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Planted Trees as Corridors for Primates at El Zota Biological Field Station, Costa Rica

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Introduction

We conducted a study at the privately owned El Zota Biological Field Station in Costa Rica to assess the effects of forest management techniques on primate ecology and behavior. While many conservation-oriented studies note the need for "corridors" to promote dispersal between isolated habitat fragments, few studies provide quantitative information on their use by primates. From July to August 2002, we studied the three primate species that occur at the El Zota Biological Field Station in Costa Rica— *Cebus capucinus, Ateles geoffroyi, Alouatta palliata*— to compare their use of planted versus naturally forested areas. We collected approximately 25 hours of data to quantify the general activities exhibited by primates in these types of habitat.

Methods

Field site

The El Zota Biological Field Station (10°57.6'N, 83°75.9'W) in northeastern Costa Rica (see Pruetz and LaDuke, 2001) is affiliated with the non-profit organization DANTA: Association for Conservation of the Tropics, which, in addition to organizing university-level field courses, seeks to preserve biodiversity in this region of the country. The station is owned by the Hiner Ramirez family of Guapiles and is also affiliated with the Fundación Neotropica in Costa Rica. El Zota has offered field courses in topics such as Primate Behavior and Conservation, and Tropical Herpetology since 2001 and provides an opportunity for students to compare intact forest ecosystems with disturbed and fragmentary habitats. Covering some 1000 ha, much of the site is primary humid and swamp forest (700 ha), but it also includes areas of planted native and non-native trees (~270 ha), as well as pastures formerly used for cattle (30 ha) but now planted with food crops or used for grazing by horses. Emergent trees typical of primary lowland forest in Costa Rica, such as *Dipteryx panamensis*, are widely logged but common at El Zota. Some of the notable fauna there include jaguar (*Panthera onca*), tapir (*Tapirus bairdii*), great green macaw (*Ara ambigua*), king vulture (*Sarcoramphus papa*), brown caiman (*Caiman crocodylus*), the fer-de-lance or terciopelo (*Bothrops asper*), and strawberry poison-dart frog (*Dendrobates pumilio*).

The large-scale plantings at El Zota are part of a reforestation plan in areas previously deforested and used as cattle pasture. Both native and exotic species were originally planted for sustainable tree harvesting, especially *Gmelina arborea* (Meliaceae), *Carapa guianensis* (Meliaceae), and *Hyeronima alchorneoides* (Euphorbiaceae). *Gmelina arborea* is a fast-growing tree indigenous to Asia (Arbonnier, 2000) and is the primary species planted at El Zota. It is planted at a density of approximately 82 trees per ha (Linsenbardt, unpubl. data) and produces fruits edible to humans, which are possibly also eaten by the non-human primates. Other tree plantings appear to be similarly spaced and probably occur at similar densities. *Hyeronima* is a large forest tree native to Costa Rica, characterized by small berry-like drupaceous fruits that are edible for humans (Martin *et al.*, 1987). *Carapa guianensis*, also native, is a medium-sized to emergent tree especially prevalent in rich soils and swamps (Gentry, 1993). The age of the plots at this site for all three species is approximately 8 to 10 years.

Study subjects

The three species of primates at El Zota overlap in range as well as diet. The mantled howling monkey (*Alouatta palliata*) is folivorous and frugivorous, preferring young leaves to mature foliage (Sussman, 2000). Flowers and a small amount of insect material also constitute a significant portion of its diet on a seasonal basis (Burton, 1995). Fruit accounts for approximately 80% of the diet of the black-handed spider monkey (*Ateles geoffroyi*), while leaves make up the remaining 20% (Burton, 1995). It has large day and home ranges due to its widely and patchily distributed food resources (Sussman, 2000). This means that this species in particular needs large contiguous forest remnants or smaller protected islands connected by large travel corridors. The white-faced capuchin (*Cebus capucinus*) has the most varied diet. It is frugivorous and insectivorous. Fruit comprises 65% of its diet, while insects (20%) and leaves (15%) also figure prominently (Burton, 1995). Capuchins have also been known to eat eggs, small vertebrates, buds, and berries (Burton, 1995).

At El Zota, these three primate species use their mutual forest habitat in structurally different ways due in part to their variable dietary requirements. The plantation trees could potentially be used alternately or in combination as food resources, travel corridors, or resting areas between separated parts of the secondary forest. To date, while use of the planted plots has been described anecdotally, no quantification has been made as to the nature of that use or possible species-specific patterns that may exist. This study is one of the first to describe patterns of forest usage exhibited by these three primate species in relation to the plantation stands.

Capuchin groups at El Zota are typical of those reported elsewhere (Sussman, 2000), having a multi-male, multi-female social system. Two groups of capuchins, each of more than 10 individuals, were identified in the main 50-ha study area. The spider monkeys showed the typical fission-fusion social system characteristic of this species (Sussman, 2000), and the largest party was observed to contain 18 individuals. Mantled howling monkeys are the most common species at El Zota. Five multi-male, multi-female groups, each including between four to seven adults in addition to lone individuals, were the focus of behavioral observations at El Zota. Pruetz and LaDuke (2001) estimated that primates at El Zota occur at densities of approximately 35 howling monkeys/km², 30 capuchins/km², and 28 spider monkeys/km².

Observers (KL, JL, JP) followed a systematic observation schedule in which focal group follows were attempted throughout the day to control for temporal bias in primate activity. Over 100 hours in the field yielded approximately 25 hours of systematic data, although contact with primate groups accounted for over 50 hours. A system of trails (3 km) that followed natural ecological contours, such as streambeds, was used in addition to more randomly-oriented transects (1 km) and roads passing through plantations (2 km). Scan-sampling of all group members was used to record general activity patterns, such as rest, travel and feeding, as well as habitat (gallery forest, secondary forest, plantation) and precise location using trail markers placed every 10 meters.

Results

The three species used areas of planted trees for movement/travel and resting, with the proportion of time devoted to moving within plantations greater than for other activities observed in this habitat (see Fig. 1). Howling monkeys spent relatively more time resting in plantation areas (26% of time) than spider monkeys and capuchins (17% and 16%, respectively). Primates were never observed to feed on the non-native *Gmelina*. Although spider monkeys were not seen to feed in *Hyeronima* trees in the plantations during systematic observations, they were observed doing so at other times, and all three species fed in *Hyeronima* trees wherever they occurred in natural forest at El Zota. Like *Ateles*, *Cebus* rested and moved within planted areas, but were never seen to forage there. *Alouatta* fed on *Hyeronima* in planted areas, and moved through these areas, but most of the feeding that we observed there was during a single feeding bout on a lone *Ficus* left standing in a *Gmelina* grove. One group of approximately 10 howlers frequented this particular tree.

Discussion

Various studies have demonstrated that primates are able to adapt to corridor habitats. Lion-tailed macaques (*Macaca silenus*), for example, readily adapt to tea gardens in the Western Ghats of India, where native rainforest fragments are separated by tea and coffee plantings as well as eucalyptus trees, and where non-native plants outnumber native plants (Singh *et al.*, 2001). The macaques fed more often on non-native plants than native ones, and changes observed with the introduction of non-native species to the macaques' habitat included their tendency to forage on the ground for insects and fallen fruits. Birth and survivorship rates at this site increased, possibly in part due to increased food sources in the corridors (Singh *et al.*, 2001). This study demonstrated that corridors can be implemented in degraded natural areas to help the animals adapt to a changing ecosystem.

Other studies have demonstrated that plantation corridors provide new food sources for primates. Brown lemurs (*Lemur fulvus*) near Perinet, Madagascar, have been recorded using old mixed eucalyptus and pine plantations as a new food source (flowers of both pine and eucalyptus) as well as for travel, resting and sleeping, although population densities in these areas were significantly lower than in natural forest, and new eucalyptus plantations were used very little (Ganzhorn, 1985, 1987). Nonetheless, Ganzhorn (1987) concluded that non-native plantation corridors were effective in connecting natural forest areas and extending the natural habitat of primates, as well as in creating a buffer zone between the natural forest and outside disturbances. Similarly, Zanne *et al.* (2001) concluded that introduced pine plantations may attract more indigenous mammals, including primates, than agricultural or fallow land in Uganda. They likened these abandoned plantations to wildlife refuges in an area where the landscape is fragmented. In this case, such habitat could be interpreted as augmenting the associated refuges. Finally, Bicca-Marques and Calegaro-Marques (1994) demonstrated that wild black howlers (*Alouatta caraya*) in southern Brazil relied on introduced plant species during periods of native fruit scarcity. Clearly, although introduced species are viewed as problematic by most wildlife conservationists, non-native or non-indigenous species may prove to be beneficial short-term solutions

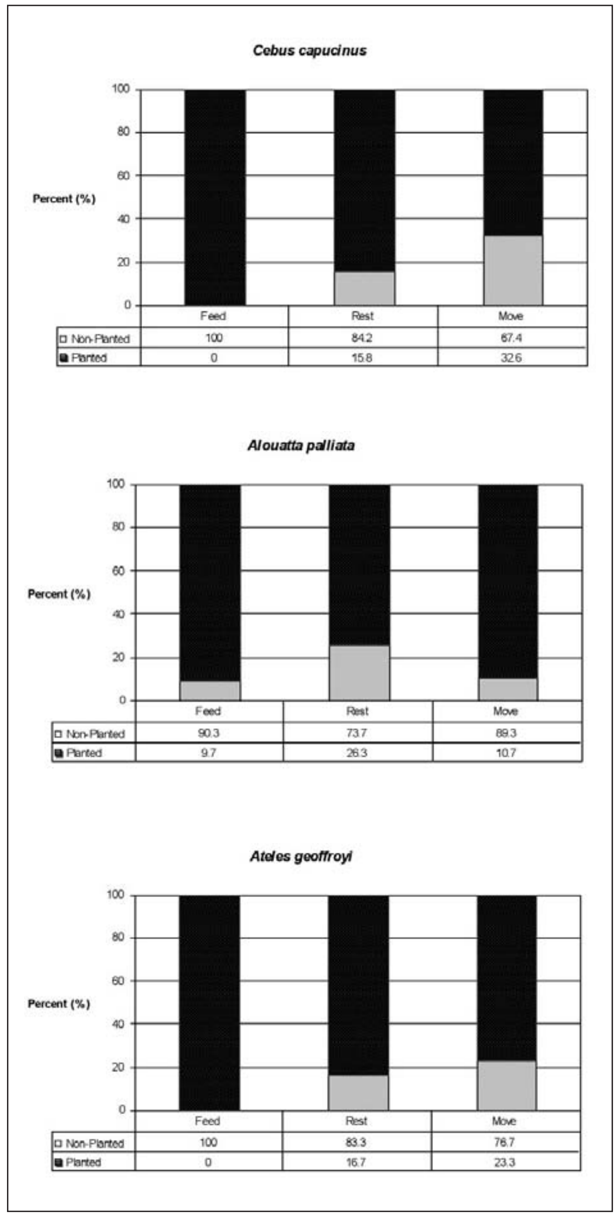

Figure 1. The use of planted versus non-planted (natural) areas by three species of primates at El Zota Biological Station. The graphs show the percentage of time dedicated to feeding, resting and moving in these areas. The numbers in the tables show the proportion of time each species spent feeding, resting and moving in the two different habitats.

for the long-term conservation of primate species in some contexts, especially in isolated forest fragments.

The propagation of non-native trees might be considered in certain cases because fast-growing species could provide travel corridors for primates or access to native food trees, as was observed with primates at El Zota. A narrow corridor of non-native, rapidly growing tree species could be supplemented with slower-growing native species. These plantations could also act as buffers and wildlife refuges in fragmented habitats and would appear to be preferable to fallow or agricultural land (Zanne *et al.*, 2001). At El Zota, trees were originally planted to provide timber for making paper. Research into the ecology of introduced species before implementing such a project is crucial. Although *Gmelina* trees at El Zota provide travel pathways for all three primates, the extensive root network of this introduced species prohibits significant undergrowth where it is thickly planted, stifling succession by native species. For this reason, future management plans at El Zota include intensive clearing of areas after *Gmelina* harvest and the propagation of native tree species, such as *Hyeronima* (J. Ramirez, pers. comm.). Using native trees and allowing succession to occur would provide areas conducive to supporting wildlife, rather than merely providing corridors for wildlife movement (Lindenmayer and Nix, 1993). Although all the plantations were originally part of a sustainable wood-harvesting scheme, the primates' use of these areas for travel has caused the management to change its harvesting plans. Tentative plans are to harvest certain trees while sparing stands that serve as pathways for primates. By cooperating with biologists, the owner and managers of this private reserve allow for a land-use regime that is compatible with the conservation of biodiversity.

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Further Information on Neotropical Monkeys Reported in the XVI Century

Bernardo Urbani

Previously, I reviewed chronicles that reported on or illustrated Neotropical primates in the XVth and XVIth centuries (Urbani, 1999). Recently, I found two new documents that are important for understanding how New World monkeys were initially represented in Europe and Asia.

The first is an Ottoman map of 1513 made by the Turkish Admiral Piri Re'is (1470–1554), a navigator and polyglot who spoke Greek, Arabic, Italian, Spanish, and Portuguese. This work, known as the Piri Re'is *Carte de L'Atlantique* (90 x 65 cm), is housed at the Topkapi Sarayi Museum in Istanbul, Turkey (La Ronciere *et al.*, 1984: plate 28). The polychrome map was lost until 1929 and was part of a larger planisphere. Monkeys were illustrated but not mentioned in the text (Afetinan, 1954; McIntosh, 2000) (Fig. 1). In addition to Portuguese and Arab sources, Piri Re'is may have drawn from a chart by Christopher Columbus, apparently found in a Spanish ship captured by the Turks in the