

First record of atypical pigmentation pattern in fin whale *Balaenoptera physalus* in the Atlantic Ocean

Running head: Atypical pigmentation in fin whale

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Abstract

Atypical pigmentation, which is rarely observed in the wild, may influence social interactions between animals and can be detrimental for survival. Hypopigmentation, which is the lack of pigment in a part or on the entire body, is a type of atypical pigmentation pattern that can be either acquired (e.g. vitiligo) or congenital resulting from the inheritance of mutations in pigment-related genes (e.g. albinism, leucism and piebaldism). This study documents atypical pigmentation in a fin whale (*Balaenoptera physalus*) along the northwestern coast of the Iberian Peninsula (Atlantic Ocean). Photographic and video data collected between 2016 and 2017 on 30 individual fin whales were examined. One fully-grown fin whale exhibited hypopigmentation. Several white patches of different shapes and sizes were present across the body of the fin whale including on the head, body, dorsal fin, flippers, and flukes. The position, shape, and lack of inflammation of the white patches on the whale observed, along with its body length and condition might indicate that the depigmentation pattern is due to vitiligo. To our knowledge, this is the first case of atypical pigmentation pattern in fin whales described with photographs and video records. As these observations are rare, especially in highly migratory, long-lived, marine mammal species, this study provides valuable information to better understand the occurrence of this phenomenon. Further studies are needed to determine the ecological and physiological implications of abnormal colourations, which might have a significant influence on the animal's survival.

Keywords

Hypopigmentation, vitiligo, fin whale, cetacean, Atlantic Ocean

1. INTRODUCTION

In the animal kingdom, pigmentation is controlled by a number of genes (Hearing & Tsukamoto 1991) and its biological function is crucial for protection from exposure to sunlight, social and sexual communication, and camouflage from predators (Pawelek & Körner 1982). In mammals, pigmentation is almost entirely dependent on melanin pigment synthesis and distribution in the

skin, hair, and eyes (Hearing & Tsukamoto 1991). The variation in pigmentation may vary with the age of the individual, the season, and the exposure to sunlight (Pawelek & Körner 1982). The range of colouration exhibited in mammals reflects the variation in the combination of eumelanin pigments, which are black or brown, and pheomelanin pigments, which are yellow or red (Quevedo 1969,

Slominski et al. 2004). The variety of hues pass from generation to generation with great precision (Pawelek & Körner 1982).

Variation in species typical colouration may influence social interactions between animals and can be detrimental for survival (i.e. loss of opportunities to engage in social behaviour and to attract mates for reproduction; increased intraspecific rejection; and increased vulnerability to predation due to lack of crypsis within the environment) (Pawelek & Körner 1982, Hubbard et al. 2010). Consequently, reporting the time and location of instances of abnormal colouration is valuable as these observations are rarely seen in the wild (Abreu et al. 2013).

Hypopigmentation, which is the lack of pigment in a part or on the entire body, is a type of atypical pigmentation pattern that can be either acquired (e.g. vitiligo) or congenital, resulting from the inheritance of mutations in pigment-related genes (e.g. albinism, leucism and piebaldism) (Slominski et al. 2004). Vitiligo is characterised by the development of depigmented patches on the skin where pigment-producing melanocytes of the epidermis have disappeared (Kemp et al. 2001); albinism is characterised by the complete lack of pigmentation in the skin, hair and eyes; leucism is characterised by reduced pigmentation of hair, but normally coloured skin and eyes; and piebaldism is characterised by the absence of pigment in localized parts of the body, resulting in irregular patches of light colour (Slominski et al. 2004, Acevedo et al. 2009).

Although scarce, hypopigmentation has been observed in several mammal species (Slominski et al. 2004). In marine mammals, while atypical colouration has been reported for several species

of cetaceans (reviewed in Hain & Leatherwood 1982, Fertl et al. 1999) and pinnipeds (e.g., Acevedo et al. 2009, Abreu et al. 2013), observations of pigmentation deficiencies are rare.

The fin whale (*Balaenoptera physalus*, Linnaeus 1758) is the only cetacean species and one of the few vertebrate species with consistent asymmetric body pigmentation. Colouration is dark on the left anterior third of the body and baleen, and white on the right lower jaw (including mouth cavity and front baleen plates) (Tershy & Wiley 1992). The right anterior third of the body is less heavily pigmented than the left side (Tershy & Wiley 1992). The occurrence of hypopigmentation in fin whale has only been confirmed for one individual in the Mediterranean Sea (Budker 1958 cited in Hain & Leatherwood 1982). Another two individuals have also been documented in the Antarctic but no information were provided to confirm the type of hypopigmentation deficiency (Budker 1958 cited in Hain & Leatherwood 1982, Ogord cited in Fertl et al. 1999). For all three cases, the date of observation and type of deficiency were not recorded, and no images were obtained.

In this study, we document, for the first time, atypical pigmentation in a fin whale observed in the Atlantic Ocean. To our knowledge, this is the first case of abnormal pigmentation pattern on a fin whale described with photographs and video records.

2. MATERIALS & METHODS

The current observation occurred along the continental shelf of the Galician coast (Northwest Spain) (Fig. 1). This region is at the northern boundary of one of the four major upwelling systems in the world, the North Atlantic Upwelling System. Several baleen whale species have been

recorded in these highly productive waters (Díaz López & Methion 2019).

Boat-based observation surveys were conducted from January 2016 to November 2017 by the Bottlenose Dolphin Research Institute BDRI (www.thebdri.com) as part of a longitudinal study on the ecology of cetacean species (Díaz López & Methion 2019). The study area was systematically monitored using a 12 m research vessel during daylight hours. At least three experienced observers, stationed on a flying bridge (situated at 4 m above the sea level), were scanning 360 degrees of the sea surface in search of fin whales (with the naked eye and 10x50 binoculars). Surveys were performed when the visibility was not reduced by rain or fog, sea conditions were up to 4 on the Beaufort wind force scale, and wave height were smaller than 1.5 m. Details on the data collection procedure can be found in Díaz López & Methion (2019).

Upon sighting of a fin whale (*Balaenoptera physalus*), the vessel slowly maneuvered towards the whale in order to minimise disturbance during the approach, allowing the fin whale to be monitored at close ranges (<50 m). The total body length of the fin whale was estimated by comparison to the vessel length when the whale was in close proximity (< 20 m). We recorded the date, initial and final time, location (latitude and longitude), and environmental data (depth, sea surface temperature, and sea surface salinity). Digital photographs and videos were taken using digital single lens reflex (DSLR) cameras equipped with 18- to 300- mm and 200- to 500- mm telephoto zoom lens for individual identification, body condition analyses, and identification of ectoparasites. The whale's behavioural activity was also monitored continuously by the three experienced researchers

stationed on the flying bridge. The atypical hypopigmented fin whale was observed on October 7, 2017 and followed continuously between 12:45 and 14:03 UTC. The respiratory pattern of the whale was recorded to the nearest second using a digital stopwatch for 33 minutes (from 13:19:45 to 13:52:38 UTC).

3. RESULTS

From January 2016 to November 2017, 32 daily boat surveys were spent in the field covering 2925 km. Throughout this period, 30 individual fin whales (*Balaenoptera physalus*) were observed during 27 sightings (Fig. 1).

On 7 October 2017, at 12:45 UTC, a solitary fin whale with white skin patches was observed at 42°17,8'N and 009°10,0'W, on the continental shelf at 25 km from the southern Galician coast (Fig. 1). The water depth, sea surface temperature, and sea surface salinity, were 144 m, 16.7 °C and 35 ppt, respectively.

The anomalously pigmented fin whale was a full grown, adult individual, with an estimated length of around 20 m. Several white patches of different shapes and sizes were present across the body of the fin whale including on the head, body (both sides), dorsal fin (both sides), dorsal side of both flippers, and dorsal side of both flukes (Fig. 2) (see Video S1 at www.int-res.com/articles/suppl/d135p121_supp/).

The presence of ectoparasites was observed on the trailing edge of the dorsal fin (around 40 *Xenobalanus globicipitis*) (Fig. 2e) and over the head (one *Penella balaenoptera*). A potential fishing line was apparent over the leading edge of the dorsal fin in one picture (Fig. 2e), but was not present in subsequent pictures of the same body region. In addition, a dorsal depression was

observed on both sides of the vertebral column (Fig. 2f).

On several occasions, the fin whale was observed partially opening the mouth and distending the throat pouches. Foraging behaviour was also supported by the duration of the dives and the observation of multiple euphausiid swarms surfacing in the area. Moreover, another fin whale and other marine species were also observed foraging in the same area including short-beaked common dolphins (*Delphinus delphis*), harbour porpoises (*Phocoena phocoena*), a leatherback sea turtle (*Dermochelys coriacea*), yellow legged-gulls, (*Larus michahellis*), northern gannets (*Morus bassanus*), European storm petrels (*Hydrobates pelagicus*), and Sabine's gulls (*Xema sabini*). In total, nine breaths were recorded between dives, with a mean dive interval of 226 ± 76 seconds (min=74, max=808).

4. DISCUSSION

Even though the fin whale (*Balaenoptera physalus*) is encountered in most water masses of the world and despite several decades of intensive whaling, marine research and whale-watching activities all over the world (Reilly et al. 2013), this is, to our knowledge, the first report of anomalous pigmentation in fin whale described with photographs and video records.

Abnormal melanin production can be caused by genetic or environmental factors (Slominski et al. 1989). As the whale exhibited multiple white patches on the dorsal side of the body, its pigmentation could be a result of either piebaldism or vitiligo, since the phenotype of both these conditions is characterized by partial hypopigmentation of the body (Spritz 2008, Thomas et al. 2004). Individuals affected by piebaldism are born with a predefined pattern of hypopigmentation

and, for several different species, individuals have a lower chance of reaching adulthood (Lucati & López-Baucells 2017). Vitiligo appears in early adulthood and is usually characterized by symmetrical, irregularly-shaped depigmented skin patches (lacking visible inflammation, unlike skin infections) often beginning at extremities and then spreading inwards (Kugelman & Lerner 1961). The aetiology of vitiligo is unknown, but could result from pathological autoimmune response against melanocytes or be caused by multifactorial inheritance (genetic, environmental, or neural factors) (Slominski et al. 1989).

Entanglement events with fishing gear can cause scarring in baleen whales. In such cases, individuals exhibit scars that show evidence of ropes or lines having wrapped around a given body part, often coupled with multiple line impressions, lacerations or even amputations (Cassoff et al. 2011). Fishing gear lesions are commonly found around the mouth, head, flippers, dorsal fin, peduncle or flukes (Cassoff et al. 2011). Although a potential fishing line is apparent over the dorsal fin in one of the pictures, the white patches present across the body (head, right and left side of the body, right and left side of the dorsal fin, dorsal side of both flippers, and dorsal side of both flukes) do not appear to be caused by fishing gear. The position, shape and lack of inflammation of the white patches on the whale observed, along with its body length might therefore indicate that the depigmentation pattern is due to vitiligo; however, the lack of tissue samples does not allow us to define surely the origin of the condition.

The colouration of mammals has functional significance for intraspecific communication, cryptism and prey acquisition (Hubbard et al. 2010, Caro et al. 2011). Therefore, abnormal colouration

could be detrimental for survival in multiple ways. For mammals, pigment anomalies can be associated with anaemia, reduced fertility, sensorial system defects and increased susceptibility to infections (Kugelman & Lerner 1961). Little is known about abnormal pigmentation in marine mammals. As colouration in cetaceans is believed to facilitate predation, abnormal colouration might affect foraging efficiency (Caro et al. 2011). Although fin whales do not have natural predators (except in areas of high concentration of killer whales) (Aguilar 2009), the atypical colouration of the observed individual could make it more conspicuous to predators (Hain & Leatherwood 1982). Additionally, this individual could have a higher risk of lower heat absorption (Abreu et al. 2013, Hain & Leatherwood 1982) and an increased susceptibility to UV radiation (Polanowski et al. 2012).

Visual assessment of body condition captures the general trends in overall health in mysticetes (Fearnbach et al. 2018). The observed prominent vertebral column and adjacent symmetric depressions might indicate poor health status or age of the individual (senile animals are usually thinner, Lockyer 1986). Nevertheless, behavioural observations confirmed that the whale was able to forage. Since the whale was observed at the end of the feeding season (Silva et al. 2013), the poor physical conditions of this individual in comparison to the other fin whales observed might not be explained by the seasonal migration. The body length (~20 m) coupled with the poor body conditions suggest that the fin whale observed was an adult (Aguilar 2009) and might possibly be a senile individual. The observed body condition (body length and poor physical conditions) reinforce that the depigmentation pattern might be due to vitiligo.

Further studies are required to investigate the impact of the colouration pattern on the fitness of anomalously pigmented mammals, to identify any significant influence. Over the past few years, the frequency of reported species exhibiting abnormal pigmentation has increased, due to the intensification of systematic and long term monitoring field studies (Abreu et al. 2013). Nevertheless, these observations are rare, especially in highly migratory, long-lived, marine mammal species. This type of study therefore provides valuable information to better understand the occurrence of this phenomenon.

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Fig 1 Study area (Galicia, Northwest Spain) showing the location of the encounter with the fin whale (*Balaenoptera physalus*) exhibiting hypopigmentation (star) and all the other fin whale encounters (circles)

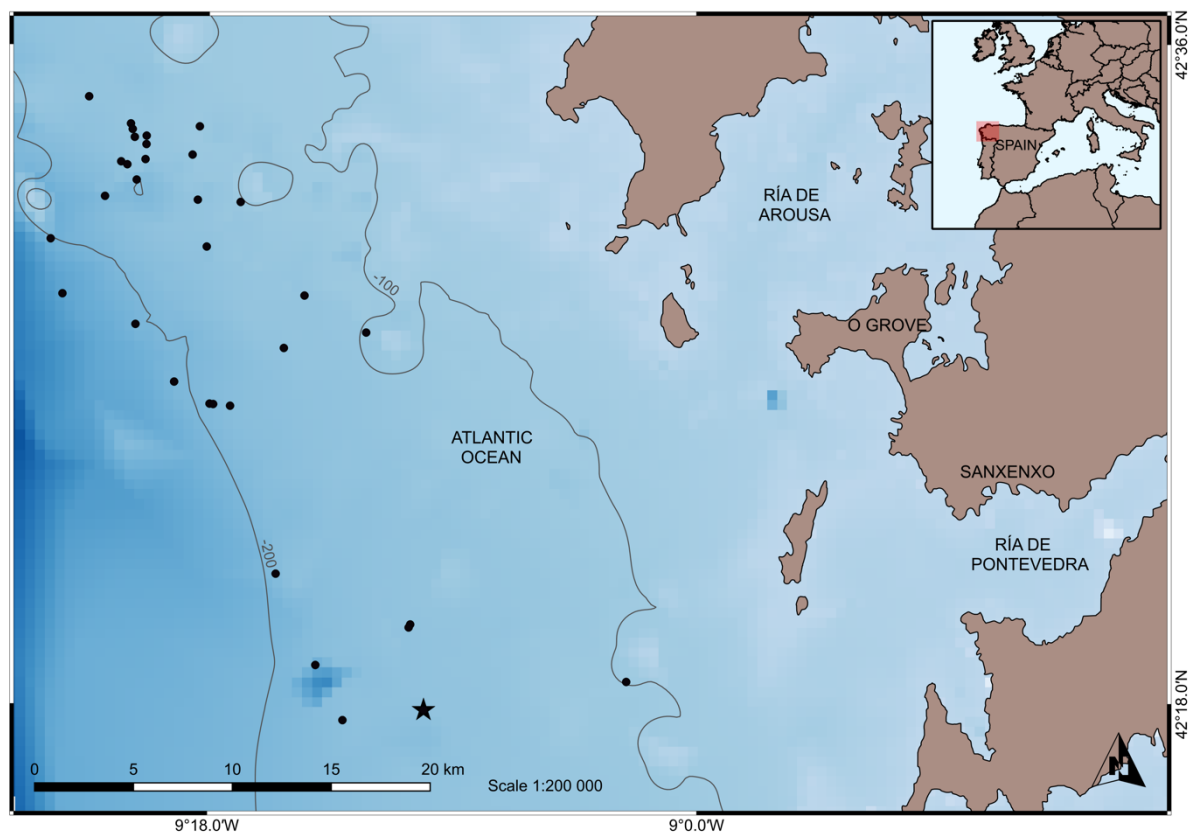


Fig 2 Fin whale *Balaenoptera physalus* with abnormal pigmentation. Views of (a) the head; (b) the blowhole and dorsal part of the body (right side); (c) the dorsal part of the body (right side); (d) the blowhole and dorsal part of the body (left side); (e) the dorsal fin; and f. dorsal view.

