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Morphology and Histology of the Mysticete's Prostate and Its Implications in Male Fertility

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Abstract

The global whale population has dramatically declined in the past centuries due to anthropogenic abuse, whereas, climate change, ship strikes, entanglements, pollution, and water debris are currently making an enormous impact on the recovery of all whales on the planet.

The prostate is recognized as the only male accessory gland in odontocete cetaceans, and prostatic pathologies have been recently described as very common in these animals. But nothing is reported about the male accessory gland in any species of mysticete. Here, we describe the topography and histology of the prostate of two baleen whales: a fin whale (*Balaenoptera physalus*) and a Bryde's whale (*Balaenoptera edeni*) and conclude that in the mysticetes, the prostate displays the same general morphologic and histologic characteristics as in odontocetes.

The prostatic gland of the mysticete may be a target for many pathogens that wants to spread by a sexual transition to other animals and the offspring which may have great impact on reproductive capability for the individuals.

Keywords: Mysticete, whales, cetacean, prostate, fertility, reproduction, recovery.

In the past century, the global whale population has dramatically declined, mainly, due to anthropogenic abuse (IWC, 2006). These marine mammals were hunting for their oil and meat and this activity put the whales between the most endangered animals on the planet (Pershing et al., 2010; IWC, 2006). Fortunately, after the moratorium of whale-hunting in 1982 by the International Whaling Commission, in which their harassment was temporarily abolished, their number has been progressively increasing (IWC, 2006). However, hunting is not the only threat for these animals. Climate change, ship strikes, entanglements, pollution, and water debris make an enormous impact on all the whales on the planet (Puig-Lozano et al., 2018; Díaz-Delgado et al., 2018, Häussermann et. Al, 2017; Arbelo et al., 2013).

The mysticetes usually travel alone or in small groups and meet for mating in certain periods (Bryden, 1988). The gestation period is very long (Hunt et al., 2016; Bryden, 1988; Harrison, 1972) and mortality in the first period of life is high (Díaz-Delgado et al., 2018; Arbelo et al., 2013; Lambertsen, 1992). Due to their ecologic and seasonal reproductive strategies, it is of critical importance that individuals keep their fertility, as the mating opportunities in the ocean are concentrated in the breeding season, and intense male competition may occur (Tyack & Whitehead, 1983). Moreover, pregnancy failure (i.e. extended inter-calving intervals) of whales has been reported based on endocrinological investigation and, whereas maternal or fetal problems has been proposed to explain the reproductive failure (Hunt et al., 2016), the male fertility has been overlooked.

The prostate is recognized as the only male accessory gland in odontocete cetaceans (Suárez-Santana et al., 2019). Pathologies in this organ are very common in these animals, mainly due to parasitism by worms of the genus *Crassicauda* (Suárez-Santana et al., 2018). However, all the works reported in the literature are focused on the prostate of odontocetes, whereas the male accessory gland has not been studied in any species of mysticete. Here, we describe the topography and histology of the prostate of two baleen whales: a fin whale (*Balaenoptera physalus*) and a Bryde's whale (*Balaenoptera edeni*).

The two whales stranded alive on the coast of Fuerteventura (Canary Islands, Spain) in 2016 (Bryde's whale) and 2020 (fin whale) and died shortly after. A complete routinely standardized necropsy was performed within 24 hours after death, and the whole penis root was dissected for a detailed analysis focused on the prostate. Based on morphological and biometrical data, both animals were categorized as neonates (Kuiken & Hartmann, 1993).

In both animals, there were a focal poorly demarcated area of whitish glandular tissue in the penis root, surrounded by potent *ischiocavernosus* muscles and closely related with the proximal urethra. Histologically these glands were composed of lobules separated by trabeculae. The lobules contained acini with secretory epithelium that excreted PAS-positive and Alcian Blue positive material to the lumen. The material was canalized to collector ducts that communicate with the urethra. This glandular tissue was consistent with the prostate and no other male accessory glands were observed, despite microscopic evaluation of different sections of the penis

root.

The previous observations indicate that in the mysticetes, the prostate displays the same general morphologic and histologic characteristics as in odontocetes (Suárez-Santana et al., 2019). The two cases described in this article correspond with neonates, and the prostate of adult individuals is expected to have much greater development (Suárez-Santana et al., 2019). Attempts to locate the prostate were performed in other stranded adult individuals, but the large dimension of the bodies made more difficult the location of such a small organ in these giant animals. Even in the neonate, this organ may be difficult to locate because of its discrete size compared with other cetaceans, such as delphinids, in which the prostate is easily recognized even in the young animal (Suárez-Santana et al., 2019).

Crassicauda nematode has been described heavily parasitizing the prostate of many odontocetes species, and the lesions they cause may persist in time and impact male fertility (Suárez-Santana et al., 2018). *Crassicauda spp.* are well-documented parasites of the circulatory system and urinary tract of baleen whales (Lambertsen, 1992). Although *Crassicauda pacifica* is usually found in the urethra of these animals (Lambersten, 1985), prostatic infestation caused by this nematode has not been reported in mysticetes. Prostatic infection by several bacteria and viruses are also possible based on the current knowledge of the male genital tract pathologies in several mammalian species, including cetaceans (Suárez-Santana et al., 2018; Foster, 2017). The prostatic gland of the mysticete may be a target for many pathogens that wants to spread by a sexual transition to other animals and the offspring (Foster, 2017). Prostatic lesions tend to be chronic and relatively silent, but with great impact on reproductive capability for the individual (Foster, 2017; Yoo, 2010). Moreover, the venereal transmission of reproductive diseases due to prostatic infection (e.g., brucellosis) may impair the fertility of a whole group (Yoo, 2010). When dealing with endangered species, it is of crucial importance that the remaining individuals keep their reproductive capacities especially when conservation programs are in progress (Herrick, 2019; Ceballos et al., 2017).

This paper is the first description of the prostate in mysticetes. Further research needs to be done to detect and evaluate prostatic lesions in these animals, as prostatic pathologies may impair the reproduction capacity of the whales and therefore the recovery of the populations.

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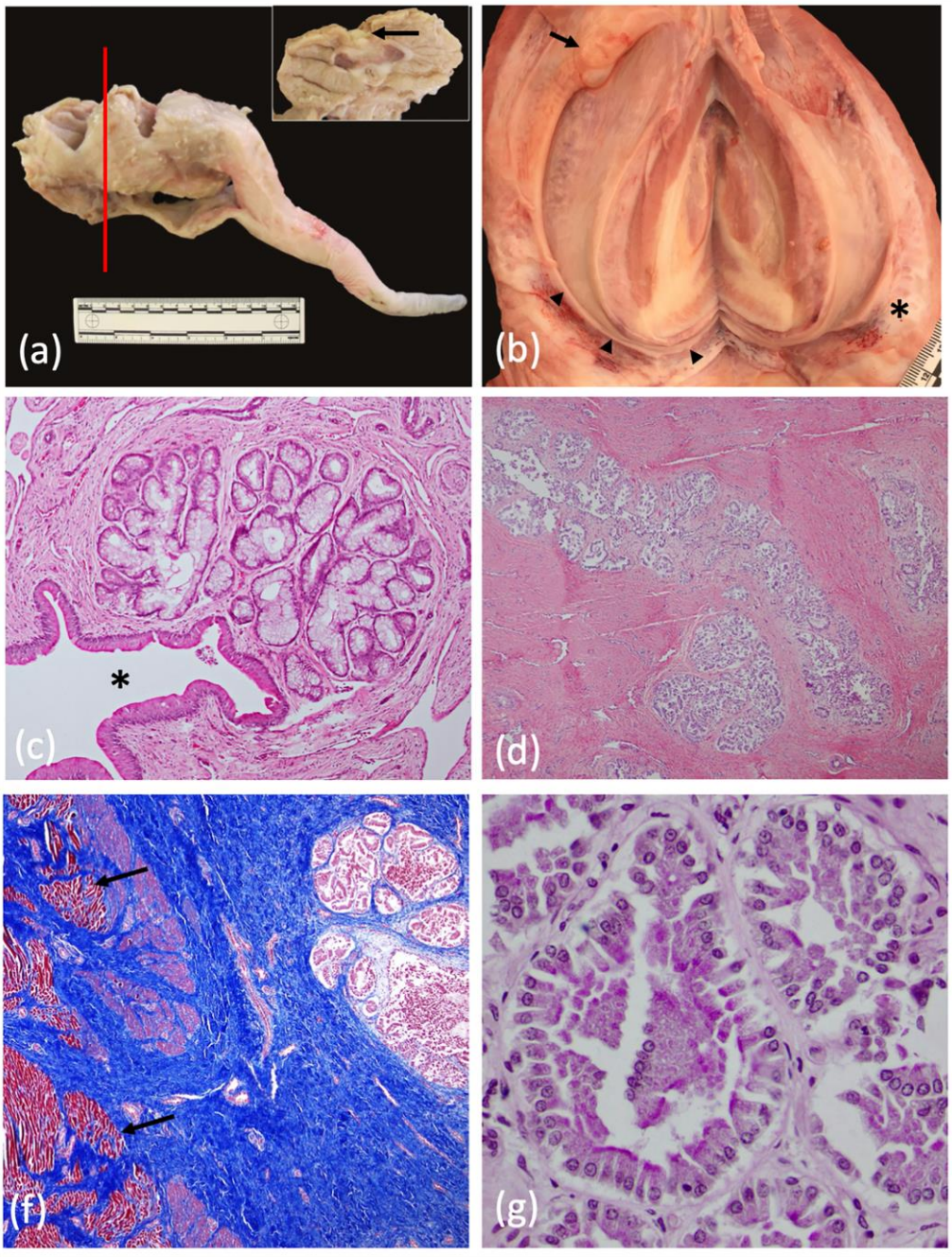

Figure 1.

Morphology and histology of the mysticete's prostate. (a) Penis root and penis of a Bryde's whale (*Balaenoptera edeni*). The prostate is located by approximately half of the penis root and supported by the well-developed muscles *ischiocavernosus*. Inset: Transversal cut of the penis root at the level of the red line. The prostate (arrow) is located dorsally to the penis *crura*. (b) Sagittal section of the penis root and urethra of a fin whale (*Balaenoptera physalus*). The prostate (asterisk) is a discrete glandular tissue located above the *crura* of the penis, and

surrounding the proximal urethra (arrowhead). The arrow points the *Colliculus seminalis*. (c) Histology of the prostate of a Bryde's whale. Numerous seromucous glandular acini are distributed surrounding the urethra (asterisk). H&E, 20x. (d-g) Histology of the prostate of a fin whale. (d) Prostatic lobules. H&E, 4x. (f) The prostate is externally covered by ischiocavernosus muscle and *muscle compressor prostatae* (arrows). Masson's trichrome, 4x. (g) Prostatic epithelium produces PAS-positive substance. PAS, 40x.

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