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Artículo

A CASE OF ALBINISM IN THE CENTRAL AMERICAN SPIDER MONKEY, *Ateles geoffroyi*, IN HONDURAS

Mario Espinal[1], José Manuel Mora[2], Luis A. Ruedas[3], Lucía Isabel López[4], and Leonel Marineros[5]

[1] Investigador Asociado, Centro Zamorano de Biodiversidad, Escuela Agrícola Panamericana, Honduras.
[2] Instituto Internacional en Conservación y Manejo de Vida Silvestre (ICOMVIS), Universidad Nacional (UNA), Heredia, Costa Rica. [Correspondencia: José M. Mora <josemora07@gmail.com>]
[3] Department of Biology and Museum of Natural History, Portland State University, SRTC–247, 1719 SW 10th Avenue, P.O. Box 751, Portland, OR 97207–0751.
[4] Bióloga y consultora ambiental. <luciaisa2@gmail.com>
[5] Colaborador de la Fundación para la Investigación, Estudio y Conservación de la Biodiversidad (INCEBio).

ABSTRACT. We report the first case of complete albinism for the Central American spider monkey (*Ateles geoffroyi*), a juvenile female from eastern Honduras. Albinism is a genetic condition reported in numerous vertebrate species. Although normally infrequent, the incidence of albinism in populations may change as a result of environmental stress, including inbreeding in isolated populations. Coat color disorders result from pleiotropic effects in mammals. Sensory organs and nerves are particularly affected by these disorders because of the shared origin of melanocytes and neurocytes in the neural crest. The instance of an albino spider monkey from eastern Honduras might result from increased inbreeding.

RESUMEN. **Un caso de albinismo en el mono araña centroamericano, *Ateles geoffroyi*, en Honduras.** Presentamos el primer caso de albinismo completo para el mono araña centroamericano (*Ateles geoffroyi*), una hembra juvenil del este de Honduras. El albinismo es una condición genética presentada en numerosas especies de vertebrados. Si bien normalmente poco frecuente, la incidencia de este fenómeno en poblaciones silvestres puede aumentar debido a estrés ambiental, cual puede ser endogamia en poblaciones aisladas. En mamíferos, los trastornos de color del pelaje son el resultado de efectos pleiotrópicos. Los órganos y nervios sensoriales se ven particularmente afectados por estos trastornos debido al origen común de los melanocitos y los neurocitos en la cresta neural. El caso de un mono araña albino en el este de Honduras podría resultar de un aumento de la consanguinidad.

Key words: Coat color. Conservation. Genetic disorder. Leucism. Mammals. Neotropic.

Palabras clave: Coloración del pelo. Conservación. Desorden genético. Leucismo. Mamíferos. Neotrópico.

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INTRODUCTION

Albinism has been observed in numerous vertebrate species (Mora, 1990; Abreu et al., 2013) but its occurrence in the wild, particularly in Primates, is rare (Mahabal et al., 2012; Abreu et al., 2013). Abreu et al. (2013) compiled all published cases of anomalous pigmentation reported in Neotropical mammals, undertaking a comprehensive review of peer reviewed articles between 1950 and 2010: they found no records of albinism in Neotropical Primates, but in numerous cases in other Orders of mammals. Mahabal et al. (2012) examined the phenomenon in *Macaca* sp., and noted that only two records of complete albinism had been reported in the literature for the Bonnet macaque, *Macaca radiata* (Mahabal et al., 2012). One macaque was tied up with a chain to a tree outside a house in Goa, India. The other report corresponded to a captive individual in Trivandrum Zoo, South India in 1936. Partial albinism ("leucism," see below), was responsible for the recognition of several species of primates: Lesson (1831, plate XXXII) named *Troglodytes leucoprymnus*, as a distinct species of chimpanzee (now known as *Pan troglodytes*) based on a partially leucistic individual. Cabrera (1897) also reported on an individual that he identified as that species (based on coloration) that had just died in the Madrid Zoo. Among humans, the condition occurs in ca. 1 out of 17 000 newborns (Montoliu and Kelsh, 2014).

Albinism refers to the absence of pigmentation in an organism (Uieda, 2000). Distinct forms of albinism have been defined, all characterized by a normal number of melanocytes (Rees, 2003) accompanied with varying degrees of reduced melanin production. Complete ("real") albinism refers to the total absence of integumentary and retinal pigmentation (Sandoval-Castillo et al., 2006). This form is phenotypically expressed by a lack of retinal and integumentary melanin, indicating integumentary defects in the retinal melanophores (Muto et al., 2012). A second form of occurrence is partial albinism characterized by reduced or absent integumentary pigment, but with pigmented retinas (Muto et al., 2012). However, the latter condition and its name have been deemed obsolete, and "partial albinism" is now preferentially known as leucism (Abreu et al., 2013).

Albinism is a genetic condition caused by at least up to 18 different mutations (Summers, 2009; Hu et al., 2013; Bridge et al., 2014; Montoliu and Kelsh, 2014; Montoliu et al., 2014) and coat color may in effect result from pleiotropic interactions (Reissmann and Ludwig, 2013). The rarity of the phenomenon in the population derives from the recessive nature of the alleles (Hu et al., 2013; Prado-Martínez et al., 2013). Leucism, although thought to be controlled by a single recessive allele (Owen and Shimmings, 1992), has recently been documented to be the result of at least six genes (Reissmann and Ludwig, 2013). Multiple alleles control skin, hair and eye pigmentation, and different alleles control the amount of pigmentation (McCardle, 2012). Caro (2005) argued that coloration differences were caused by a single genetic mutation that is thought to have no adaptive significance; however, Bridge et al. (2014) pointedly noted that oculocutaneous albinism results in a loss of visual acuity that is maladaptive, and further leads to increased rates of cancer among humans (Hu et al., 2013).

Under natural circumstances, albinos of most species are rapidly removed from their populations by the predators (Ruedas and Noel, 1991; Kuras et al., 2001; Nkosi and Twala, 2002; Caro, 2005; Delibes et al., 2013; Alves Da Costa et al., 2014; Silva-Caballero et al., 2014). However, it has been hypothesized that such selection may be absent under certain circumstances: in particular, alien species within an introduced range absent of natural predators (*Genetta* in Spain, Delibes et al., 2013), or high nutritional quality habitat with good ground cover (*Microtus pennsylvanicus*, Peles et al., 1995). In addition, a proportion of albino individuals in most species have been observed to reach adulthood. Although the frequency of unpigmented individuals in a population ultimately is dependent on mutation rate, that frequency also may be affected by such environmental factors as habitat fragmentation and loss, which habitually lead to inbreeding as a result of reduced population numbers. As a result, the manifestation of albinism (or con-

versely melanism) in a population may reflect a higher probability of the expression of recessive alleles due to factors such as inbreeding, probably driven by populations or groups of individuals that are separated in isolated forest fragments, which may lead to mating among closely related individual, thereby increasing the local incidence of albinism (Kuras et al., 2001; Prado-Martínez et al., 2013; Nedyalkov et al., 2014).

The purpose of this paper is to report on an instance of complete (oculocutaneous) albinism for the Central American spider monkey (*Ateles geoffroyi*), the first documented record of albinism for this species. This record thus increases the number of species with known pigmentation anomalies and adds to the understanding of this condition. Few instances of leucism or albinism have been reported for any *Ateles* species. Two leucistic *Ateles hybridus* were filmed in the wild in the Magdalena River valley, Colombia (National Geographic, 2015). Two similarly leucistic females potentially of that same species lived in the Knowland Park Zoo (Oakland, California) in the 1970's (Kaemmerer, 1980); interestingly, they changed color from gold or buffish to leucistic ("whitish") over a period of three to four years (Kaemmerer, 1980). The Barranquilla Zoo (Barranquilla, Colombia) had at the same time an albino female identified as *A. fusciceps* (C. A. Olaciregui Pineda, Head of Biology & Conservation Department, Fundación Botánica y Zoológica de Barranquilla, in litt., 4 March 2016; G. Lovett, Spider Monkey North American Studbook Keeper, in litt., 2 March 2016). No further information is available on that specimen. Another spider monkey, presumably *A. geoffroyi*, is known to have lived in the 1980's in the Club Auto Safari Chapin, Escuintla, Guatemala; it is unknown whether it was leucistic or albino (G. Lovett, in litt., 2 March 2016). No living or deceased albino or leucistic spider monkeys are otherwise known from zoos in North America (G. Lovett, in litt., 2 March 2016). Abreu et al. (2013), in their review of anomalous color in Neotropical mammals did not document any cases of albinism in any primate species.

RESULTS AND DISCUSSION

On 27 July 2015, an *Ateles geoffroyi* was observed and photographed in captivity in Catacamas, Olancho, Honduras. The individual is a juvenile female, about six months old that was captured nearby in the wild by a local hunter; she was captured at San Pedro de Pisijire, 17 km northeast from Dulce Nombre de Culmi, Olancho Department, Honduras (14º 32' 58.31" N, 85º 48' 20.79" W, **Fig. 1**). The individual has all the characteristics of complete albinism, lacking pigmentation over the entire body surface, including the iris (**Fig. 2**).

The Central American spider monkey is the only member of the genus found in Central America and ranges from southern Mexico to Panamá (Konstant and Rylands, 2013). The species is one of the largest New World primates with a body weight of 7.0-9.4 kg (Konstant and Rylands, 2013). Because of its relatively large body size, it is hunted for meat over a broad geographic area (Mora, 2000). Individuals may live up to 27 years (Konstant and Rylands, 2013).

The survival probability of albino individuals in the wild remains unknown, but the documented reduction in visual acuity and associated neurological changes (Bridge et al., 2014) suggest that albinism would result in higher susceptibility to predation, as documented by Kuras et al. (2001; see also Nkosi and Twala, 2002; McCardle, 2012; Silva-Caballero et al., 2014). However, as we noted above, albino or leucistic individuals in some mammal populations are not selected against (Peles et al., 1995; Delibes et al., 2013). Survival of albino individuals can therefore also be linked to habitat quality and habitat cover (Peles et al., 1995; Kehas et al., 2005) or absence of natural predators (Delibes et al. 2013). Another potential problem for an abnormally colored individual may result from changes in intraspecific interactions, such as ostracism (McCardle, 2012; Slavík et al., 2015).

Fur coloration is a key factor because it determines individual survival in mammals, especially because of its camouflage function (Nedyalkov et al., 2014). Albinism generally is considered a major disadvantage to animals in the wild: a key issue is that white

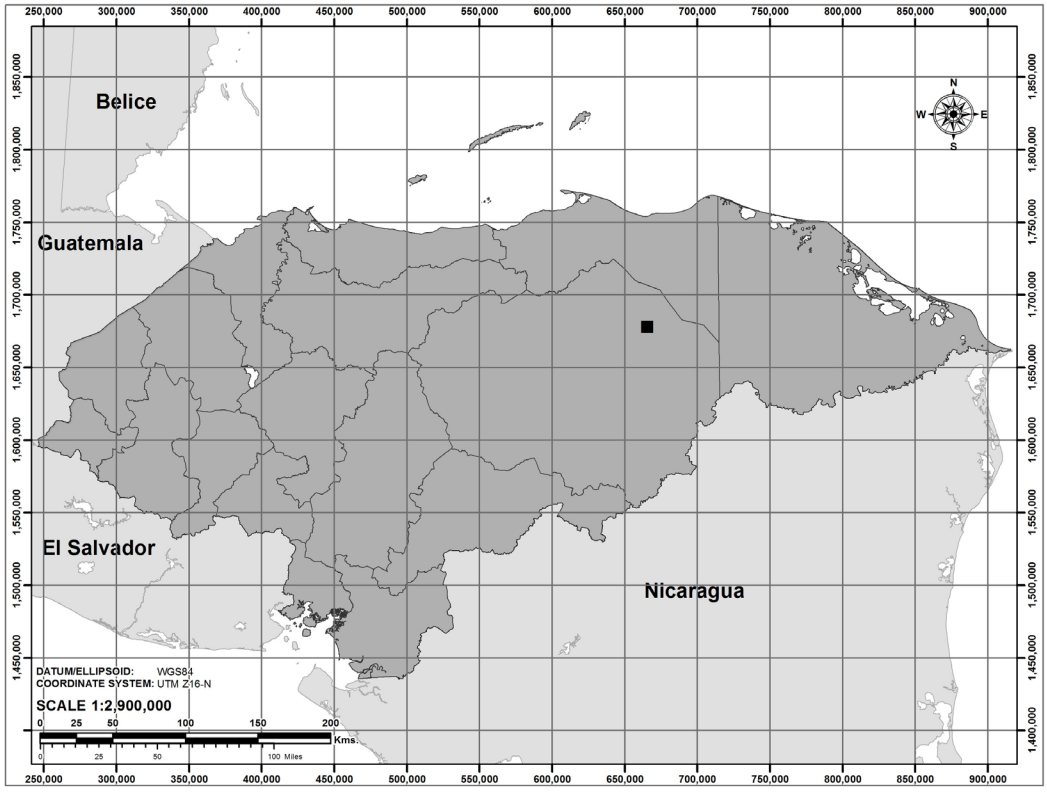

Fig. 1. Capture locality (black square) of an albino spider monkey (*Ateles geoffroyi*) at San Pedro de Pisijire, Dulce Nombre de Culmi, Olancho Department, Honduras (14º32'58.31" N, 85º48'20.79" W). (Map by Jorge Funez).

animals tend to be very conspicuous against a forested background (Uieda, 2000; Kuras et al., 2001; Nkosi and Twala, 2002; McCardle, 2012). However, under some circumstances, white fur may appear pale green due to light filtering through leaves (during the day), such that—for example—white bats are well camouflaged and less visible (Oliveira and Aguiar, 2008). Notwithstanding, we hypothesize that the reduction in visual acuity associated with albinism (Prado-Martínez et al., 2013; Bridge et al., 2014; Lee et al., 2015) most likely would result in an increased frequency of predation and may well be the most potentially damning effect from the condition.

The frequency of albino individuals may also be partly related to specific habitats. Such a case is the high number of albino moles found in various parts of Europe as a result of low predator pressure and due to a subterranean lifestyle (Nedyalkov et al., 2014). In this case, the subterranean lifestyle potentially provides sufficient cover to protect from predators, much as Peles et al. (1995) demonstrated with meadow voles, *Microtus pennsylvanicus*. However, we cannot discount inbreeding even in this instance: indeed, Chętnicki et al. (2007) found that atypically colored shrews, *Sorex araneus*, occurred more often under conditions leading to inbreeding, such as isolated populations exhibiting limited gene exchange with neighboring populations. A reduction in pigmentation also is seen in subterranean fishes (Romero and Paulson, 2001; Proudlove, 2006). Loss of natural camouflage that results in excessive exposure and increased susceptibility to diseases seems to be the major risk for animals with disabilities in melanin production (Da Costa Toledo et al., 2014).

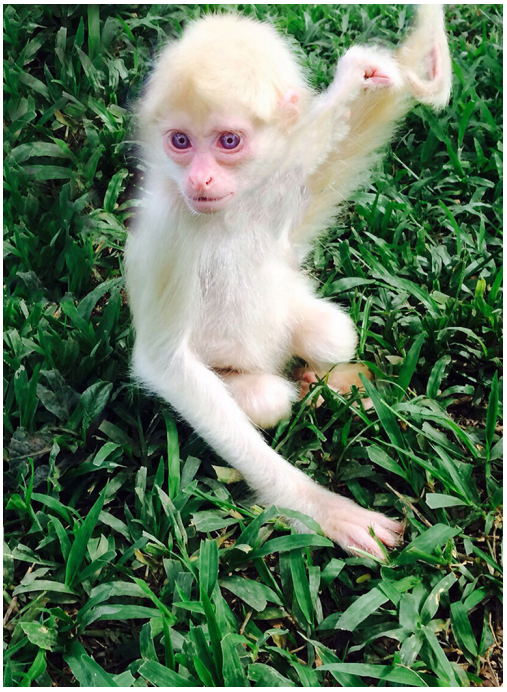

Fig. 2. Albino spider monkey (*Ateles geoffroyi*), a juvenile female from Olancho, Honduras. (Photograph by Gilberto Guifarro Montes de Oca, July 2015)

Prado-Martinez et al. (2013) found that an albino gorilla from Equatorial Guinea (Snowflake) residing in the Barcelona Zoo was the result of its parents' inbreeding. This was the first report of inbreeding in a wild born Western lowland gorilla. Previous parentage studies in this subspecies of gorilla never found inbred mating, suggesting it is probably a rare behavior (Prado-Martinez et al. 2013). That study bears particularly on the taxonomy of conservation status of the spider monkey in Central America. Hines (2005) suggested that the spider monkey in northern Honduras represented a distinct subspecies of *A. geoffroyi* generally distributed north of the Cordillera Nombre de Dios. He further hypothesized that museum specimens from Catacamas, Olancho, appeared to represent the border between his proposed subspecies and the otherwise nominal subspecies for the area, *A. g. vellerosus* Gray, 1866 (although note that Gray noted "Brazil?" as type locality in his original description, which was amended to Veracruz, Mexico, by Kellogg and Goldman [1944]). The instance of an albino from the area of Catacamas (Olancho Department) documented herein could therefore support on the one hand the hypothesis that there is increased inbreeding (by kin mating) among the local subspecies, as for example documented in gorillas by Prado-Martínez et al. (2013), due to increasing fragmentation of habitat into discrete forest patches. This hypothesis would result in the suggestion that stronger conservation measures are required for that population. Alternatively, if Hine's taxonomic hypothesis is correct, the manifestation of albinism likewise could support the hypothesis that two distinct and cohesive subspecies are present in the area, insofar as it could represent some form of hybrid breakdown between the two putative subspecies (Burton et al., 2013). This hypothesis likewise suggests that stronger conservation measures be taken, as the breakdown in cohesive mating likely would be driven (or enhanced) by habitat fragmentation. The current lack of data on albinism in general suggests that more accurate statistics on the occurrence of this phenomenon at large and among primates in particular, as well as refutation of any potentially explanatory hypotheses, depend on increasing the number of case studies, something highly encouraged by both Abreu et al. (2013) and Da Costa Toledo et al. (2014). It also is important to follow albino and leucistic individuals in the wild to more fully understand the aspects of their ecology and biology discussed above.

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