Albino and melanistic genets (*Genetta genetta*) in Europe

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Abstract While melanistic genets (*Genetta* spp.) are well known in a few species of the genus, albino specimens have not been described to date. Here, we report on the presence of unusual albino and melanistic common genets (*Genetta genetta*) in Spain, discussing their frequency of occurrence in the wild. Melanistic and albino common genets are not known in the original African range of the species, thus phenotypical variability in coat colour appears to be greater in Europe, its introduced range. Natural (e.g. a reduced risk of predation in Europe) and/or artificial (e.g. captive-rearing of the species) selection could explain this fact, but more research on the topic is needed.

Keywords Albinism · Artificial selection · Carnivora · Coat colour · *Genetta* · Invasion pathways · Melanism · Natural selection

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Introduction

Species of mammalian carnivores usually exhibit gradual variation in background and spot colouration across populations (Obbard 1987). Nevertheless, aberrantly coloured individuals also exist. A strong genetic basis is recognized for colour variations, although environmental influences during development can affect coat colour. Mutations affecting colour must be common among carnivores, as descriptions of atypical specimens are frequent in the literature. A melanistic coat (unusual black or dark brown colouration, presumably eumelanin-based) is the most commonly identified unusual morph in the wild. Species of canids (e.g. Anderson et al. 2009), viverrids (e.g. Gaubert and Mézan-Muxart 2010), felids (e.g. Eizirik et al. 2003) and mustelids (e.g. Hosoda et al. 2005) include melanistic individuals. Among some ursids, the black morph is not unusual but nearly ubiquitous, as it happens with the populations of *Ursus americanus* in eastern North America (Rounds 1987). The partial or total lack of melanin pigment (albinism, hypomelanism and leucism) is much less common in wild carnivores (e.g. Ozoga and Harger 1966). White phenotypes are generally absent in the wild given that albinism has no adaptive significance, except in cold and snow-covered regions, and thus mutants are removed from populations rapidly (Caro 2005). Exceptional red-pigmented carnivores (probably pheomelanin-based colouration) are also rarely reported in the wild (e.g. Veron et al. 2004). On the other hand, in captive-reared species such as cats, dogs, minks, foxes, ferrets, etc., it is possible to produce a number of different variations in colour, including white phenotypes, by appropriate selection (Ewer 1973).

In the past, most cases of colour variations in nature were described as anecdotal curiosities. However, a recent interest in colour polymorphisms has arisen from two convergent

fields. During the last decade, considerable research regarding the genetic basis of pigmentation in mammals has been conducted (e.g. Eizirik et al. 2003; Hoekstra 2006), as this provides a way to assess the relationship between genotype and phenotype in an evolutionary and ecological context. At the same time, certain kinds of colour polymorphisms detected in the wild have been related to the history of particular lineages. For example, gene mutations affecting colour patterns have been introduced into wild populations via introgression from domestic mammals, either through the return of domestic individuals to the wild (e.g. Van Dam 2001) or hybridization with their wild relatives (e.g. Anderson et al. 2009). In this context, the study of unusual colour patterns in the Common Genet (*Genetta genetta*), a presumable invader of SW Europe from Africa (Gaubert et al. 2009), is particularly interesting.

Black genets have been observed in Europe for a long time (Graells described a *Genetta melas* in the middle of the nineteenth century; de la Paz Graells 1897). However, only recently, it has been postulated that the presence of melanistic individuals is a peculiarity of continental Spain and Portugal, as they have not been detected in the native range of the species (Gaubert and Mézan-Muxart 2010). In this paper, we describe several unusually coloured genets found in the wild in Spain, including black, reddish-black and the first albinistic genets observed anywhere in the world. We try to estimate the frequency of unusual colour coats in European genets and briefly discuss if natural selection (e.g. a scarcity of genet predators with respect to Africa) or artificial selection (e.g. related to a possible captive-rearing of the species) could be the main cause of the higher colour polymorphism detected in European genets.

Material and methods

During the 1960s and 1970s, skins and skulls of European genets were actively collected from hunters and taxidermists stores by researchers from the Doñana Biological Station, National Council for Research (CSIC), Seville (Spain). Subsequently, a number of genets found dead were incorporated to the scientific collection, which increased the total to 172 skins of the species. In 2010, a set of 290 tanned skins confiscated from an illegal furrier by the Andalusian environmental authority was added to the collection. The localities of origin for these more recent specimens are uncertain, but in all likelihood they came from Southern Spain. We revised this collection (a list of the catalogue numbers can be obtained from the authors upon request), along with the available bibliographical information and recent data on aberrantly coloured genets in Spain.

Results and discussion

Description of cases

We observed a great variety of coat colour types, including some white genets not previously recorded in the literature, as well as several types of melanistic genets. The main ones are described below.

In 1973, a young white genet was identified by one of us (MD) in the atelier of the taxidermist G. Campón in Cáceres (central-west Spain). Mr. Campón said that the animal had red eyes (which we could not verify) and was captured along with a normal coloured sibling on July 13, 1973. At that time, the fur appeared completely white, although today, after the passage of time, it is light sand-coloured. However, some details of the coat pattern (especially the dorsal crest and the tail rings) are still visible (Fig. 1a). The skin is preserved in the CSIC collection at the Doñana Biological Station, Seville, Spain (EBD, number 15470).

On December 29, 2004, a completely white common genet was found dead on a road by the Ranger Corps of the Government of Catalonia in the borough of Ivorra, Lleida (NE Spain). The animal had been run over by a vehicle and was taken to Vallcalent Animal Recovery Center for its identification and necropsy. This individual looked completely white (no spots or ring marks in the fur) with just a light brown stripe visible on the forehead (Fig. 1b). Judging by appearances, it was a young animal (C. Pinyol, pers. comm.).

A stuffed genet with a pale coat was bought by one of the authors (MD) in La Bañeza, León (north-west Spain) in 1970. It corresponded to an adult female captured during the month of January, in 1965. This specimen, which the owner called a "royal genet", has the standard fur pattern, but the black colour is unevenly diluted (hypomelanism). The tail rings and spots of the body are brown or greyish instead of black, and the background colour is whitish instead of greyish brown (Fig. 1c). The skin is preserved in the collection housed at the Doñana Biological Station (EBD, number 15454). For this specimen, some post mortem decolouration of the skin cannot be ruled out.

As recently discussed by Gaubert and Mézan-Muxart (2010), melanistic genets have been well known in the Iberian Peninsula at least since the nineteenth century (Cabrera 1905; de la Paz Graells 1897). The former authors estimated the frequency of melanistic morphs as c. 1 %. We found

Fig. 1 Genets with different colour coats in Spain. **a** and **b** white genets; **c** pale genet; **d** and **f** black genets; **e** and **g** dark red genets; **h** intermediate black-red genet; **i** normally coloured genet. **a**, **c**, **d**, **e**, and **i** correspond to skins preserved in the Scientific Collection of the National Council for Research (CSIC) at the Doñana Biological Station. **b**, **g**, **f**, and **h** were provided by Piñol, Rodríguez-Piñero, Duarte and Rubio and Mostacero, respectively. See text for more details


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melanistic genets well distributed throughout the country, as indicated by Gaubert and Mézan-Muxart (2010), and not particularly aggregated in the south, as previously suggested by Duarte and Rubio (1999). The following are examples of recent melanistic specimens we have identified with documentary evidence (photos and videos): Puentes-Poveda and López-Bao (pers. comm.) found an adult male black genet in La Rúa, Orense (April 7, 2009; NW Spain); García-Talegón (pers. comm.) captured another individual in a box-trap in Villoldo, Palencia (March 1, 2009; central north Spain); and a melanistic specimen was recently photographed in the wild by Fernando Mostacero (pers. comm.) in the Jerte valley, in Cáceres (February 4, 2012; west central Spain). In addition, black genets have been found in Europe outside of mainland Spain. For example, Alcover (1983) described two black genets in Sóller, Majorca, Baleares, and reported that the presence of melanistic genets on this island goes back at least to 1884, when they were first described by the Archduke Luis Salvador.

Perhaps more importantly, melanistic genets include different types of coat, which should correspond to different genetic mutations. We found almost completely black genets (melanistic sensu stricto; eumelanin-based colouration) as well as some other lighter specimens, with reddish tonalities (likely pheomelanin-based colouration). Both types are present in the Doñana collection (EBD). For example, the specimen EBD-1522 (locality: El Mustio, Aroche, Huelva, SW Spain; without date of collection) is mostly black, although a careful examination will reveal the characteristic spotted coat (Fig. 1d). Alternatively, the skin EBD-6058 (La Rúa, Orense, NW Spain; January 1977) is mostly reddish-black; with the spotted design clearly visible (Fig. 1e). Similar differences have also been observed in the field. For instance, the adult female found dead inside a box-trap in Málaga (south Spain) by Duarte and Rubio (1999) was completely black, including the nose and apparently the eyes (Fig. 1f). In contrast, at least one of the dark individuals live-captured in Algar, Cádiz (SW Spain) in 1988 and photographed by Rodríguez-Piñero (1998) was reddish, with dark red body spots and tail rings, a dark face, orange eyes and a rose-coloured nose (Fig. 1g). It is likely that this pattern represents the colour type referred to by previous authors (as quoted by Gaubert and Mézan-Muxart 2010) when they described genet skins as "speckled and spotted with rufous blotches and spots". Furthermore, the specimen recently photographed by F. Mostacero in Cáceres also has a rose-coloured nose, but black eyes (Fig. 1h). Finally, the picture of a normally coloured genet (Fig. 1i) was included in the figure for comparison.

Black and white genets in Europe and Africa

To estimate the absolute frequencies of unusually coloured individuals in genet populations is very difficult, as scientific and/or private collections are usually not the result of random sampling from the wild. For example, four (2.33 %) of the 172 skins from the original EBD collection were regarded as "rare" (numbers 15470, 15454, 1522 and 6058; see above), but we know that at least two of these specimens were bought just because they were atypical. In contrast, none of the 290 confiscated skins was unusually coloured, probably because the furrier preferred to store homogeneous coats in order to make blankets and fur dresses. Perhaps a closer approximation to a random sample is that offered by two newspaper advertisements from the late 1950s (newspaper ABC: March 27, 1958, page 42 and April 29, 1959, page 90) concerning the auction of 276 (73+203) skins of "normal" genets and 2 (1+1) black genets captured in Asturias (North Spain) during an official predator control campaign. Based on these advertisements, the relative frequency of black genets should be about 0.7 %.

Despite uncertainty about the relative abundance, we think it is possible to conclude that, although present at a low frequency in the wild, a considerable colour polymorphism exists in the genets of Spain, which includes white, pale, normal grey, reddish-black and black animals. This does not appear to be the case in Africa, neither for *G. genetta* nor for other species of the genus. According to Gaubert and Mézan-Muxart (2010), black genets are most likely absent in 14 of the 17 species recognized in the genus *Genetta* by Gaubert et al (2005). Besides, they are very rare, or nonexistent, in African populations of *G. genetta*, as Gaubert and Mézan-Muxart (2010) did not find any black specimen among 449 examined African skins. In addition, to our knowledge, the common genet is the only species of the genus for which albino specimens have been found in nature, and then only in Europe. Moreover, melanistic animals appear to be widespread in Iberia, and albino individuals have been found in distant locations. This supports the idea that unusual coats are more than an exceptional and local phenomenon in Europe.

The reasons for this higher colour variability in the introduced range of the species are difficult to identify without more research. Gaubert and Mézan-Muxart (2010) indicated that a genetic bottleneck resulting from the introduction into Europe of a reduced pool of individuals could have lead, by chance, to an increase in the frequency of a rare melanistic genotype. This should be possible for a rare mutation, but the different (black, red, white, etc.) colour varieties of European genets suggest that several different mutations would be involved, as it happens in other mammalian species (e.g. Hoekstra and Nachman 2003; Anistoroaei et al. 2008). Thus, while it is certainly possible that an introduction-related founder effect followed by genetic drift does increase the frequency of one originally low-frequency variant, the increase of the several colour coat variants in Europe might be better explained by some sort of selection,

either natural or artificial. For instance, Ortolani (1999) suggests that spotted coats in carnivores have evolved for camouflage. Thus, a higher frequency of homogenous (black or white) specimens in Europe could reflect a relaxation of selection against non-spotted coats, maybe because the number of carnivore species potentially killing genets is much higher in Africa than in Europe (see Caro and Stoner 2003). Artificial selection would have been also possible. Captive-rearing of genets could have occurred locally somewhere in northern Algeria before their introduction into Europe (see Gaubert et al. 2009). In addition, the earliest genet remains thus far found in Europe suggest it was a house-kept species for some Muslims (Morales 1994; see Mézan-Muxart and Jemin 2011 for more examples of human–genet interactions). Furthermore, it is known that clothing made from skins of black genets was highly prized during the Middle Ages (Gaubert and Mézan-Muxart 2010), which could have induced some people to rear the melanistic phenotypes, later escaped or released into the wild.

Anyway, the higher frequency of unusual colour coats in the introduced European genets with respect to the African ones is an intriguing case whose causality demands more research, including that on historical and literary sources.

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