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Erythristic leopards *Panthera pardus* in South Africa

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Abstract

Background. Leopards *Panthera pardus* show genetically determined colour variation. Erythristic (strawberry) morphs, where individuals are paler and black pigment in the coat is replaced by a red-brown colour, are exceptionally rare in the wild. Historically, few records exist, with only five putative records from India known.

Objectives. To record the presence of erythristic leopards in our study site (Thabo Thalo Wilderness Reserve, Mpumalanga), and to collate records from across South Africa.

Method. A network of camera traps was used to record individual leopards at Thabo Thalo. We also surveyed local experts, searched the popular South African press and used social media to request observations.

Results. Two out of 27 individual leopards (7.1%) recorded in our study site over three years were of this colour morph. We obtained records of five other erythristic leopards in the Waterberg and Mpumalanga region, with no reports outside of this population.

Conclusions. Erythristic leopards are widely dispersed across north-west South Africa, predominantly in the Lydenburg region. The presence of this rare colour morph may reflect the consequences of population fragmentation.

Introduction

There is a high degree of coat colour variation between geographic populations of leopards *Panthera pardus* L. (Carnivora: Felidae) (Friedmann & Traylor-Holzer 2008; Stein & Hayssen 2010). Individuals from arid regions are generally pale with dispersed and open-centred rosettes, in contrast to those residing in forests which are darker with clustered and small-centred rosettes. These patterns are thought to correspond with differing vegetation types and light levels in order to conceal the animal from prey and possibly other predators (Allen *et al.* 2010; Kingdon *et al.* 2013). This adaptive explanation is supported by the frequent occurrence of melanistic leopards in humid habitats such as the Malayan peninsula (Kawanishi *et al.* 2010; Schneider *et al.* 2012). The frequency of "black panthers" dramatically decreases across more arid regions (Kawanishi *et al.* 2010). The release of eumelanin into mammalian pelage is known to be regulated by the *extension* gene and phaeomelanin (yellow-red pigmentation) by the *agouti* gene (Vage *et al*. 1997, Fontanesi *et al*. 2009). Mutations to either of these genes can produce melanism in felids; however it is a mutation in the *agouti* gene which results in melanism in leopards (Stein & Hayssen 2010; Schneider *et al.* 2012).

In contrast, extreme pale (albino) colour morphs, which lack any pigmentation, or erythrism, which contain red pigmentation instead of black, are rarely documented in wild leopards (Divyabhanusinh 1993; Sunquist & Sunquist 2002; Hartwell 2015). Although the cause of erythrism in large felines is unknown, Peterschmitt *et al.* (2009) found evidence for a recessive mutation in the *extension* gene which produces more phaeomelanin resulting in an amber colour in the domestic Norwegian Forest Cat (*Felis catus*). Similar mutations may also be responsible for the red colouration seen in dogs and humans and other mammals (Majerus & Mundy 2003; Fontanesi 2009).

Reports of erythristic leopards (also informally known as strawberry or red leopards, or pink panthers; Dell'Amore 2012; Anon 2013; Anon 2014a) are exceptionally rare. A detailed search of the literature found only one paper (Divyabhanusinh 1993), which reported that five pale leopards with light brown spots (one male, one female and the rest undetermined) had been shot in India between 1905 and 1965. To our knowledge, no other records of wild erythristic leopards were documented until 2012 when a male was photographed by a guide at

the Madikwe Game Reserve in the North West Province of South Africa (Figure 1). This was subsequently reported in the popular press (Dell'Amore 2012). Here, we report new sightings from Mpumalanga and the results of a survey of managers and section rangers of National Parks, wildlife reserves and leopard organisations in South Africa, supplemented by press reports and social media, to understand the possible distribution and abundance of this leopard colour morph.

Methods

Our study

Original images were taken by camera traps as part of a wider study conducted at Thaba Tholo Wilderness Reserve (TTWR, Latitude: 24º57”404 S, Longitude: 30º21”105 E), Mpumalanga, South Africa, c. 20 km north west of Lydenburg. TTWR is 3,170 ha and is situated between the Steenkampsberg and Mauchsberg mountain ranges. The reserve lies on the boundary of two major biomes formally classified as savannah in the valleys and northern section of the reserve, and grassland on top of the mountains in the southern section of the reserve (Mucina and Rutherford 2006). Altitudes range between 1100-2000m and the reserve has an average annual summer rainfall of 700-900mm falling mainly between October-February.

Leopard presence at TTWR was recorded using a network of 31 camera trap sites; sites were chosen to maximise the likelihood of recording leopards and covered all regions. Little Acorn 5210A (Ltl Acorn, Green Bay, Wisconsin) camera units were used, which had three heat and motion sensors which could be triggered up to 15m away. A series of three images were taken per trigger, with a 30 second interval between captures. The cameras have been in place for three years as of October 2015.

Wider survey

Twenty-five senior individuals from South Africa National Parks, Endangered Wildlife Trust, Panthera and other reserves and organisations across South Africa were contacted via e-mail and asked if they have had reports of erythristic/strawberry leopard colour morphs. A request was made to reply even if no animal had been witnessed. Other reports were located using Web of Science (www.wos.com), Google (www.google.co.uk) and references from Hartwell

(2015). A general request was also posted on Twitter using the #mammalwatching hashtag, where it was seen 2975 times at the time of writing.

Results

Five erythristic leopards have been captured on camera trap, killed or caught, in the Lydenburg area, Mpumalanga and two animals in Madikwe Game Reserve and surrounding area, North West Province (Figure 1, Table 1). Of the 28 individual leopards recorded at Thabo Thalo during this three-year study, two (7.14%) were erythristic.

Of the 25 individuals approached we received replies from 19 managers, section rangers and researchers of reserves and organizations from across South Africa. Only one other erythristic animal (Table 1, animal 1 had been observed. No other responses were received from the social media call for information on strawberry leopard sightings.

Discussion

To our knowledge, only one previous paper has reported the presence of erythristic leopards (in India; Dilvyabhanusinh 1993). Here, we provide the first formal report of the presence of wild erythristic leopards outside of India and have collated other reports from the national press. From the survey conducted of 25 senior people and researchers from over 25 national parks, wildlife reserves and leopard organisations across South Africa, there were no other reports of erythristic leopards received from the 19 responses or the social media. Of 28 individual leopards identified on camera traps at TTWR since 2012, two displayed this colour morph. In total there are seven records of wild erythristic leopards in South Africa.

South Africa's first erythristic leopard report in 2012 was recorded in the North West Province, some 400 km from our Mpumalanga study site. While such distances are likely to preclude dispersal of offspring of any given individual, it has been suggested that these widely separated leopard populations may be considered part of a single core population (Friedmann & Traylor-Holzer 2008).

General colour resemblance (where an animal resembles the general colour of their environment may be the reason for the higher frequency of melanistic leopards in moist habitats sporting thick vegetation (Allen *et al.* 2010), but this is unlikely to provide an

explanation for the presence of the erythristic forms recorded here, as this region does not exhibit a prolonged dry season and leopards in savannah habitats are thought to be predominantly nocturnal hunters (Bailey 1993) and hence a pale pelage would not be beneficial.

It is worth considering other explanations for the recent sightings of erythristic leopards in Mpumalanga, and we posit three hypotheses. First, this is simply a reflection of reporting bias, although given the numbers of observers and sightings shared though social media from large National Parks to small holdings, we feel this is unlikely (although due to the secretive nature of leopards, it is possible that unusual behaviours or forms are overlooked, e.g. Pirie *et al*. 2014). Second, and highly speculatively, this may reflect leopards released or escaping from captive breeding programmes, where animals are reared for trophy hunting. Some nine game ranches in South Africa breed leopard (Lindsey *et al.* 2011) and the captive breeding of colour morphs of other species for hunting, such as lion, is known to occur (Crowley 2015). Indeed, there is a record of a captive bred male strawberry leopard born to parents which came from the same area as the wild individual seen in 2012 (Anon 2014a). This is possible, but unsubstantiated. Third, that this reflects the result of population fragmentation and a highly reduced effective population size, resulting in the expression of a *de novo* or previously rare allele at higher frequencies. Potentially it is this scenario, combined with natural selection for the darker colour morph, which may have caused the rapid near fixation of melanism in leopards in the Malaysian peninsula (Kawanishi *et al*. 2010, Hedges *et al*. 2015). Similarly, Hagg *et al*. (2010) reported genetic drift within small fragmented jaguar populations over a relatively short time frame. Perhaps this is the most reasonable explanation for observing the erythristic morph in relatively high numbers in a single area.

The geographical range of the leopard has diminished by an estimated 37%, which underlined the need to re-classify the leopard on the IUCN Red data list from least concern to near-threatened in 2008 (Balme *et al.* 2010). Within South Africa, the destruction of suitable leopard habitat has produced highly fragmented areas with depleted prey densities, (Chase-Grey 2011; Swanepoel *et al.* 2012) which combined with persecution (Lindsey *et al*. 2011) has substantially reduced leopard numbers and caused populations to become isolated (Freidmaan & Traylor-Holzer 2008).

Protecting leopards in much of their range, in spite of their declining population, remains highly challenging given that 150 CITES (Convention for the International Trade in Endangered Species) trophy and problem animal permits are allocated annually to South Africa (Balme *et al.* 2010; Lindsey *et al*. 2011). The expression of rare recessive genotypes which are hidden in larger populations may well be the result of this decline. Erythristic leopards may therefore be a visible warning of the consequences of population fragmentation and increased inbreeding in this charismatic species of significant conservation concern.

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Table legend

Table 1: All reports found of erythristic leopards in South Africa.

Figure legends

Figure 1: Map of South Africa with relative locations of 1) Madikwe Game Reserve, North West Province and 2) Thaba Tholo Wilderness Reserve, Mpumalanga 3) Lydenburg, Mpumalanga (Google Street Map downloaded 02-07-2015 in QGIS 2015).

Figure 2: Image of erythristic individual 4 taken on a property on the R37 outside Lydenburg, Mpumalanga, Latitude: 24º93"310 S Longitude: 30º337160" E. 01 May 2015.

Figure 3: a) First in a series of three images of an adult female leopard, FS44 left, and her erythristic cub, middle, taken on 31 March 2015 at Thaba Tholo Wilderness Reserve, Latitude: 24º98"322 S Longitude: 30º35"086 E; b) last image in the series taken on 31 March 2015 at TTWR of FS44's erythristic cub (centre frame of image) and the second cub (far right of image).

293

294 Table 1

Date	**Animal**	**Age and sex**	**Location**	**How recorded**	**Reference**	**Notes**
Unknown +/- 15 years	1	Adult female	Close to Botswanan border and Madikwe Game Reserve	Shot	Anon (*Pers. comm.*)	Skin given to a farmer in Greater Lydenburg Area
August 2005	2	Adult female	R36, Lydenburg	Carcass; road death	Mr. B Van der Wal (*Pers. comm.*)	
2012	3	Adult male	Madikwe Game Reserve Latitude: 24º8167 S Longitude: 26º2167 E	Photographed	Dell-amore 2012	Photographed by Deon De Villiers
September 2015				Camera trap images	Samantha Sealie, Madikwe Conservancy Private Game Reserve; Gareth Mann, Panthera	
March 2013	4	Adult female	Sekhukhune road, Lydenburg	Carcass; road death	Anon 2013	Had recently weaned cubs
January 2014		Unknown	Lydenburg area	Photographed	Anon (*Pers. comm.*)	Probably animal 4 or 5
September 2014 (x3)	5	Probable adult female	Thaba Tholo Wilderness Reserve Latitude: 24º98"322 S Longitude: 30º35"086 E and	Camera trap images (Figure 2)	This study	With known male
October 2014						
January 2015						
February 2015 (x2)						

May 2015			surrounding properties Latitude: 24º93"310 S Longitude: 30º337160" E			
November 2014	6	Two year old male	Lydenburg area	Photographed; later captured and released	Anon 2014b	Satellite collared by Mpumalanga Parks and Tourism Authorities
January 2015					Anon 2015	
March 2015	7	Un-weaned cub	Thaba Tholo Wilderness Reserve Latitude: 24º98"322 S Longitude: 30º35"086 E	Camera trap images (Figure 3).	This study	With mother (normal coloured mother and grandmother)
May 2015						
June 2015						
July 2015				Observed by field worker		

295

296

297

298 Figure 1

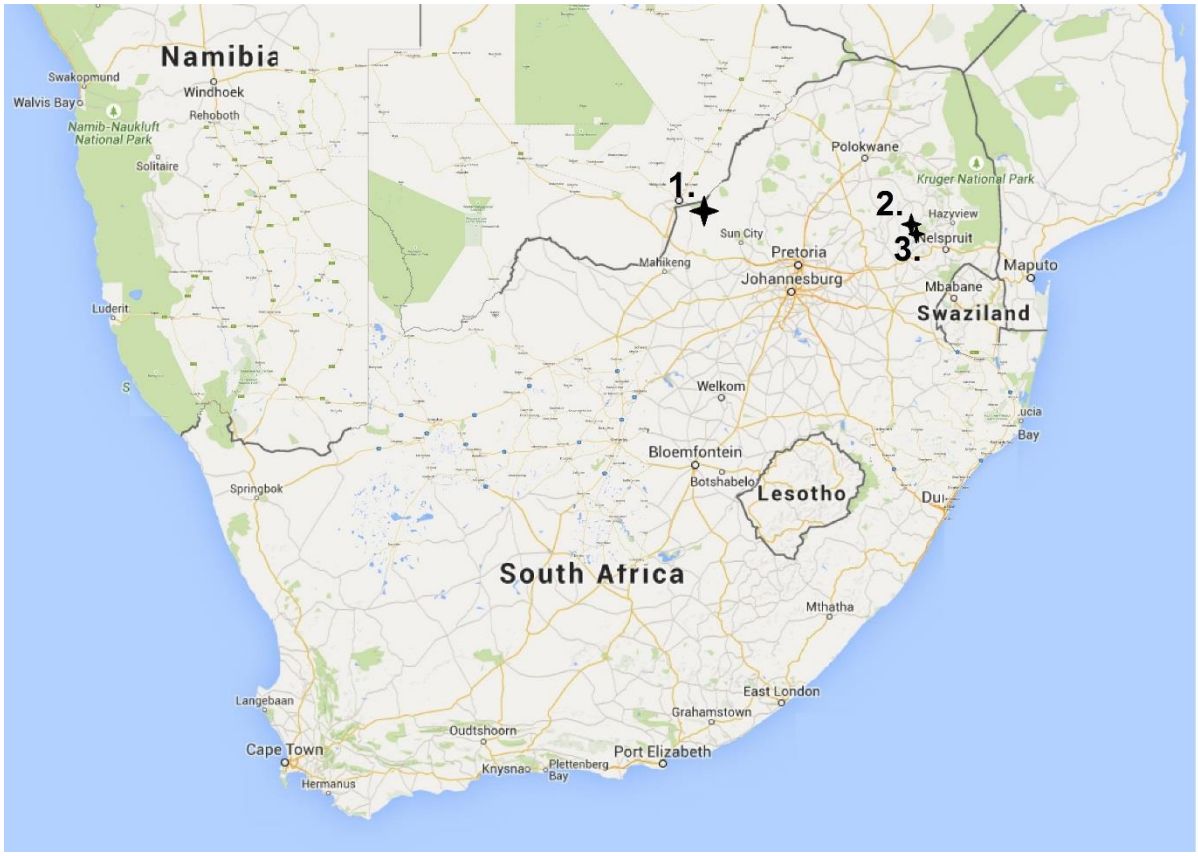

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Figure 2

Figure 3