in the population if methods are not standardized from year to year. Continuation of this annual monitoring of basilisk populations should adopt explicit, standardized methods for both time of day and search time. Observations during our sampling suggested that search times greater than 10 min per transect yielded little change in the number of basilisks observed; we therefore recommend 10 min as a standard search time for transects (with one researcher observing each riverbank on smaller streams and two per riverbank on the larger Rio Claro). From our two censuses of Stream 2 and general observations, basilisks seemed to be less active in the mornings, especially before mid-morning, when the temperature becomes hot. We suggest that sites be identified and 50-m transects flagged in the morning. Non-intrusive measures (such as stream width, percent cover) can be taken at this time. Basilisks are skittish; many of our basilisk sightings were made as they fled from us. Censusing should be done in the afternoon (as it was in 1999 and 2000), when basilisks are fully active and a couple hours have passed to allow them to return to their streamside perches after the disturbance of the morning flagging.

A final note: the Rio Claro and riverbanks in general in Corcovado have been reported to be sites of rather high snake abundance, including the fer de lance, *Bothrops asper* (Berg et al 1998). While we saw no snakes, we did come within meters of a couple crocodilians (one small, one not so small) ~ 300 m up the Rio Claro. In all areas, vigilance is recommended.

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Effect of Time of Day on Spider Monkey (*Ateles geoffroyi*) Behavior

Justin E. Campbell, Christina L. Glastris, Shane R. Heath, Dora J. Sugar

Abstract: The behavior of spider monkey groups is known to be dynamic over the course of a day. Here we attempted to determine whether time of day consistently affects individual spider monkey behaviors. We examined the proportion of time spent drinking, feeding, resting, and traveling, as well as the extent to which an individual's behavior matches that of the rest of the group members. We hypothesized that the proportion of time spent resting by spider monkeys would be greatest during the midday when the temperature is highest and that foraging activity would be greatest in the early morning and late afternoon. We observed 71 *Ateles geoffroyi* individuals for 10-min intervals at Corcovado National Park over three days, and noted the proportion of time spent drinking, feeding, resting, and traveling. We found that time of day had no effect on proportion of time spent drinking, feeding, or traveling. As predicted, however, spider monkeys rested more at midday, minimizing physiological stress by avoiding exertion during the hottest part of the day. In all activities, individual behavior was consistent among group members. Our results imply that the effect of time of day should be taken into account in further studies of monkey behavior.

Key Words: Balsa, foraging, Ochroma lagopus, *primate behavior*

Introduction

Spider monkeys, *Ateles geoffroyi*, live in sub-groups which undergo frequent changes in size, age structure, and sex ratio throughout the day (Chapman 1990a). Previous studies have investigated the effect of sub-group size, food availability, and sex ratio on time spent feeding, traveling, and watching for predators (Dums et al. 1997, Chapman 1990a, Dallison et al. 1999). These studies, however, did not take into account or examine daily fluctuations in behaviors. We sought to quantify changes in spider monkey behavior over the course of the day, examining the proportion of time spent drinking, feeding, resting, and traveling. We predicted that the individual behaviors measured would closely match the behaviors of the rest of the group members at any given time.

We also predicted that the proportion of time spider monkeys spent resting would be greatest during the midday and that foraging activity would be higher in the early morning and late afternoon. Such a pattern would minimize exertion during times we thought would be stressful physiologically, as the temperature at Corcovado was observed to be highest during midday.

We observed that spider monkeys drank water, nectar, or both from the cup-shaped flowers of balsa, *Ochroma lagopus*, early one morning. As nectar and water may accumulate in the flowers to a greater degree during the night, we predicted that monkeys would visit balsa flowers most often in the morning.

Methods

Spider monkeys were observed on 3 - 5 February 2001 in Corcovado National Park, Costa Rica. Individuals and sub-groups were located by searching along seven trails, all within 3 km of Estación Biológica Sirena. The searches were conducted from 05:30 - 06:30, 07:30 - 11:30, and 12:30 - 17:30. Once encountered one to several focal individuals in each group were observed simultaneously or sequentially for 10 min periods. During this interval we measured the amount of time the focal monkey exhibited feeding behavior (placing leaves or fruits in mouth), drinking behavior (placing mouth in flower), resting behavior (prolonged inactivity), and traveling behavior (movement between trees).

Observation intervals were placed in one of three categories: morning (05:30-10:00),

midday (10:00 - 15:00), or afternoon (15:00 - 17:30). Feeding, drinking, resting, traveling activities, and foraging behavior (the combination of feeding and drinking behavior) across all three time categories were compared using nested ANOVAs (time of day within group). These nested ANOVAs were used to determine how closely individual behavior matched the behavior of the rest of the group members.

Results

We observed during the three days of study a total of 71 spider monkeys: 26 in the morning, 29 in midday, and 16 in the afternoon. There was no effect of time of day on proportion of time spent drinking (ANOVA, $F = 0.00$, $df = 1$, $P = 1.00$), feeding (ANOVA, $F = 0.00$, $df = 1$, $P = 1.00$), or traveling (ANOVA, $F = 0.04$, $df = 1$, $P = 0.84$). Proportion of time spent resting was significantly affected by time of day (ANOVA, $F = 23.22$, $df = 1$, $P < 0.0001$), with individuals resting most at midday (Fig. 1). Group behavior had a significant effect on all individual behaviors (ANOVA, $P < 0.0001$ for all behaviors tested), indicating that individuals within groups tended to engage in similar activity.

Behavioral observations

Foraging. On 3 February 2001, a group of five spider monkeys were observed from 05:50 - 07:00 foraging in balsa trees along the Sendero Pavo. Individuals would spend several minutes in the same tree, moving from flower to flower. An individual monkey was observed to tilt the flowers towards its mouth and apparently drink the nectar or liquid inside.

During the afternoon of 4 February 2001 (16:30 - 17:00), a group of four spider monkeys was observed picking flowers from the branches of five adjacent balsa trees on Sendero Rio Sirena. Individuals tore pieces of the flower off and put them to their mouths or dipped their hands into the flower and then licked their fingers. They then discarded the entire flower without eating any of it.

Spider monkeys were observed on several occasions (e.g., morning of 4 February 2001: 06:30 - 06:40; 07:35 - 07:45) foraging on foliage. Monkeys tended to switch feeding sites every few minutes on the same or adjacent trees. Individual monkeys ate from 25 to 42 leaves over a 10 min observation period. Individuals of a group would often forage in the same tree on different branches or in adjacent trees.

Resting. Two groups of spider monkeys were observed resting along the Sendero Espaveles in the afternoon of 3 February 2001 (13:25 - 13:50). In each group, all individuals were in the same tree (many on the same branch) and were spaced no more than 1 - 2 m from the next nearest individual, often making physical contact. Individuals did not change their positions, and rarely their postures, over the 10 min period.

Traveling. On 4 February 2001 at approximately 16:30, one group of spider monkeys was observed traveling through 22 trees

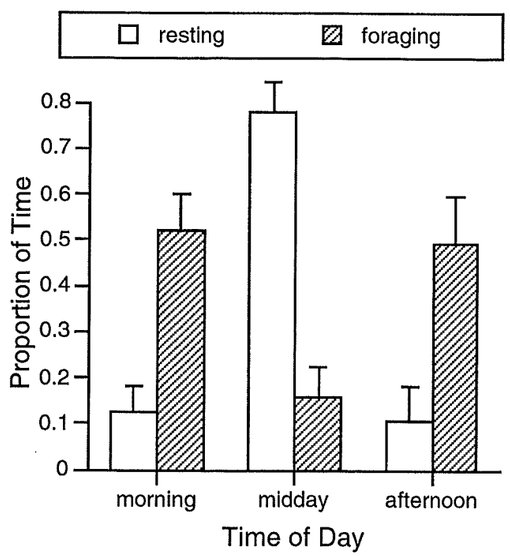

Fig. 1. Mean proportion of time (± 1 SE) individual *Ateles geoffroyi* spent resting and foraging during a 10 min observation period (n = 71). Foraging is the sum of the proportion of time spent feeding and proportion of time spent drinking.

within the 10 min observation period. Individuals in all groups frequently followed the same path through the trees as the lead individual, although subsequent individuals might be several minutes apart.

Discussion

All behaviors of spider monkey individuals were significantly affected by those of the entire group; individuals within a group engaged in the same behaviors concurrently. This result is in keeping with the sub-group behavior noted by Chapman (1990a, 1990b), since individuals that perform different behaviors at the same time would travel at different rates and thus dissolve sub-group structure. This cohesion was further demonstrated by the tendency of the monkeys to use the same path while traveling. The benefits of spider monkey group structure include heightened predator awareness (Dums et al. 1997) and improved foraging efficiency (Chapman 1990b).

As predicted, spider monkeys rested more during midday. This lends credence to our assumption that monkeys minimize exertion during this period of the day to avoid temperature-related physiological stress. Since spider monkeys are largely inactive during midday, it follows that high exertion activities, such as foraging, would be proportionately higher in the early morning and late afternoon. Our data did not support this prediction. The diurnal variation in spider monkey foraging behavior merits future study.

Our data also did not support the prediction that the utilization of balsa flowers (for nectar, water, or both) by spider monkeys would occur exclusively in the morning. The use of balsa flowers varied during the day, as described in the results. In the morning, water from dew or rainfall may collect in the flowers or nectar may be produced overnight enabling monkeys to drink in the early morning. During the day this water may have evaporated, making it necessary for them to tear apart the flowers and lick the nectar from them or wipe the nectar out with their hands. Thus, increase in temperature during the day could be altering nectar availability and necessitating a change in foraging behavior.

Our study suggests that time of day influences spider monkey behavior. Further studies should account for biases in observations which may be associated with the time of day at which sampling is conducted.

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