Short Articles

ROPE BRIDGES: A STRATEGY FOR ENHANCING HABITAT CONNECTIVITY OF THE BLACK HOWLER MONKEY (*ALOUATTA PIGRA*)

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Introduction

The development of linear infrastructure such as roads, highways and power lines is an important element in social and economic development (Delgado et al., 2004; Beckmann et al., 2010). However, like almost any human activity, it causes negative impacts on wildlife (Seiler, 2001; Santos and Tellería, 2006; Taylor and Goldingay, 2010). Habitat fragmentation is one of the main effects caused by the implementation of this infrastructure, creating linear clearings and forest edges which isolate wildlife populations (Delgado et al., 2004; Laurance et al., 2009; Beckmann et al., 2010). This is the case of primates like the black howler monkey (*Alouatta pigra*), an endangered species restricted to southern México and northern Guatemala and Belize (IUCN, 2008; SEMARNAT, 2010). This species has been affected due to poor connectivity of forest patches through its range in southern Mexico, particularly in Tabasco and Campeche states (Pozo-Montuy and Bonilla-Sánchez, 2008; Pozo-Montuy et al., 2008). For arboreal primates, forest fragmentation prevents free movement of primates through the landscape matrix (Isabirye-Basuta and Lwanga, 2008). In addition, this can lead them to adopt unusual behaviors such as movement on the ground to reach another fragment in search of food, sleeping sites or mates (Pozo-Montuy and Serio-Silva, 2007; Martínez-Mota et al., 2007). Such movements on the ground increase the probability of predation, disease transmission from other wild or domestic animals, or road kills (Martínez-Mota et al., 2007; Pozo-Montuy and Bonilla-Sánchez, 2008). Because of that, several methods to mitigate the impacts of fragmentation have been proposed, such as canopy bridges (Gregory et al., 2013) and rope bridges (Valladares-Padua et al., 1995; Weston et al., 2011), which can connect fragments allowing primate movement. The use of both types of bridges has been documented for several arboreal mammals in Belize, Peru, Brazil and Australia (Lyon and Horwich, 1996; Turbher and Ayarza, 2005; Weston et al., 2011; Gregory et al., 2013; Zimmerman Texeira et al., 2013). Canopy bridges have been implemented in tropical evergreen forest, where tall trees (15-35 m high) allow binding of canopy (Turbher and Ayarza, 2005; Gregory et al., 2013). In southern Mexico, the dominant vegetation type is medium stature forest (sub-perennial and semideciduous forest; Rzendowsky, 2006), which makes it almost impossible to form canopy bridges. Nevertheless, rope bridges have been implemented for spider monkeys (*Ateles geoffroyi*) in Punta Laguna, Quintana Roo and for black howler monkeys in Balancán, Tabasco, both locations in Mexico. However, their efficiency and functionality are unknown.

This paper reports the use of one rope bridge by a troop of black howler monkeys between two fragments of habitat in Palizada, Campeche, Mexico. This contribution provides critical information on the behavioral flexibility and adaptability of this species to use artificial devices like the rope bridges.

Methods

Study Area

The study site, Environmental Management Unit "Rancho San Román" (UMA; acronym in Spanish), is a private ranch located within the wildlife protected area "Laguna de Términos", 16 km southwest from Palizada, Campeche, Mexico (N 18°6'46.09", W 92°5'35.20"). The predominant climate in the region is warm humid with a mean annual temperature of 27°C (INEGI, 2009). There is a rainy season with an annual average rainfall above 1,500 mm (INEGI, 2009). The main types of vegetation in the UMA are low flooded forest and gallery forest surrounded by grassland for livestock, plots of fruit trees (mango, orange and zapote) and ecotourism cottages (Hernández-Pérez et al., 2014).

Implementation of the Rope Bridge

Prior to installation of the bridge, a study was conducted to report on the feeding behavior of a troop of black howler monkeys (one adult male, one adult female, one young female and one infant) in the rainy season (August-October; Hernández-Pérez et al., 2014). In this study six crossings between patches (places where one or more individual came to the ground and moved to another patch) were documented. Two of those patches (15 m apart) were connected by an electric power line which sometimes was used by the troop to cross. Due to the damages to the electrical infrastructure caused by the troop of monkeys, the UMA owners decided to remove the power line, which caused the monkeys to begin to move on the ground more frequently. Therefore, on October 16, 2014 the rope bridge was constructed in the location of the previous power line. The goal was to avoid movement of monkeys on the ground, which could cause them to be attacked by dogs or be killed by a vehicle, as the patches are separated by a dirt road.

The bridge was made using silk rope of 15 mm diameter and wooden rods (50 cm long and 3x1 cm thick). The wooden rods were placed 20 cm from each other, on two parallel lines of rope and fixed with wires. The bridge was tied to the trunks of the trees nearest to the fragment edge, at a height of 3 m from the ground. Two poles were placed in T-shape to stabilize the bridge and to prevent twisting. The bridge had a length of 20 m.

Figure 1. Male black howler monkey (*Alouatta pigra*) using a rope bridge in Rancho San Román UMA, Palizada, Campeche, Mexico. Foto: José D. Cú-Vizcarra.

Monitoring of Troop

After the rope bridge installation, we followed the troop for three months looking for the monkey troop´s habituation and any sign of use of the bridge. *Ad libitum* data were taken (Martin and Bateson, 1986), recording only behaviors that indicate the use of the bridge, for example, to get to the bridge, sit still watching the bridge, touch it, etc. The observations did not follow a defined schedule, and were made only when the troop moved towards place where the bridge was located. This was in the morning between 8:00 and 10:00 h, and in the afternoon between 17:30 and 19:00 h. We totaled 127 hours of observation.

Results

During the first month, after the rope bridge installation, we did not observe any curiosity or interest in the bridge by the monkeys. However, in November, the adult male began to show interest in the bridge, getting as close as about 1 to 2 m to the bridge at moments, followed by the rest of the troop (adult female, young female and infant), until the rest came one meter from the bridge. It was not until January 11, 2015, we observed for first time the adult male crossing the rope bridge (Fig. 1), and after few days the rope bridge was used by all individuals in the troop. The rope bridge was used by monkeys on average of two times per day, approximately, between 9:00-10:00 h and 17:00-18:00 h. We document that the bridge was used for travel between patches, we did not observe other uses by the monkey troop, but by gray squirrels (*Sciurus aureogaster*) which were observed feeding on the bridge. Besides howler monkeys and gray squirrels, the bridge was used by another species, the common opossum *Didelphis marsupialis*.

Discussion

Habitat fragments near roads and highways are the first to disappear, due to edge effects (Bonilla-Sánchez et al., 2011) that reduce the fragment area and its functionality and increase the isolation of wildlife populations (Forman et al., 2002). The installation of rope bridges could help to mitigate this effect, until native trees are planted to form live fences that naturally connect fragmented areas. Live fences have been used in response to fragmented landscapes, creating corridors of trees that connect several habitat fragments and facilitate reforestation (Chacón-León, 2006). However, the planting of trees to connect patches of habitat is not always possible. For example, it is impossible to plant trees in road areas like dirt roads highly frequented by people, paved roads and highways. Therefore, rope bridges can become relevant to maintain connectivity, as they are an inexpensive tool in manufacturing and installation. In addition, they function as an ideal substrate for the movement of the monkeys and other arboreal wildlife, preventing them from coming to the ground where they are vulnerable to hazards.

Cuarón (1995) mentioned that the use of rope bridge in open areas can cause negative effects like predation of small primates by raptors, because they are exposed. This author, suggests some modifications, such giving the bridge a "roof", mesh on the sides and natural vines to camouflage, or to take a tubular shape to avoid predation. However, these modifications may attract other predators such as snakes, and also could be used as nesting sites for birds and mammals (like rats and mice). Moreover, the howler monkeys are considered one of the largest primate species of America (CONABIO, 2011), and the largest raptor (*Harpia harpyja*) is absent from our study area, making it unlikely that howlers would suffer predation by raptors when using of the rope bridges.

This study demonstrates the functionality of rope bridges by an *Alouatta pigra* troop in a fragmented habitat at Palizada, Campeche, Mexico. In general, we recommend following up and evaluating various artificial bridge types and designs under different conditions (dirt roads, paved roads, distance between habitat fragments, target species as the spider monkeys, etc.), in order to know the impact and functionality for primate populations, and in their conservation.

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