



Spider monkey grouping patterns, habitat use and sex differences in behaviour

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Spider monkeys are frugivorous primates that live in complex societies characterised by high degree fission-fusion dynamics whereby members of the same community are rarely all together and spend their time in fluid subgroups that constantly change in size and composition (Aureli et al., 2008). Spider monkeys are large-bodied, frugivorous primates that generally occupy primary forest with large fruiting trees that can provide sufficient fruit supply. As they are unable to adjust their diet if food supply diminishes, spider monkeys are considered to be unable to adapt to changes to their environment associated with habitat fragmentation (Chavez et al., 2012). However, spider monkey home ranges can incorporate areas of low and medium forest that are generally used as corridors to gain access to different patches of high forest (Ramos-Fernandez & Ayala-Orozco, 2003).

Flexible subgroup sizes in spider monkeys are an adaptation to reduce feeding competition by matching subgroup size to food patch size (Symington, 1990). Subgroup size is therefore directly related to food availability but fission-fusion dynamics cannot completely eliminate competition for resources. Group size and composition can have a notable effect on activity budgets, ranging and social interactions, particularly as there are notable sex-differences in the quality of social relationships and the type of social interactions exchanged by males and female (Slater et al., 2009). Unlike other primates, spider monkeys rarely engage in social grooming and have a unique suite of friendly behaviour consisting of embraces, kisses and pectoral sniffs (Aureli & Schaffner 2007; Slater et al., 2007; 2009). Rates of friendly behaviour and aggression vary considerably between male-male, male-female and female-female dyads and can provide insight into the strength of social bonds (Slater et al., 2009, Schaffner et al., 2012). There are also considerable sex differences in the context in which aggression and friendly behaviour arise. For example, females use embraces as a currency to “purchase” commodities (Slater et al., 2007), whereas males use embraces to reduce the likelihood of aggression during tense situations such as fusion events (Aureli & Schaffner, 2007) or when in the presence of potential mates (Slater et al., 2009). Patterns of aggression also differ between the sexes. Aggression between males is generally rare, and males direct the vast majority of their aggression towards females (Slater et al., 2008). Female aggression also occurs relatively infrequently, but when it does occur it is generally between adult females in the context of feeding (Asensio et al., 2008; Slater et al., 2009).

A large community of spider monkeys in the Calakmul Biosphere Reserve has been studied each summer since 2013. The summer months are associated with the onset of rainy season and high fruit production resulting in large subgroups of spider monkeys. However, in 2015 the reserve suffered a severe drought and during this time virtually no fruit was available. Using the long-term data set students can investigate changes to ranging patterns, subgroup composition and the associated effect on rates of social interactions in relation to rainfall patterns and food availability. Another project could focus on spider monkey activity and habitat use. An investigation of how spider monkeys use the different forest types will determine whether spider monkey populations could survive in disturbed areas with limited availability of high forest. In addition, projects can investigate sex differences in aspects of social behaviour such as embraces and aggression.

As spider monkeys live in the upper canopy of the forest, they are generally difficult to study and documentation of their social interactions is limited to a small number of field sites. The low and partially open canopy of the Calakmul forest means that spider monkeys can be viewed very easily, and the abundance fruit crop from June to September means that the monkeys don't have to spend large amounts of time travelling and searching for food such that social interactions occur at a very high rate. As virtually all data on the social behaviour of spider monkeys come from one site in Mexico (Punta Laguna), this long-term project in Calakmul will provide the first "test ground" of the hypotheses developed in Punta Laguna. Projects can aim to investigate, the context in which different social interactions occur, sex differences in rates and type of social interactions and the effect of group composition on activity budgets.

Methods

The Calakmul Biosphere Reserve is an UNESCO World Heritage Site of Culture and Nature due to the forest of outstanding biodiversity that surrounds multiple ancient Maya ruins sites, including the city of Calakmul that contained up to 150,000 people during the height of its power between 250BC – 900AD. The tropical semi-deciduous forest in Calakmul Biosphere Reserve is unusual in that areas close to Mayan Ruins contain unusually high densities of large fruiting trees (the result of Ancient Mayan agro-forestry) in comparison to other areas (Ross & Rangel, 2011). As there are no rivers or streams in the reserve, forest structure is also heavily affected by distance from the limited number of lakes in the reserve known as aguadas. The Calakmul forest contains the largest remaining population of spider monkeys in Mexico. Data will be collected on a large troop of spider monkeys (*Ateles geoffroyi yucatanensis*) that base their home range around a large aguada close to the main base camp at km20 (Figure 1).

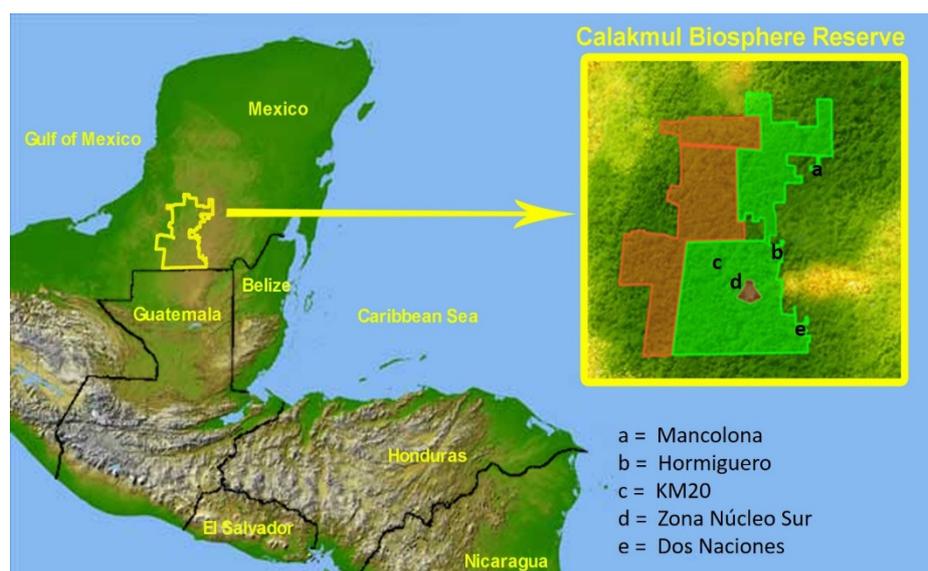


Figure 1: Location of research camps in Calakmul

Behavioural observations will be conducted each day for roughly 6.5-hour periods either from 05.30 until 12.30 or from 12.00 until 18.30. An equal number of morning and afternoon observations will be conducted throughout the summer. The GPS location of the group will be recorded throughout the day at half hour intervals in order to assess home and day range. Activity budget data will be collected using instantaneous scan samples (Altmann 1974) at 10-minute intervals noting the behaviour (feeding, moving, resting, social and vigilant; Table 1) of each adult male and female in the group and the type of forest (high, medium or low) that the monkeys are located in. Friendly and aggressive social interactions (Table 1) will be recorded using all occurrences sampling, noting the time of the event, the sex of the individuals involved, and the context in which the behaviour occurred. Subgroup composition will be recorded throughout the day in conjunction with the scan samples, but the specific time of all fission and fusion events will be recorded, noting the subsequent changes to subgroup composition as they occur.

Table 1: Ethogram of spider monkey behaviour used for the study

| Behavioural Pattern | Description |
|---------------------------------------|--|
| BEHAVIOUR FOR ACTIVITY BUDGETS | |
| Feed | Monkey masticates food while food is in hand or mouth. Feeding posture (suspensory or non-suspensory) should also be recorded. Suspensory feeding is defined as feeding while hanging from the branch by arm, leg or tail. |
| Move | Monkey moves from substrate to substrate by walking, running or brachiation |
| Rest | Monkey is stationary on substrate, either sitting, lying or dangling |
| Social | All forms of social interaction with one or more individuals |
| Vigilant | Monkey is stationary with head raised, scanning the surroundings and looking into the distance |
| AGONISTIC SOCIAL BEHAVIOUR | |
| Chase | Rapid follow of a retreating individual or fast charge at another |
| Contact | All forms of contact aggression such as striking, biting and wrestling, generally to force the recipient towards the ground |
| Threat | Fixed gaze on another with mouth slightly opened and a little bit of teeth showing. May also involve extreme retraction of lips with full teeth exposure |

AFFILIATIVE SOCIAL BEHAVIOUR

| | |
|----------|---|
| Arm Wrap | Two monkeys wrap their arms round the shoulders of the other, with both monkeys facing in the same direction. While arm-wrapping, the monkeys direct coalitionary aggression toward conspecifics, human observers or other animals. |
| Copulate | Female sits on male's lap. Male responds by wrapping his legs round the female's thighs. Intromission may last 10-30 minutes |
| Embrace | Monkey wraps one or both arms around another individual. May be accompanied by a kiss pectoral sniff |
| Groom | Monkey manipulates fur of another individual with hands and / or mouth |
| Play | Sustained contact with two or more individuals that may contain, but is not limited to: chasing, mock biting, slapping and wrestling, but not severe enough to cause harm. Often occurs in conjunction with panting vocalization |

Additional data collection

Habitat surveys will be conducted in each of 20m x 20m survey sites to investigate tree diversity and forest structure. The number of saplings (trees with circumference <15cm and a minimum height of 3 metres), and epiphytes will be counted for each plot. For each tree in the plot with a circumference >15 the species and DBH of the tree, and whether the tree is alive or dead will be recorded on datasheets. For each tree with a circumference >30cm, height of the tree will also be recorded on datasheets. The DBH and length of each fallen tree within the plot will also be recorded. Forest structure measurements include understorey vegetation, canopy cover and leaf litter depth. To measure understorey vegetation, the plot will be bisected to produce the four quadrants. A 3m pole marked in 0.5m segments will be used to record the number of vegetation touches on the pole in each 0.5m segment every 1m along these bisecting tapes. The openness of the canopy will be measured by taking a reading with a canopy scope from the centre of each of the four quadrants and one from the centre of the overall 20m X 20m square.

Suggested Reading

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