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Short communication

New population and range extension of the Critically Endangered Ecuadorian brown-headed spider monkey (*Ateles fusciceps fusciceps*) in western Ecuador

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Abstract

The western lowlands of Ecuador form part of the Tumbes-Chocó-Magdalena hotspot, a region with exceptionally high endemism but also elevated rates of deforestation. The Critically Endangered Ecuadorian brown-headed spider monkey *(Ateles fusciceps fusciceps*) is endemic to the region and threatened by continuing habitat loss and hunting. Studies of the species' conservation status maintain that its current distribution is restricted to several large tracts of primary forest remaining in northwestern Ecuador, and that the total population numbers around 250 individuals. We report a previously unknown population of brown-headed spider monkeys found 100 km southwest of the species' known distribution in a highly fragmented landscape of Manabí province. This finding not only represents an important advance in our knowledge of the species' geographic distribution, but also suggests that brown-headed spider monkeys may be able to persist as a metapopulation in human-modified landscapes.

Key words: Primate, distribution, conservation, habitat loss, human-modified landscapes.

Resumen

Los bosques del Ecuador occidental forman parte del hotspot Tumbes-Chocó-Magdalena, una región con un endemismo excepcional pero también con altas tasas de deforestación. El mono araña de cabeza café (*Ateles fusciceps fusciceps*) es endémico a la región y se encuentra Críticamente Amenazado por la pérdida de hábitat y la cacería. Estudios sobre el estado de conservación de esta especie mantienen que su distribución actual está restringida a algunas áreas de bosque primario localizadas en el noroccidente de Ecuador, con una población total de unos 250 individuos. Este estudio presenta datos de una nueva población de *A. f. fusciceps* localizada a 100 km al suroeste de su distribución conocida, en una región muy fragmentada de la provincia de Manabí. Este reporte no solo representa un avance importante en el conocimiento de la distribución geográfica de la especie, sino que también sugiere que *A. f. fusciceps* podría ser capaz de sobrevivir como metapoblación en un paisaje antropogénico.

Palabras clave: Primates, distribución, conservación, pérdida de hábitat, paisaje antropogénico.

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Introduction

The western lowlands of Ecuador are part of the Tumbes-Chocó-Magdalena hotspot, a region with exceptionally high rates of endemism but also extensive habitat destruction [1, 2]. An estimated 72% of the original forest cover in western Ecuador has been eliminated [3] by decades of logging and agricultural expansion [1]. This habitat loss has particularly affected species that rely on large areas of intact forest [4], yet the conservation status of even well-known taxa like mammals and flowering plants is poorly understood in the region [5, 6]. Here we report a previously unknown population of the Ecuadorian brown-headed spider monkey *(Ateles fusciceps fusciceps*) found well outside its known distribution.

Classified as Critically Endangered by the IUCN Red List [7], the brown-headed spider monkey is one of the 25 most endangered primates in the world [8]. The species is known to avoid human settlements and prefer humid lowland forests, which have become increasingly fragmented over the past 60 years and are largely unprotected throughout its range [9]. Its large body size and savory meat have long made it a favorite target of hunters [10]. Moreover, a low reproductive rate (2-3 year interbirth interval), high infant mortality, and low population density make the brown-headed spider monkey vulnerable to anthropogenic pressures and hinder its recovery after population decline [11, 12]. The combined effect of these factors has resulted in an estimated 80% reduction of the species' original distribution in Ecuador [10]. Despite the urgent need to protect the brown-headed spider monkey, there is a paucity of information about its distribution, ecology and behavior.

Here we provide evidence of its presence in a human-modified landscape of Manabí province located 100 km southwest of its known distribution. This represents a significant extension of the species' current distribution and suggests an ability to persist in fragmented landscapes according to metapopulation dynamics. We discuss the implications of this finding and propose an agenda for further research and conservation actions.

Methods

Study area

The 1,500-km^2 study area is located in the Jama Coaque Range of northwestern Manabí and includes portions of Flavio Alfaro, El Carmen and Chone cantons. Topography is hilly with steep escarpments, and elevation ranges from 150 to 600 m [13]. Climate is humid tropical with a mean annual temperature of 23°C and annual precipitation of 1,500 mm [14]. Despite a marked dry season between June and December, relative humidity is elevated due to the "garúa" or summer fog [15]. The human population of the area is approximately 40,000, one sixth of whom reside in the city of Flavio Alfaro and the remainder in hamlets and farms scattered throughout the countryside [16].

The landscape consists of a mosaic of cattle pastures, cacao agroforests, tree plantations, and remnants of tropical moist forest. Local residents indicate that forest conversion began in the 1920s when settlers cleared land for subsistence crops, cacao and coffee. Large-scale ranching led to extensive deforestation beginning in the late 1960s. Today the area is 89% deforested, and most forest fragments are < 300 ha in size; only five fragments > 600 ha remain [13]. Almost all land, including forests, is privately owned by family farmers and ranchers. Most forests have been selectively logged for timber but otherwise remain intact, although deforestation continues in remote areas. The closest protected area, Mache-Chindul Ecological Reserve, is 60 km away.

Data collection

While conducting fieldwork in August 2014 to assess the relative impacts of land use and fragmentation on mammals in the study area (*unpublished data*), we encountered a brown-headed spider monkey female in a 124-ha forest fragment. We subsequently began to investigate the species' distribution and population size in the region. We conducted semistructured interviews with local farmers and ranchers to identify sites where the species was likely to occur. To assess respondents' ability to recognize the brown-headed spider monkey, we showed them pictures of the target species, two species known to occur in the region (white-fronted capuchin monkey - *Cebus aequatorialis,* and mantled howler monkey - *Alouatta palliata*), and monkeys not known to be present in the region (Panamanian night monkey - *Aotus zonalis*, white-faced capuchin monkey - *Cebus capucinus* and Ecuadorian squirrel monkey - *Saimiri macrodon*) [17]. We asked respondents how frequently they observed each species and to provide estimates of group sizes.

Targeting fragments where the brown-headed spider monkey was reported to occur, we used a rapid playback method to confirm its presence [12]. We played long calls recorded from the species in Esmeraldas province every 100 m along existing trails, aiming the speaker in four directions to optimize dissemination of the sound [12]. After playing the call for 1 minute, we waited 5 minutes for a response before moving to the next point. If we received a response we located the group and recorded the date, time, GPS location, group

size, and composition (sex and age) [18]. Research permits were provided by the Ecuadorian Ministry of Environment.

Results

In 38 interviews, at least one person living around six of the 11 surveyed fragments reported having seen the brown-headed spider monkey, while no one reported the species in two fragments (Table 1). Residents reported groups consisting of 5-15 individuals. Between March and July 2015, we surveyed six forest fragments using the playback method. Including the fragment where we encountered the first female, we sighted groups ranging in size from one to seven individuals in four fragments (Fig. 1). Overall, we visually confirmed the presence of 16 individuals, including eight females, five males, and three juveniles, two of which were infants.

Table 1. Survey results of *A. fusciceps fusciceps* in 11 forest fragments of northwestern Manabí province, Ecuador. PM = Playback Method; VD = Visually Detected; ND = Not Detected.

Forest fragment	Area (ha)	Coordinates	No. inter-viewees	Reported by local residents	Method	Group size	Adult females	Adult males	Immatures
P3	35	0° 24’ 24.9” S 79° 39’ 5.3” W	0		PM VD	7	4	0	3
Hierbas	36	0° 15’ 14.4” S 79° 49’ 50.2” W	11	no	PM ND				
Cabecera de Pambilar	37	0° 24’ 7.2” S 79° 39’ 59.2” W	6	yes	PM VD	5	1	4	0
P1	51	0° 24’ 24.4” S 79° 39’ 28.3” W	0		PM VD	3	2	1	0
La Crespa	116	0° 21’ 44.5” S 79° 42’ 31.2” W	3	yes					
Tigrera	124	0° 26’ 19.9” S 79° 44’ 14.4” W	0		VD	1	1	0	0
Mono	134	0° 23’ 9.12” S 79° 42’ 31.5” W	5	yes					
Las Lolas	250	0° 22’ 51.9” S 79° 39’ 50.2” W	4	yes					
Ciriaco	302	0° 22’ 41.1” S 79° 57’ 33.5” W	2	no	PM ND				
La Cienega	805	0° 12’ 1.6” S 79° 53’ 33.3” W	6	yes	PM ND				
Rio de Oro	1300	0° 31’ 05.1” S 79° 43’ 47.6” W	1	yes					

The nine forest fragments where the brown-headed spider monkey was either reported or directly sighted ranged in size from 35 to 1,300 ha; three were less than 60 ha (Table 1). Separated from the nearest surveyed fragment by no more than 9 km and as little as 1.3 km, eight of these fragments (Las Lolas, Cabecera de Pambilar, P1, P3, La Crespa, Mono, Tigrera and Rio de Oro) were clustered along the eastern edge of the Jama Coaque Range within an area of approximately 300 km^2. In an 800-ha fragment known as La Cienega located 30 km farther north, residents reported they had seen the species, but our brief attempt to confirm its presence using playback yielded negative results. Residents living around two of the most isolated fragments surveyed (Ciriaco and Hierbas) claimed they had never seen the brown-headed spider monkey, which was supported by the lack of response to playback at these sites.

Fig. 1. Female *A. f. fusciceps* encountered in Cabecera de Pambilar, a 37-ha forest fragment (left), and group of 7 individuals observed in P3, a 35-ha forest fragment (right).

Discussion

Given that only 250 individuals of the brown-headed spider monkey have been estimated to remain in the wild [10], the presence of a previously unknown population existing well outside the species' known distribution has important implications. Madden & Albuja [19] estimated that its historical distribution once encompassed 10 provinces extending from the western Andean foothills to the humid Pacific lowlands (Fig. 2). Based on field surveys in northwestern Ecuador, they determined that it currently occurs in Esmeraldas, Carchi and Imbabura provinces. After surveying suitable locations and documenting museum records throughout its historical distribution, Tirira [10] concluded that the brown-headed spider monkey is currently limited to two main areas: Awá Indigenous Reserve (AIR) and Cotocachi-Cayapas Ecological Reserve (CCER) and surroundings (Fig. 2). Tirira found no evidence of the species south of these areas and argued that it probably went extinct from Manabí province around the mid-20th century. Peck et al. [12] used remote sensing, modeling, and field surveys to identify areas of suitable habitat in CCER and the contiguous Los Cedros and Chontal reserves, as well as forest blocks to the south and west of CCER and within AIR. However, no study to our knowledge has found evidence of the species occurring farther to the south. Confirmation of a population inhabiting an area 100 km beyond the species' current range thus represents a considerable extension of its geographic distribution.

Presence of the brown-headed spider monkey in several forest fragments in our study area suggests at least a moderately sized population in the region. Our visual confirmation of 16 different individuals represents a 6% increase in the total population [10]. Given positive reports of the brown-headed spider monkey in other fragments and availability of suitable habitat to the north and south of our study area, these subpopulations potentially represent a considerable increase in the total population size of the species.

Because the brown-headed spider monkey is believed to rely primarily on large continuous areas of primary forest [20], its presence in a highly fragmented landscape is a novel finding that suggests the capacity to persist according to metapopulation dynamics. The species' ability to migrate through the agricultural matrix between forest fragments is key to balancing local extinctions and maintaining a metapopulation structure that will prevent regional extinction [21]. However, if groups of brown-headed spider monkeys are unable to disperse among fragments because of large distances and low matrix quality [22], the population as a whole will likely go extinct as subpopulations disappear due to fragmentation effects, inbreeding depression, and stochastic events [23].

These initial results underscore the urgent need for further study and targeted conservation actions. We need to understand the effects of local and landscape variables on the spatial distribution, density, and demography of the population to determine extinction thresholds of patch size, fragmentation, and hunting pressure [24-26]. We need detailed information on population dynamics in forest patches and habitat use in the agricultural matrix to determine whether metapopulation processes play a role in regional persistence. How does

habitat degradation impact groups living within fragments? How do matrix quality and landscape configuration affect dispersal [22]? What are the consequences of reduced migration and gene flow on population viability [26]? Long-term monitoring will be necessary to answer these questions and to assess the efficacy of interventions to conserve the brown-headed spider monkey in human-modified landscapes [27].

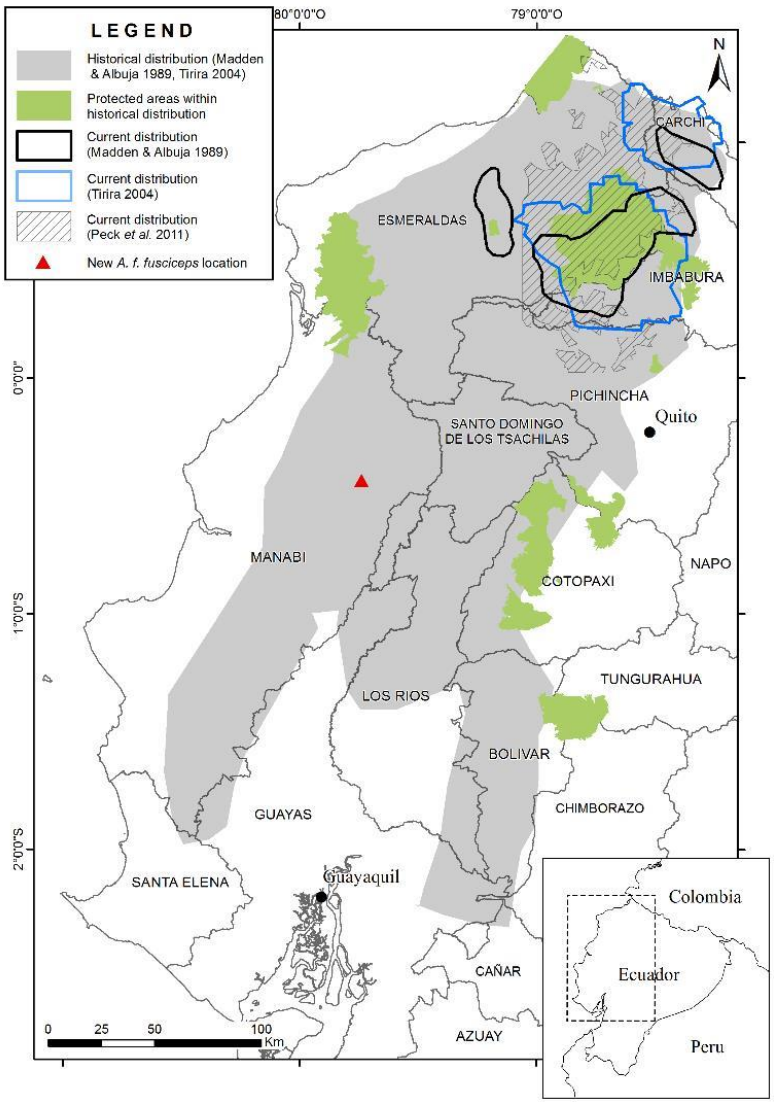

Fig. 2. Map showing the location of a new population of *A. f. fusciceps* in Manabí province, compared to the historical and currently known distribution of the species in Ecuador.

Implications for conservation

Conservation actions will be most effective if they are developed within a framework of integrated landscape management in collaboration with local communities [28, 29]. Local landowners have expressed widespread interest in protecting remaining forests, and we believe the brown-headed spider monkey could be used as a flagship species to conserve native habitat and wildlife. Building on this sentiment, programs like Ecuador's *Socio Bosque*, which provides economic incentives to individuals and communities to protect forests, should be expanded to encourage forest conservation and restoration among greater numbers of landowners in the area [30]. Yet while protection of large forest fragments should form the cornerstone of a comprehensive conservation strategy, forest preservation alone is unlikely to be sufficient to protect wide-ranging species like the brown-headed spider monkey.

An integrated approach incorporating the agricultural matrix is needed to promote biodiversity conservation and sustainable rural livelihoods at the landscape level [29, 31]. Establishment of native vegetation corridors [32, 33] and diversification of shade trees in agroforestry systems can promote primate dispersal and habitat use in the matrix [34, 35], while enhancing ecosystem services and income for farmers [36]. A promising model is the Washu project, which promotes organic cacao production as an economic alternative to deforestation while ensuring protection of brown-headed spider monkey habitat in Esmeraldas [37]. Conservation of the brown-headed spider monkey in human-modified landscapes will depend on close partnerships with local communities to develop and monitor effective management strategies.

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