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Abnormal skin pigmentation in sharks in the Eastern Atlantic: a case study from Maio Island, Cabo Verde

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RESUMO

A pigmentação anormal (hipomelanose) tem sido registada em diferentes grupos de animais e inclui o albinismo, o leucismo e o piebaldismo. Nos peixes cartilagosos, a coloração anormal é incomum em comparação com outros grupos animais, com relatos de apenas alguns casos em cerca de 60 espécies. Entre 2014 e 2019, foram registados três tubarões-enfermeiros *Ginglymostoma cirratum* com pigmentação anormal da pele em Cabo Verde, mais especificamente na ilha do Maio, dos quais dois foram registados na Baía da Praia Real (2015 e 2019, respectivamente). Este estudo apresenta os primeiros casos documentados de hipomelanose a nível nacional. Os três tubarões foram fotografados ou filmados apenas uma vez cada e a sobrevivência de nenhum dos três espécimes adultos parecia comprometida pela pigmentação anormal. Consideramos a Praia Real um local de amostragem com potencial para futuras investigações sobre pigmentação da pele em tubarões.

Palavras-chave: África, condríctios, conservação, doença genética, hipomelanose

ABSTRACT

Abnormal pigmentation (hypomelanosis) has been reported in different groups of animals, and it includes albinism, leucism and piebaldism. In chondrichthyan fishes, abnormal coloration is uncommon compared to other animal groups, with reports of only a few cases in circa 60 species. Between 2014 and 2019, three nurse sharks *Ginglymostoma cirratum* with abnormal skin pigmentation were recorded in Cabo Verde, more specifically in Maio Island, of which two were recorded in Praia Real Bay (2015 and 2019, respectively). This study presents the first documented cases of hypomelanosis at a national level. The three sharks were photographed or filmed only once each, and none of the three specimens seemed compromised by their colouration in terms of survival, having been observed as adults. We consider Praia Real as a potential sampling site for future research on the abnormal skin pigmentation conditions.

Keywords: Africa, chondrichthyans, conservation, genetic disorder, hypomelanosis

INTRODUCTION

Different types of abnormal colouration (hypomelanosis) have been documented in several shark species, as a result of genetically inherited genes or disorders (Quigley *et al.* 2018, Shipley *et al.* 2023). Albinism, a genetically inherited condition, is expressed as the complete lack of integumentary and retinal pigmentation, in which the individual shows no dark body pigments, including in the eyes (Clark 2002). Leucism is a genetic disorder in which a specimen has reduced or absent pigmentation, but the body extremities and eyes remain pigmented (Bechtel 1995, Clark 2002, Ramos-Luna *et al.* 2022). Finally, piebaldism is a rare autosomal dominant disorder where there is a partial loss of body pigmentation, but with regular coloration of eyes, typically characterized as variable patches of depigmentation (Fertl & Rosel 2009, Leroux *et al.* 2022, Shipley *et al.* 2023). The lack of pigmentation is often associated with health deficiencies, malformations, behavioural changes, and low survival rate (Kehas *et al.* 2005, Krecsák 2008, Slavik *et al.* 2015 & 2016, Perrault & Coppenrath 2019), although it is not clear if this is the case for all the species (Corn 1986). Even though these conditions in the wild are rare, abnormal pigmentation has been documented in animals around the world, including in fish (Protas *et al.* 2006, Beirl *et al.* 2014, Li *et al.* 2017).

In chondrichthyans (a group consisting of sharks, rays, skates and chimaeras) these events seem to be even rarer (circa 5% in all species), having been documented in 61 species of this group (e.g., Clark 2002, Bottaro *et al.* 2008, Veena *et al.* 2011, Quigley *et al.* 2018, Arronte *et al.* 2022). In Cabo Verde, as far as we know, there are no published reports of such events in chondrichthyans.

Praia Real Bay on Maio Island, Cabo Verde, seems to be particularly important as a mating and nursery ground for nurse sharks *Ginglymostoma cirratum*, but also for species such as lemon sharks *Negaprion brevirostris*, supported by the local observations of neonates in the area and mating events (Ratão unpub. data). The nurse shark is a large (>2.5–3 m) coastal shark, found in tropical and subtropical waters and is plain brownish coloured with dark spots in their young (Compagno 1984). It is a common shark in Cabo Verde and is still relatively abundant on Maio (Ratão unpub. data, Lopes *et al.* 2016). Regardless of being reported as the most abundant shark species in coastal shallow waters (Castro 2000, Hazin *et al.* 2000, Castro & Rosa 2005, Heithaus *et al.* 2007, Karl *et al.* 2011), it is classified as vulnerable by the IUCN Red List (Carlson *et al.* 2021).

Shark skin depigmentation is a relatively understudied topic compared to other aspects

of their biology, resulting in unclear understanding of the causes leading to abnormal pigmentation in chondrichthyans. Therefore, this study aimed to report cases of

hypomelanosis in sharks observed during shark monitoring in Praia Real Bay, Cabo Verde, and to propose it as a potential sampling area for further investigations in this field.

MATERIAL AND METHODS

The environmental non-governmental organization (NGO) Maio Biodiversity Foundation (FMB) has been monitoring sharks at Praia Real Bay, inserted within the Natural Park, located in the north of Maio Island, south-east of the Cabo Verde Archipelago (Fig. 1), since 2014. Praia Real is a small (1.6 x 1.7 km), shallow (4–7 m deep at the centre)

bay, characterized mainly by a mixed substrate of algae, corals and rocks, with some sandy patches. In this area is possible to regularly observe several shark species, such as nurse sharks *Ginglymostoma cirratum*, tiger sharks *Galeocerdo cuvier*, and lemon sharks *Negaprion brevirostris* (Ratão unpub. data).



Fig. 1. Location of the study area and the study site. **A)** Location of the study area, Maio Island, in the Cabo Verde Archipelago, next to West Africa. **B)** Location of the study site on Maio Island. **C)** Detailed map of the study site, Praia Real Bay at the north, one of the no-take zones of the Natural Park of the North of Maio Island.

To monitor, a minimum of two snorkellers swam next to each other, and run one single transect parallel to the north facing coastline approximately in the centre of the bay between its northern and southern extremities. One snorkeller recorded in a dive slate the transect start and end time, the start and end geographical positions (geographic coordinates marked through the GPS receiver) and the environmental conditions, namely: wind direction, visibility in the water (use of Secchi disk at the beginning, middle and end of the transect), sea state, and swell. This snorkeller also recorded all sharks encountered (start and end time of the sighting, the

geographical coordinates (decimal degrees), the number of individuals (N), the total length of each individual (m), the depth (m), the behaviour, and the type of substrate (rock, stone, mixed, etc.). The second snorkeller kept vigilant on the surroundings and supported the colleague when needed. The snorkellers filmed the observed sharks with either a GoPro 3 action camera or an Olympus Tough TG-4 camera. These surveys run with different frequencies throughout the years due to changes in monitoring plans, staffing, and funding availability (once a week, once a month, or twice a month) between 2014 and 2019, and each lasted circa 1 hour.

RESULTS

The first two nurse sharks *Ginglymostoma cirratum* with hypomelanosis were seen outside the transect line, before starting the transect at Praia Real. The first nurse shark observed with colour aberrations in Praia Real was on 10th July 2015 (Fig. 2). This individual was estimated to have 1.5–2.0 m of the total length. It was swimming at knee-high water depths with several other “normal looking” nurse sharks during mating season. This individual was not seen again since. On 9th July 2019, another nurse shark with clear hypomelanosis was also observed in Praia Real. This shark was estimated to be around 2 m long, with similar skin colour pigmentation

to the previous, although the white patches were mainly in the head (Fig. 3). As an example, part of the footage of the first record was deposited in Figshare repository (<https://figshare.com/s/8b00fea5d9110227b5d2>). Finally, a third record of an adult nurse shark with skin depigmentation was caught on Maio Island by a sport fishing company (Maio Fishing Club), however, the date (likely caught between 2019 and 2020) and the location are uncertain (Maio Fishing Club 2023a, 2023b). The distinctive white patch patterns in all three sharks indicate that they are different individuals.



Fig. 2. A nurse shark with patchy depigmentation along its body, observed in Praia Real Bay, Maio Island, Cabo Verde, on 10th July 2015 (photos by FMB).



Fig. 3. A nurse shark exhibiting white patches on its head, observed in Praia Real Bay, Maio Island, Cabo Verde, on 9th July 2019 (photos by FMB).

DISCUSSION

This is the first time that abnormal pigmentation in sharks is reported in Cabo Verde. Neither specimen seemed compromised by their colouration in terms of survival, as they had all grown to adult-size sharks and showed typical swimming behaviour at the time when they were observed. Both nurse sharks seen in Praia Real, and the individual caught by the sport fishing company were predominantly brown, with obvious small white patches on the body or head. They resembled a nurse shark with abnormal pigmentation observed in São Tomé (Porriños 2020), indicating a possible case of piebaldism or leucism. The third observation although it is from an unknown location on Maio Island, further supports the idea of Maio being a good place to study abnormal pigmentation conditions in sharks. The distinct shapes and distribution of the white patches on the bodies of all three individual sharks imply that they were all different individuals, providing

additional evidence for considering this location as a promising sampling area.

Globally, five other reports of abnormal pigmentation in similar species were reported, namely: i) a dead adult tawny nurse shark *Nebrius ferrugineus* caught on a net off Ugui, Wakayama Prefecture, Japan in 1986 (Taniuchi & Yanagisawa 1987), ii) a live Atlantic nurse shark *Ginglymostoma cirratum* caught on a fishing line off Captiva Pass, Florida, USA in 2014 (NBC2 News 2014), iii) an individual *G. cirratum* observed swimming off Grand Turk at Turks and Caicos Islands in 2016 (Keartes 2016), iv) another *G. cirratum* recorded swimming past a Baited Remoted Underwater Video Station (BRUVs) in São Tomé and Príncipe (Porriños 2020), and v) a single female *G. cirratum* observed by divers at Utila, Honduras (Shipley *et al.* 2023).

Given that these and other studies have found colour aberrations in elasmobranchs of adult size could indicate that this condition does

not necessarily impact growth or lead to a lower survival rate (Taniuchi & Yanagisawa 1987, Bigman *et al.* 2016, Shipley *et al.* 2023). The causes leading to abnormal pigmentation in chondrichthyans are still unclear. It is known that genetic alterations in melanin production cause it, however, there are other factors such as inbreeding within isolated populations, environmental stress associated with areas of high human activity, exposure to elevated temperatures, interspecific hybridization, hormonal imbalance or diet might play a role too (Gervais *et al.* 2016, Quigley *et al.* 2017,

Bruckner & Coward 2018).

Given that two distinct nurse sharks were observed within four years in a small bay where this species is abundant, we propose Praia Real as a valuable main sampling site for future research on abnormal pigmentation conditions and recommend collecting tissue samples to accurately identify and assess the condition. By investigating it, we can gain insights into the potential vulnerabilities or disadvantages they may pose to chondrichthyans, as well as to the local nurse shark population.

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