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SHORT COMMUNICATION

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Striping patterns may not influence social interactions and mating in zebra: Observations from melanic zebra in South Africa

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1 | INTRODUCTION

Colouration serves many functions in animals including crypsis, aposematism, mimicry, intraspecific communication, communication between species and thermoregulation (Caro, Caswell Stoddard, & Stuard-Fox, 2017). On occasions, abnormalities or discontinuous variations in colouration and/or patterning of an individual within a population can occur, leading to albinism (Osinga, 't Hart, & Vader, 2010), leucism (Reisinger, Mufanadzo, de Bruyn, & Bester, 2009) or melanism (Eizirik et al., 2003; Majerus, 1998). Melanism, a rare condition occurring when a group of pigments (pheomelanin or eumelanin) is overproduced, has been reported in a variety of mammal species.

Zebra (*Equus spp.*) are widely distributed in southern Africa in a variety of ecosystems with two species found in South Africa: the plains zebra (*Equus quagga*) and the Cape mountain zebra (*Equus zebra*) (Caro, 2005; Marais, Nel, Bertschinger, Schoeman, & Zimmerman, 2007). These animals have distinctive white and black striping patterns which can vary regionally from heavy black and white striping over the entire body to areas of reduced stripe coverage with thinner and lighter stripes (Rubenstein, 2011). Pigmentation decisions occur at around 3–5 weeks of development, while the hairs that show the pattern do not grow until about 6 months (Bard, 1981). Many hypotheses exist to explain striping in zebra; including camouflage against predators, disrupting predatory attacks, thermoregulation, social cohesion and avoidance of ectoparasite attacks from biting flies and other insects (Blaho et al., 2012, 2013; Caro, 2016; Egri et al., 2012; Horvath et al., 2010; Larison et al., 2015; Melin, Kline, Hiramatsu, & Caro, 2016; Ruxton, 2002).

This manuscript describes two cases of melanic plains zebra observed inside the Mkambati Nature Reserve in the Eastern Cape Province of South Africa. This reserve of 7,736 ha is managed by the Eastern Cape and Tourism Agency (ECPTA) and is located approximately 25 km south of the coastal town of Port Edward (KwaZulu-Natal). Zebra were introduced in the reserve in 1979, along with several other ungulate species. At that time of introduction, no large predators were present and none are present today (De Villiers & Costello, 2006).

During two field excursions (3 June 2015–24 June 2015 and 20 November 2016–7 December 2016), opportunistic photographs of melanic zebra were taken from as close to the animal as possible (approximately 20 m) and from both sides. The number of animals in each melanic zebra's group, defined as all animals within 100 m of each other, was also noted and photographed for later identification. In 2016, observations were taken at least every 2 days, when animals were within viewable range.

To quantify the colouration patterns, the amount of black/saturated area and percentage of striped areas were visually estimated for different parts of the body (head and neck, flank, rump and legs) to the nearest 5% or 10% depending on photograph quality. The intensity of the black colouration was scored as "light" (<30%), "medium" (30%–60%) or "dark" (>60%). Where there was striping, the number of stripes was counted and the shape of the stripes was described.

2 | EXAMPLE 1: ZEBRA A

The first melanic zebra (Zebra A) was observed in June 2015 and was re-sighted in November 2016. This specimen was an adult female and was pregnant in both years (Figure 1d), with a

distended stomach, as seen in striped zebra. The female was observed grazing in a herd of six other adult zebra in 2015 and eight animals in 2016 (Figure 1a–d). Zebra A was in close proximity (<5 m) of other animals during 100% of observations, engaged in the same behaviour as striped zebra. There was no obvious rejection or exclusion of Zebra A from the group, as she interacted in the same way as all other zebra in the group during all observations. Zebra A had few stripes and dark saturation of colour. The colouration pattern for the head and neck area was mostly black (>95%), without any stripes. One large brownish spot was observed above the nostrils, and some white areas were observed around the eyes and on the ears, especially the left ear; however, these were minimal (<5%). Similarly, the flank was mostly black with fewer than five white spots on both sides. The rump, from the groin to the end of the body stopping at the leg joint, however, was considerably whiter, with two black stripes, one wide and one thin. The top of the rump was mostly black. The legs were white and black spotted, with back legs being mostly white (approximately 60%–70%) and front legs more black (approximately 50% each). The belly and chest were mainly white, not striped, with few small black spots (approximately 25% black spots), and the side of the belly and upper chest was mostly black (>90%). The black colour on this animal was classified as "dark" throughout the body, with areas of "medium" colouration on the top of the legs and lower rump.

3 | EXAMPLE 2: ZEBRA B

In November 2016, one juvenile melanic individual, Zebra B, was observed. This animal was seen in a group of 18 animals, grazing within 5 m of other zebras in the group. There was no obvious rejection or exclusion of Zebra B from the group, as it interacted in the same way as all other zebra in the group during all observations. Zebra B had more stripes than Zebra A, but with grey areas and limited vibrant white. On the neck, there were 12 visible black stripes with the remaining area being "light" black (approximately 50% of the head and neck). In addition, more stripes were observed on the melanic form than on other zebra in the group, with white areas having grey hues. The face was greyish with no visible striping. The flank had numerous (>15) very thin black stripes ~~and~~ close together, making it difficult to identify each separately, with large areas of "medium" black colouration in between. The rump had more defined "dark" black stripes (5), with areas in between a grey colour, becoming white closer to the leg. On the legs, there was little colouration, being mostly white with 1–2 poorly defined black stripes on the front legs. The belly was mostly black in a "medium" tone with some white spots on the chest area. Overall, the striping was closely spaced, with poorly defined individual stripes, and less vibrant white colour than in normal zebra. Finally, in 2016, Zebra A and Zebra B's groups were reported within 200 m of each other, performing the same behaviour, which suggests they formed a single group comprising 26 animals.

Despite melanism, these two zebra appeared well integrated into groups feeding within 5 m from neighbouring animals during all of our observations, and Zebra A was mating without resistance with other individuals. These observations do not support previous hypotheses that melanism in zebra would reduce social interactions and causes a drop in fitness, which could suggest that striping pattern serves other functions more strongly than a social function. Instances of abnormal colouration (i.e. melanism, albinism or leucism) are rarely seen in wild populations as individuals are thought more likely to succumb to predation early in life (Acevedo & Aguayo, 2008; Marin-Vasquez, Ortega-Rincon, & Ramirez-Chaves, 2010), making research into these abnormal colourations difficult with low sample sizes. In the absence of any large predators within the reserve, this selection pressure for enhanced cohesion is absent, providing a unique situation with two abnormal animals in a relatively small geographic area.

Disorders in colouration and/or patterning have previously been described in zebra at other locations within its biogeographical range, including Namibia, South Africa, Rwanda and Zimbabwe (Monfort, 1977), but reports are rare in the scientific literature. One leucistic zebra, born in 2008, was observed in a private game reserve in South Africa. In this case, the animal showed noticeably lighter stripes than the other zebra and was also observed in a herd of adult zebra (Kingdon, 1984). Zebra can also show broken or distorted stripes and blotches, which may lead to a spotted coat pattern rather than a striped pattern (Caro, 2016) as observed in Zebra B.

According to Kingdon (1984), zebra with unusual coating patterns would not benefit from social interactions and would likely suffer a reduction in fitness. Distortions of typical colouration and/or patterning may result in an inability to attract mates, engage in social behaviours or in active rejection by conspecifics (Kingdon, 1984). Given that the two melanic zebra appeared to be socially integrated into herds, showing no differences in attractiveness or activity from normally coloured zebra, and with one (Zebra A) successfully mating in two consecutive years, we did not observe these effects in this reserve. Although no obvious rejection was occurring as animals appeared well integrated into herds, further research with extended periods of observation is needed to determine if more subtle rejection is occurring and to investigate the mechanisms of mate selection for this species.

The lack of normal colouration or patterning could increase exposure to predators because of ineffective camouflage or reduction in confusion associated with dazzle colouration, although there is no evidence of this in zebra (Caro, 2016; Stevens, Searle, Seymour, Marshall, & Ruxton, 2011). Stripes are not easily seen by predators (Melin et al., 2016), which suggests that melanic zebras would not be at increased risk of predation from lack of stripes. Rather, lack of stripes may reflect a genetic defect or weakness which may put them at higher risk from predators. This effect could not be evaluated as the reserve lacks lions (*Panthera leo*), cheetahs (*Acinonyx jubatus jubatus*), leopard (*Panthera pardus pardus)* or spotted hyaenas (*Crocuta crocuta*).

COLOR

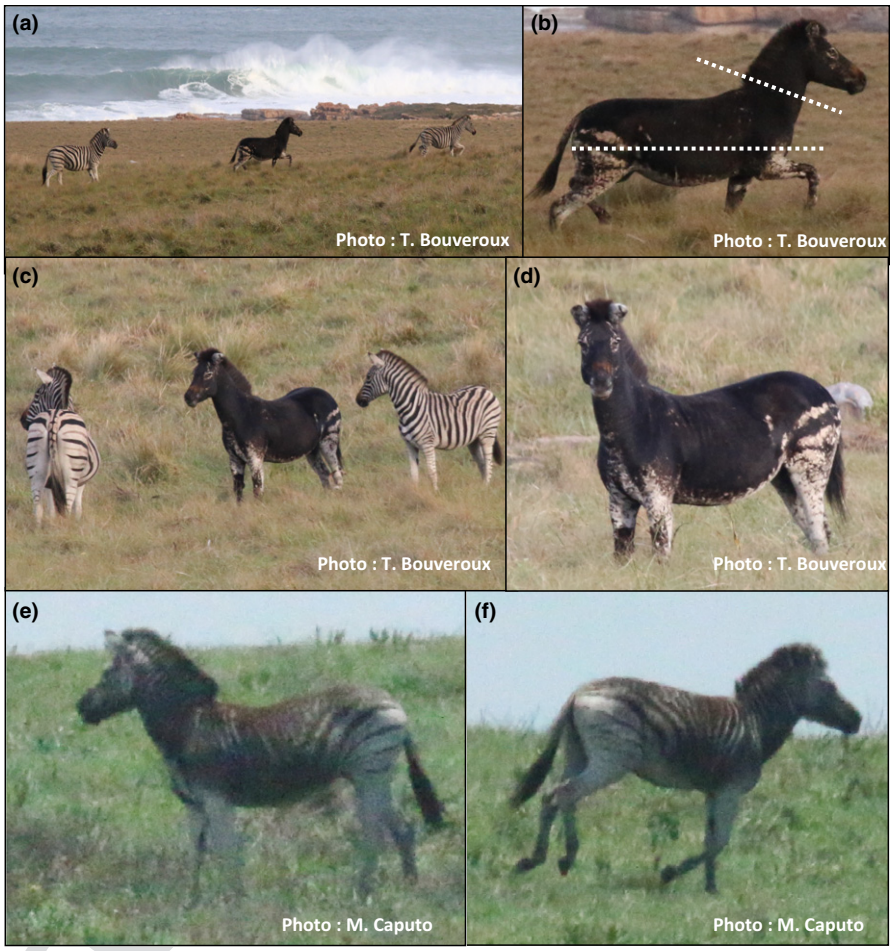

FIGURE 1 Pictures of two melanic zebra in South Africa; (a–d) female zebra (Zebra A) observed in 2015 and 2016; (e–f) juvenile zebra (Zebra B) observed in 2016. The white lines on the picture b divide the body of the animal in sections used for describing it, head, flank, legs and belly

Studies assessing the adaptive function of zebra striping also show that some tsetse flies (*Glossina spp*.) and tabanid flies (horseflies) avoid black and white striped surfaces (Blaho et al., 2012, 2013; Caro, 2016; Egri et al., 2012; Gibson, 1992; Horvath, Majer, Horváth, Szivák, & Kriska, 2008; Horvath et al., 2010) and are thus less likely to land on black and white striped surface than on uniform surfaces. These melanic zebra provide an excellent opportunity for future research, given that their occurrence is rare in nature, especially with two animals living in one group. They provide an opportunity to investigate roles other than cohesion of zebra stripes in avoiding biting insects such as tsetse flies or tabanids. In addition, biopsy samples of these animals could be collected to study the molecular genetic mechanisms of striping pattern and melanism in zebra as well as to investigate the kinship between the two melanic animals.

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