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Short Note

Leucistic Weddell seal (*Leptonychotes weddellii*) observations in Erebus Bay, Antarctica

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Abstract

Pigmentation and colouration are important to animal fitness. Colourations convey important information and impact predation risk, thermoregulation and mate selection. There are many cases of hypopigmentation across the animal kingdom, and leucism is a common form. We observed a Weddell seal (*Leptonychotes weddellii*) pup with cream-coloured fur, light skin and white nails multiple times in 2022 in Erebus Bay, Antarctica. The pup was observed 1 year later as a generally healthy yearling. This is the first documentation of a leucistic seal within this well-studied population and the second documentation of such colouration in this species. This seal offers a potential opportunity to observe the effects of hypopigmentation in Antarctic true seals.

Keywords: Albinism; colour morph; discolouration; mutation; phocid; pinniped

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Pigmentation is important to animal fitness. Colourations help convey important information in both interspecific and intraspecific interactions and can impact predation risk, thermoregulation and mate selection (Fertl & Rosel 2002, Kratochwil & Mallarino 2023). The wide range of colours and patterns in animals is due to variation in the deposition of pigments in or from structural colours that interact with hair or feathers (Kratochwil & Mallarino 2023). Colouration and colour morphs are often genetically determined, and deviations from typical pigmentation can arise due to genetic mutations, diseases, diet or environmental conditions (van Grouw 2021). While the effects of such atypical colourations on an individual's fitness can be positive or negative, limited information on such fitness implications exists due to their rarity (Bried & Haubreux 2000, Fertl & Rosel 2002). Mutations in colour patterns may improve the population-level fitness as they can assist species in adapting to changing environments (Jones *et al.* 2018). Although most research suggests that such individuals have a higher predation risk, research by Chatellenaz & Zaracho (2021) suggests that individuals with atypical colourations may not have an increased risk of predation. Conversely, most research states that certain colour patterns may adversely affect an individual's lifespan and reproductive success, hindering fitness (Bried & Haubreux 2000, Fertl & Rosel 2002).

Colouration is thought to be important to the survival of marine mammals, as many such species utilize countershading, with lighter ventral colouration and darker dorsal colouration, which is thought to help reduce their being detected (Hain & Leatherwood 1982). The potential importance of countershading for survival may help explain why atypical colourations in marine mammals are relatively rare (Rowland 2022). Leucistic animals have reduced pigmentation caused by the hereditary absence of melanin-producing cells and frequently have white or light fur, skin or vibrissae but normal-coloured eyes (Acevedo *et al.* 2009a, van Grouw 2021). Leucism is frequently misclassified as albinism (van Grouw 2006). In contrast to leucism, albinism is a result of an inability to produce melanin, thus causing individuals to exhibit an anomalously white or light coat, pink skin and pink eyes. To classify the animal as albino, it must lack all pigmentation (Fertl & Rosel 2002, van Grouw 2021).

Documented observations of leucism in marine mammals are predominantly in cetacean species (e.g. whales, dolphins and porpoises) and infrequently in pinniped species (e.g. seals; Acevedo *et al.* 2009a,b). Most documented instances of leucistic pinnipeds have occurred in the Otariidae (eared seals) family, including a South American sea lion (*Arctocephalus australis* Zimmermann) in Chile (Acevedo & Aguayo 2008) and an Antarctic fur seal (*Arctocephalus gazella* Peters) on Marion Island, South Africa (De Bruyn *et al.* 2007). However, occurrences within Phocidae (true seals) remain relatively scarce, with only a handful of such observations having been published to date (Aguayo-Lobo *et al.* 1995, Bried & Haubreux 2000, Acevedo & Aguayo 2008, Bester *et al.* 2008, Reisinger *et al.* 2009, Romero & Tirira 2017, Jones *et al.* 2019).

Weddell seals are a true seal species found circum-Antarctica and a high-level predator in the ecosystem (LaRue *et al.* 2021). The usual colouration for adult Weddell seals is a darker grey or brown dorsal side, a lighter grey to white ventral side and light spots extending across the body. Like other marine mammals, this countershading helps camouflage Weddell seals in the water column (Hain & Leatherwood 1982). Pups are born covered in lanugo, a soft and long fur that is similar in colour to adult plumage and helps keep the pups warm in the cold Antarctic environment

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Figure 1. A pup with typical-coloured lanugo and its mother at rest on the ice. Photo credit: Morgan E. Anderson.

(Fig. 1; Ray & Smith 1968, Thomas & Terhune 2009). Shedding their lanugo at ~6 weeks of age, pups transition to their adult coat, featuring shorter, more structured hair (Thomas & Terhune 2009).

The largest population of Weddell seals is found in Erebus Bay, Antarctica (77.7°S, 166.5°E; Fig. 2) and has been the focus of intensive research through a long-term capture-mark-recapture project spanning over 50 years (Stirling 1969, Siniff *et al.* 1977, Cameron & Siniff 2004, Hadley *et al.* 2006, Rotella 2023). During each field season from October to December, hundreds of adults and pups are observed daily as part of the tagging work associated with the long-term project, and since 1982 every single pup in the study area has been tagged with a uniquely identifiable plastic livestock tag (various makes and models). Over 29 000 seals have been tagged throughout the history of this project, and thousands more have been observed but not tagged. This Short Note documents the first observation of a leucistic animal in this population.

During the 2022 field season, a female leucistic Weddell seal pup (unique identifying number: 28324) was documented in Erebus Bay, Antarctica. The leucistic pup was born with cream-coloured lanugo, white nails and pink skin; however, her pupils were pigmented (Fig. 3a). Her coat colour was visibly lighter than that of other pups both while on the ice and while swimming (Supplemental Video 1). She was first documented at Hutton Cliffs, one of the largest colonies in Erebus Bay (Fig. 2b), on 22 October 2022, when she was fewer than 2 days old. As part of the ongoing capture-mark-recapture project, she was tagged on 26 October 2022. She was regularly seen and photographed (Fig. 3) throughout the season, with the final recorded observation occurring on 28 November 2022, when she was seen alone on the sea ice. She was denoted as a generally healthy-looking pup who displayed typical behaviours for a pup of her age, including nursing, steadily gaining weight and swimming with her mother (Petch *et al.* 2023). As the pup got older and began to shed her lanugo, she grew in a darker-coloured coat, similar in colouration to that of a typical adult Weddell seal; however, her skin, nails and vibrissae showed no signs of darkening (Fig. 3c). Her mother (unique identifying number: 21607) was 10 years old, had typical coat colouration and had given birth to four previous pups. None of the previous pups were observed with leucistic traits.

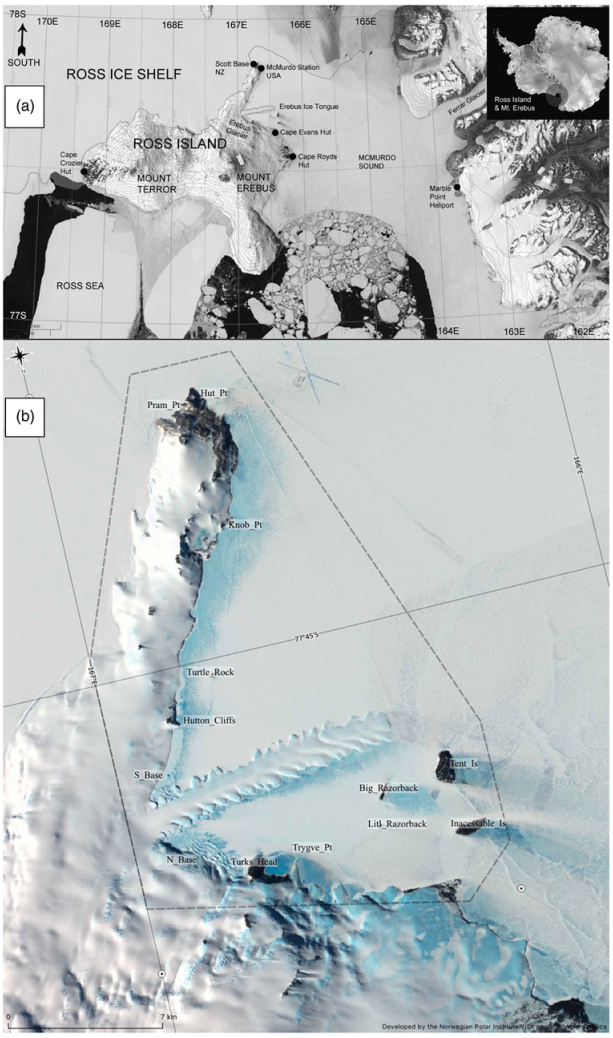

Figure 2. a. Erebus Bay study area location relative to **b.** Antarctic continent study area boundary (dashed line) and major pupping colonies. Hutton Cliffs, located along the peninsula, is where the pup described in this paper was born and resided for the entirety of our study period. It is one of the biggest colonies in the study area. Turtle Rock, located north of Hutton Cliffs, is the location of her re-sighting.

During the subsequent field season, the leucistic female was spotted and recorded on 23 October 2023 as a yearling ~1 km from where she was born in 2022. Her coat appeared noticeably paler, and her white whiskers and pink eye rings persisted (Fig. 4). She was observed to be healthy and inquisitive. She was last observed on 14 November 2023 during a census of the study area, ~5 km west of the Turtle Rock colony (Fig. 2b) and closer to the open ocean. On this observation, the leucistic female had some small lacerations, probably from intraspecies fighting that occurs within the colonies (Smith 1966). Weddell seals have just under a 50% chance of surviving the first year of life and are typically not re-sighted in the Erebus Bay study area until at least 4 years old (Hastings *et al.* 1999, Stauffer *et al.* 2013). Given the moderate survival and re-sight probabilities for juveniles with normal pelage, it is notable that we observed this leucistic individual as a yearling in 2023.

Based on the observed characteristics (e.g. notably lighter fur but pigmented eyes), it is highly probable that the female is leucistic rather than an albino. Her light pigmentation was present within the first 48 hours of her life and has remained with her for over

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Figure 3. a. A leucistic female Weddell seal pup and her mother at the Hutton Cliffs colony in Erebus Bay, Antarctica. Note the light skin, lanugo, whiskers and nails. Photo credit: John Hobgood. **b.** Leucistic female pup on 18 November 2022 with her extremely light lanugo coat at ~3 weeks of age. Photo credit: Parker M. Levinson. **c.** Leucistic female at ~1 month of age on 27 November 2022, having shed her lanugo to reveal a darker-coloured coat. Note the pink eye rings and light whiskers. Photo credit: Parker M. Levinson.

Figure 4. Leucistic yearling female near Turtle Rock on 23 October 2023. Note the pink eye rings, pale coat colour and white whiskers. Photo credit: Parker M. Levinson.

1 year, making it probable that this was not a result of diet. Additionally, no other seals in the vicinity or in the history of the study have been documented with this colouration, suggesting that the colouration was not a result of environmental causes. As such, we are reasonably confident that her light colouration is a result of a genetic mutation causing leucism, and, based on her pigmented eyes, it is improbable that she has albinism. More extensive genetic or physiological testing would be required for this to be confirmed.

This sighting marks the first documented instance of leucism in the Erebus Bay Weddell seal population. Although it is possible that other occurrences of leucism and albinism might have gone unrecorded, the intensive nature (visits to each pupping colony typically occur every 2–3 days and all pups are approached within 1–15 m on each visit) of the multi-decadal population study makes such oversights improbable (Rotella 2023). Prior documentation of leucism in Weddell seals is limited to a single juvenile seal found on Livingston Island, Antarctica (Acevedo *et al.* 2009a). Because both leucistic Weddell seals were observed as subadults, it is unknown whether whatever causes leucism in Weddell seals only impacts juveniles or persists into adulthood. However, given the pink pigmentation of her eye rings, it appears that this seal's skin is also impacted by this mutation, and she will probably carry some, if not all, of the leucistic traits with her throughout her life.

Due to the infrequency of observations, there has been little research on the fitness cost of leucism in marine mammals. Leucism could be a rare and deleterious mutation that drastically decreases an individual's fitness so that few, if any, survive to adulthood. It is possible that these individuals are more susceptible to predation due to increased visibility (Acevedo & Aguayo 2008). Negative impacts could also involve reduced viability due to sensory or nervous system defects, low fertility, increased susceptibility to disease, a decrease in heat absorption and a decrease in ultraviolet protection (Hain & Leatherwood 1982,

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Fertl & Rosel 2002, Acevedo & Aguayo 2008). As such, it is probable that there could be a fitness cost for this individual due to her pelage colour, and researchers will continue to keep watch for her in future years, which may aid in answering some questions about how leucism affects an individual's fitness.

However, genetic mutations are important for evolution and population persistence because rare phenotypes can hold some fitness benefit in rapidly changing environments (Acevedo & Aguayo 2008, Jones *et al.* 2018). Additionally, these colour mutations may be associated with different genes that control traits other than pigmentation, increasing an individual's fitness in other ways (Brazill-Boast *et al.* 2013, Lehnert *et al.* 2018). Documentation of mature individuals with leucism shows that leucistic individuals can reach adulthood and potentially pass on their genes (Hain & Leatherwood 1982, Fertl *et al.* 1999, Acevedo *et al.* 2009a, Romero & Tirira 2017, Grebieniow *et al.* 2020). As such, despite the potential for decreased fitness of leucistic individuals, the mutation may hold some evolutionary benefit to the population in the rapidly changing Antarctic environment (Convey *et al.* 2009). Without having a large sample size or genetic samples, it is impossible to determine any answers to these questions, but such a mutation does pose interesting evolutionary possibilities.

Supplementary material. To view supplementary material for this article, please visit http://doi.org/10.1017/S095410202500001X.

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Author contributions. All authors contributed to data collection and fieldwork. MEA and PML contributed to the writing of the paper, with crucial editing and review conducted by PML and JJR.

Data availability statement. The capture-mark-recapture database for the Erebus Bay Weddell seal population can be found on the US Antarctica Data Center website (https://www.usap-dc.org/; filed under 'Rotella') and includes unique Weddell seal identifying numbers, seal ages and the number of pups produced by each female seal. The database through 2017 is available at https://www.usap-dc.org/view/dataset/601125, and up-to-date databases are published on the US Antarctica Data Center website every 5–7 years. If data are required in the interim, they can be obtained from Dr Jay Rotella (rotella@montana.edu).

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