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Notes and Discussion Piece

A Leucisitic Fisher (Pekania pennanti) and the Prevalence of Leucism in Wild Carnivores

Abstract.—Animal coloration has adaptive roles for communication, concealment, sexual selection, and physiological function. Genetic mutations sometimes cause abnormal coloration such as leucism, in which an animal appears partially or entirely white, except for exposed soft skin tissue. Here we document a leucistic fisher (*Pekania pennanti*). Fisher fur normally ranges from deep brown to black, but the function of the pelt color is not understood. The literature on the occurrence of leucism includes 33 other records of leucism among carnivores. Reporting cases of rare coloration in the wild helps to understand the distribution, prevalence, and significance of abnormal colors.

Introduction

The colors of animals demonstrates evolutionary adaptations for communication, concealment, sexual selection, and physiological function (Caro, 2005). For example gray wolves (*Canis lupus*) have adapted facial color patterns that allow group communication in darkness during attacks on prey (Asa and Harrington, 2003), and the white and black aposematic coloration on striped skunks (*Mephitis mephitis*) deters predators by signaling their potential to spray offensive and potentially harmful fluids (Hunter, 2009). White-tailed deer (*Odocoileus virginianus*) fawns passively avoid predators through camouflage (Caro, 2005). Color can also be an attractant, as many male birds increase their breeding success by showing off vibrantly colored plumage to females (Ferns and Lang, 2003). Color may also serve such physiological functions as thermoregulation (Caro, 2005). Rarely, however, genetic anomalies cause excess or deficiency of color-related pigment in the wild, resulting in irregular coloration in fur, feathers, or skin. Such rare colors may allow selection of new color traits, allowing stabilizing selection for the common color traits. Occurrence of abnormally colored individuals challenge adaptive explanations of color patterns in animals, and question the adaptive significance of abnormal colors.

Leucism is a genetic abnormality of partial loss of pigmentation, causing individuals to appear partially or entirely white (Sage, 1962; Jehl, 1985; Lawrence, 1989). It is sometimes referred to as partial albinism, ghosting, or schizochroism (Sage, 1962; Cooke and Buckley, 1987; Bensch *et al.*, 2004). The trait is controlled by a single locus, with the allele controlling leucism recessive to normal pigmentation (Owen and Skimmings, 1992). Leucism, however, does not affect soft exposed skin, such as the nose and eyes, which appear normally pigmented, differentiating the condition from albinism (Cooke and Buckley, 1987; Owen and Skimmings, 1992). The frequency of leucism has been linked with inbreeding, increasing the probability of white phenotypes (Owen and Skimmings, 1992; Bensch *et al.*, 2004). Leucism has also been linked with environmental factors, such as nuclear pollution, which can increase mutation rates (Moller and Mousseau, 2001). For example, the frequency of leucism in barn swallows (*Hirundo rustica*) increased after fallout of the Chernobyl nuclear plant (Ellegren *et al.*, 1997; Moller and Mousseau, 2001).

Leucism and other abnormal color phases are rare in the wild because they are often selected against (Moller and Mousseau, 2001; Caro, 2005). Abnormal color in animals is often considered to be a disadvantage (Moller and Mousseau, 2001), because it may reduce an individual's ability to communicate, increase detection by predators (Camargo *et al.*, 2014), or decrease effectiveness of hunting (Caro, 2005). In the case of sexual selection, abnormal color may result in low breeding success. White coloration compromises protection from ultraviolet radiation and scatters light towards the skin, which may have thermoregulatory consequences (Caro, 2005). Rare coloration may also increase an animal's appeal to hunters and poachers (Owen and Skimmings, 1992). Despite these disadvantages, reports of leucistic animals at mature life stages still occur (Fertl and Rosel, 2009). It is important for biologists to document abnormal coloration among species of birds, reptiles, or mammals to help provide insights to the underlying causes of these phenomenon and their prevalence, distribution, and impacts on survival.

Methods

We set a camera trap (WGI Innovations, Grand Prairie, Texas, U.S.A.) on 9 September, 2017 on a wildlife trail to capture photos of white-tailed deer on our study site (45°33′45.82″N; 90°06′54.75″W) on

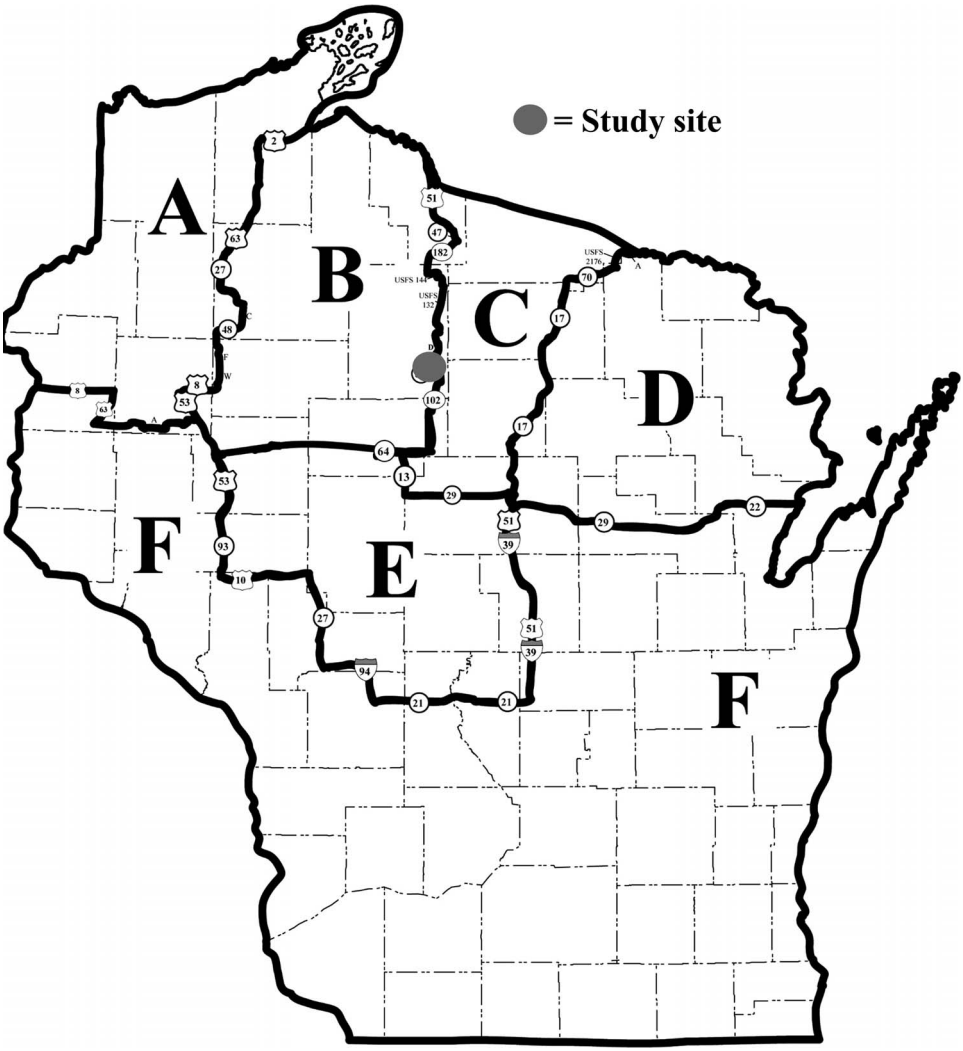

FIG. 1.—Fisher management zones and our study site within Wisconsin, U.S.A.

private land near Brantwood, Wisconsin, U.S.A. (Fig. 1). The study site is comprised of mixed deciduous forest dominated by balsam fir (*Abies balsamea*), poplar (*Populus spp.*), sugar maple (*Acer saccharum*), and spruce (*Picea spp.*). Major public lands around the study site include the Chequamegon-Nicolet National Forest and county-owned land.

Wisconsin encompasses the southernmost distribution of fishers in mid-continental North America (Lewis *et al.*, 2012). Fishers are generalist predators (Powell, 1993), whose common prey on our study site included porcupines (*Erethizon dorsatum*), ruffed grouse (*Bonasa umbellus*), eastern cottontail rabbits (*Sylvilagus floridanus*), snowshoe hares (*Lepus americanus*), red (*Tamiasciurus hudsonicus*) and gray squirrels (*Sciurus carolinensi*), and carrion of white-tailed deer (*Odocoileus virginianus;* (Kirby *et al.*, 2018) or roadkill (Powell, 1993). Fishers are trapped commercially and recreationally in Wisconsin.

FIG. 2.—Leucistic fisher captured on 10/10/2017 at 9:18 AM CST within Price County, Wisconsin, U.S.A.

In November 2017, we searched the literature systematically to determine the frequency of leucism among classes of chordates. We first searched Web of Science for the terms *leucistic, leucism*, and *partial albinism*. We read each entry and removed duplicate, mismatched publications, literature reviews, and studies of invertebrates and domesticated animals.

RESULTS

On 10 October, 2017 at 09:18 h CST a leucistic fisher was photographed (Fig. 2). The fisher's fur was uniformly white, although the eyes and nose displayed normal pigmented color. This is the first documentation of a leucistic fisher in the scientific literature.

Through our literature review, we found 572 unique scientific records of individuals displaying leucism among the chordate classes Chondrichthyes, Actinopterygii, Amphibia, Reptilia, Aves, and Mammalia (Fig. 3). The majority of records were from Aves (n = 416), with the second most common source from Mammalia (n = 114). Within Mammalia, the most records were from the Carnivora (n = 33) and Eulipotyphla (n = 40). Of the records from the Carnivora, leucism was the most common within the family Mustelidae (n = 18).

DISCUSSION

Ours is the first record of a leucistic fisher in the scientific literature. Fisher fur normally ranges from deep brown to black (Powell, 1993), but the function of pelt color for fishers is not known. Therefore, the advantages or disadvantages of being white for this individual are unknown. Some life history traits of fishers may buffer the potential fitness consequences of being white. Fishers communicate mainly

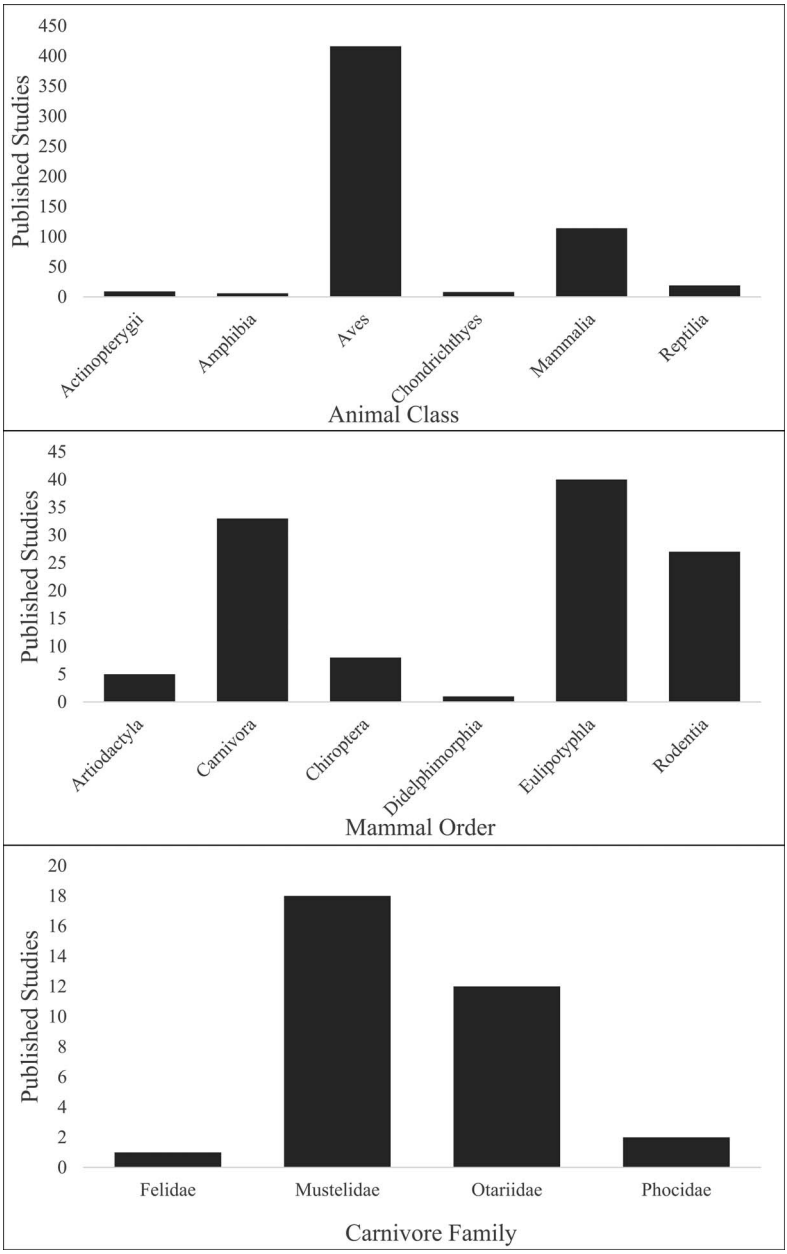

FIG. 3.—Prevalence of leucism among published studies within animal class, mammal order, and carnivore family

through scent marking (Powell, 1993), rather than through visual cues. During snow cover, white fur color may provide concealment for fishers from predators, such as bobcat and coyote (Wengert *et al.*, 2014), or concealment from prey while hunting, with the contrasting disadvantages without snow cover. Based on size and stature, the fisher in our photo was, potentially, a healthy male (Powell, 1993).

Within Mammalia, carnivores provided the second most number of leucistic records trailing the Eulipotyphla. Within the Mustelidae, leucism has been documented most frequently in the tropics (Arriaga-Flores *et al.*, 2016; Talamoni *et al.*, 2017), though 14 of the 18 records for mustelids were for leucistic tayras (*Eira barbara*), nine of which were museum specimens (Talamoni *et al.*, 2017). Although the museum specimens may be biased by selection for their oddity, examining museum specimens and other historic records may still provide valuable information. Leucistic records may also be biased from errors in reporting. For example, there appears to be confusion between albinism and leucism among scientists. Therefore, some records may be inaccurate in this respect. It is also possible leucistic animals are unreported, especially when detection becomes common. Additionally, many mustelids experience seasonal molts, and color records collected during molting, may be misinterpreted as rare.

Camera traps are popular among both biologists and the general public (Goad *et al.*, 2014; Allen *et al.*, 2016; Kays, 2017) with many large-scale camera trap projects across the world (*i.e.,* Snapshot Serengeti, Snapshot Grumeti, eMammal). Snapshot Wisconsin, a statewide camera trap project, began in 2015 to allow personnel at the Wisconsin Department of Natural Resources to track animal movements and population patterns throughout Wisconsin. Camera traps have captured photos of unique coloration in other wildlife, such as melanism in jaguars (*Panthera onca*) (Kays, 2017). Large-scale camera trapping may help provide information to determine isolated subpopulations susceptible to genetic inbreeding through photographic evidence of abnormal colors. These camera trapping efforts can potentially provide a greater number of records of leucism with more accurate location information for fishers and other species in Wisconsin to increase our understanding of its occurrence and distribution throughout the state.

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