed. This adult male Sowerby's beaked whale from the Moray Firth was too decomposed for a thorough post-mortem assessment, and it remains unknown if the animal died as a direct result of the physical trauma to the

rostrum (potentially affecting foraging success), although the inflammation and combined soft tissue and osteological damage would have been painful and would have increased the likelihood of infection.

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Literature Cited

- Arranz, P., de Soto, N. A., Madsen, P. T., Brito, A., Bordes, F., & Johnson, M. P. (2011). Following a foraging fish-finder: Diel habitat use of Blainville's beaked whales revealed by echolocation. *PLOS ONE*, 6(12), e28353. <https://doi.org/10.1371/journal.pone.0028353>
- Baird, R. W., Webster, D. L., McSweeney, D. J., Ligon, A. D., Schorr, G. S., & Barlow, J. (2006). Diving behaviour of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales in Hawai'i. *Canadian Journal of Zoology*, 84(8), 1120-1128. <https://doi.org/10.1139/z06-095>
- Berrow, S., Meade, R., Marrinan, M., McKeogh, E., & O'Brien, J. (2018). First confirmed sighting of Sowerby's beaked whale (*Mesoplodon bidens* [Sowerby, 1804]) with calves in the Northeast Atlantic. *Marine Biodiversity Records*, 11(1), 2-5. <https://doi.org/10.1186/s41200-018-0154-1>
- Brownlow, A. (2011). *Annual final report: 1 April 2008 to 31 March 2011 for Marine Scotland, Scottish Government*. Scottish Marine Animal Stranding Scheme.
- Brownlow, A., & Davison, N. (2013). *Annual report: 1 January to 31 December 2013 for Marine Scotland, Scottish Government*. Scottish Marine Animal Stranding Scheme.
- Brownlow, A., Davison, N., & ten Doeschate, M. (2014). *Annual report: 1 January to 31 December 2014 for Marine Scotland, Scottish Government*. Scottish Marine Animal Stranding Scheme.
- Brownlow, A., Davison, N., & ten Doeschate, M. (2015a). *Final report: 1 April 2012 to 31 March 2015 for Marine Scotland, Scottish Government*. Scottish Marine Animal Stranding Scheme.
- Brownlow, A., Davison, N., & ten Doeschate, M. (2015b). *Annual report: 1 January to 31 December 2015 for Marine Scotland, Scottish Government*. Scottish Marine Animal Stranding Scheme.
- Brownlow, A., Davison, N., & ten Doeschate, M. (2016). *Annual report: 1 January to 31 December 2016 for Marine Scotland, Scottish Government*. Scottish Marine Animal Stranding Scheme.
- Brownlow, A., Davison, N., & ten Doeschate, M. (2017). *Annual report: 1 January to 31 December 2017 for*

- Marine Scotland, Scottish Government. Scottish Marine Animal Stranding Scheme.
- Brownlow, A., Davison, N., & ten Doeschate, M. (2018a). *Final report: 1 April 2015 to 31 March 2018 for Marine Scotland, Scottish Government*. Scottish Marine Animal Stranding Scheme.
- Brownlow, A., Davison, N., & ten Doeschate, M. (2018b). *Annual report: 1 January to 31 December 2018 for Marine Scotland, Scottish Government*. Scottish Marine Animal Stranding Scheme.
- Carlström, J., Denking, J., Feddersen, P., & Øien, N. (1997). Record of a new northern range of Sowerby's beaked whale (*Mesoplodon bidens*). *Polar Biology*, 17(5), 459-461. <https://doi.org/10.1007/s003000050141>
- Davison, N., ten Doeschate, M., & Brownlow, A. (2019). *Annual report: 1 January to 31 December 2019 for Marine Scotland, Scottish Government*. Scottish Marine Animal Stranding Scheme.
- Dinis, A., Baird, R. W., Mahaffy, S. D., Martín, V., & Alves, F. (2017). Beaked whales with rostrum deformities: Implications for survival and reproduction. *Marine Mammal Science*, 33(3), 946-954. <https://doi.org/10.1111/mms.12406>
- Einfeldt, A. L., Paterson, I. G., & Feyrer, L. J. (2019). Complete mitochondrial genomes and phylogeny of two rare whale species: True's (*Mesoplodon mirus*: True 1913) and Sowerby's (*Mesoplodon bidens*: Sowerby 1804) beaked whales. *Mitochondrial DNA Part B*, 4(1), 275-276. <https://doi.org/10.1080/23802359.2018.1541719>
- Heyning, J. E., & Mead, J. G. (1996). Suction feeding in beaked whales: Morphological and observational evidence. *Natural History Museum of Los Angeles County Contributions in Science*, 464, 1-12.
- Hooker, S. K., & Baird, R. W. (1999). Observations of Sowerby's beaked whales, *Mesoplodon bidens*, in the Gully, Nova Scotia. *The Canadian Field-Naturalist*, 113(2), 273-277.
- Jefferson, T. A., Webber, M. A., & Pitman, R. L. (2015). *Marine mammals of the world: A comprehensive guide to their identification* (2nd ed.). Academic Press.
- MacLeod, C. D. (2018). Beaked whales, overview. In B. Würsig, J. G. M. Thewissen, & K. M. Kovacs (Eds.), *Encyclopedia of marine mammals* (3rd ed., pp. 80-83). Academic Press. <https://doi.org/10.1016/B978-0-12-804327-1.00062-5>
- Martín, V., Tejedor, M., Pérez-Gil, M., Dalebout, M. L., Arbelo, M., & Fernández, A. (2011). A Sowerby's beaked whale (*Mesoplodon bidens*) stranded in the Canary Islands: The most southern record in the eastern North Atlantic. *Aquatic Mammals*, 37(4), 512-519. <https://doi.org/10.1578/AM.37.4.2011.512>
- Mead, J. G. (1989). Beaked whales of the genus *Mesoplodon*. In S. H. Ridgway & R. J. Harrison (Eds.), *Handbook of marine mammals: Vol. 4. River dolphins and the larger toothed whales* (pp. 349-430). Academic Press.
- Moore, J. C. (1960). New records of the Gulf-Stream beaked whale, *Mesoplodon gervaisi*, and some taxonomic considerations. *American Museum Novitates* (No. 1993), 36 pp.
- Moore, J. C. (1966). Diagnoses and distribution of beaked whales of the genus *Mesoplodon* known from North American waters. In K. S. Norris (Ed.), *Whales, dolphins and porpoises* (pp. 32-61). University of California Press. <https://doi.org/10.1525/9780520321373-005>
- Ostrom, P. H., Lien, J., & Macko, S. A. (1993). Evaluation of the diet of Sowerby's beaked whale, *Mesoplodon bidens*, based on isotopic comparisons among northwestern Atlantic cetaceans. *Canadian Journal of Zoology*, 71(8), 858-861. <https://doi.org/10.1139/z93-110>
- Pereira, J. N., Neves, V. C., Prieto, R., Silva, M. A., Cascão, I., Oliveira, C., Cruz, M. J., Medeiros, J. V., Barreiros, J. P., Porteiro, F. M., & Clarke, D. (2011). Diet of mid-Atlantic Sowerby's beaked whales *Mesoplodon bidens*. *Deep Sea Research Part I: Oceanographic Research Papers*, 58(11), 1084-1090. <https://doi.org/10.1016/j.dsr.2011.08.004>
- Pitman, R. (2009). Mesoplodont whales (*Mesoplodon* spp.). In W. F. Perrin, B. Würsig, & J. G. M. Thewissen (Eds.), *Encyclopedia of marine mammals* (pp. 721-726). Academic Press. <https://doi.org/10.1016/B978-0-12-373553-9.00167-X>
- Reiner, F., Gonçalves, J. M., & Santos, R. S. (1993). Two new records of Ziphiidae (Cetacea) for the Azores with an updated checklist of cetacean species. *Life and Marine Sciences*, 11A, 113-118.
- Tyack, P. L., Johnson, M., Soto, N. A., Sturlese, A., & Madsen, P. T. (2006). Extreme diving of beaked whales. *Journal of Experimental Biology*, 209(21), 4238-4253. <https://doi.org/10.1242/jeb.02505>
- Varona, L. S. (1970). External morphology and cranial characters of an adult male *Mesoplodon europaeus* (Cetacea: Ziphiidae). *Poeyana, Serie A*, 69, 1-17.
- Waller, G. N. H. (2014). A review of nineteenth-century records of Sowerby's beaked whale (*Mesoplodon bidens*). *Archives of Natural History*, 41(2), 338-356. <https://doi.org/10.3366/anh.2014.0252>
- Wenzel, F. W., Polloni, P. T., Craddock, J. E., Gannon, D. P., Nicolas, J. R., Read, A. J., & Rosel, P. E. (2013). Food habits of Sowerby's beaked whales (*Mesoplodon bidens*) taken in the pelagic drift gillnet fishery of the western North Atlantic. *Fishery Bulletin*, 111(4), 381-389. <https://doi.org/10.7755/FB.111.4.7>
- Wojtek, B., Cermeño, P., & Norman, S. A. (2014). *Mesoplodon bidens strandings: A short review* (Reports of the IWC SC65b/SM02). International Whaling Commission.
- Yamada, T. K., Kitamura, S., Abe, S., Tajima, Y., Matsuda, A., Mead, J. G., & Matsushita, T. F. (2019). Description of a new species of beaked whale (*Berardius*) found in the North Pacific. *Scientific Reports*, 9(1), 1-14. <https://doi.org/10.1038/s41598-019-46703-w>