Affiliative Behaviors in Pairbonded Red Titi Monkeys (Callicebus Discolor)

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Abstract
Adult titi monkeys (Callicebus spp.) form strong pairbonds and reside in socially monogamous groups. In addition, adult males are heavily involved in infant care, exhibiting a degree of direct investment unusual even among primate species with paternal care. Most of the research exploring the nature of these social bonds has focused on captive populations, and data on wild titi populations are limited. In particular, data quantifying the pairbond and exploring the costs of infant care are rare for wild titi monkeys. I analyzed data from two groups of titi monkeys (Callicebus discolor) in Yasuní National Park and Biosphere Reserve and quantified the affiliative social interactions between the adult male and the adult female in the group to determine 1) the frequency and type of affiliative behaviors exhibited by pairmates, 2) whether there is evidence for sex differences in maintenance of affiliative behaviors and proximity, and 3) whether there is evidence of social costs within a pair during the period when infant care is provided. The most frequent affiliative behaviors involved pairmates resting in close proximity to each other. In addition, males and females spent significantly less time within five meters of each other when they were providing direct infant care, consistent with the prediction that infant care may correlate with a decrease in affiliative behaviors between pairmates. Although no solid conclusions can be drawn from this preliminary study given the small sample size, this research provides data suggesting that the presence of a dependent infant may influence the quality of the relationship between pairmates.

Degree Type
Thesis

Degree Name
Master of Science (MS)

Graduate Group
Anthropology

First Advisor
Eduardo Fernandez-Duque

Keywords
pair bond, monogamy, primate, paternal care

Subject Categories
Biological and Physical Anthropology

This thesis is available at ScholarlyCommons: http://repository.upenn.edu/edissertations/95
AFFILIATIVE BEHAVIORS IN PAIRBONDED RED TITI MONKEYS
(CALLICEBUS DISCOLOR)

Andrea Spence-Aizenberg

A THESIS

in

Anthropology

Presented to the Faculties of the University of Pennsylvania in Partial
Fulfillment of the Requirements for the Degree of Master of Science

2010

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Supervisor of Thesis

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Graduate Group Chairperson
ABSTRACT

Adult titi monkeys (*Callicebus spp.*) form strong pairbonds and reside in socially monogamous groups. In addition, adult males are heavily involved in infant care, exhibiting a degree of direct investment unusual even among primate species with paternal care. Most of the research exploring the nature of these social bonds has focused on captive populations, and data on wild titi populations are limited. In particular, data quantifying the pairbond and exploring the costs of infant care are rare for wild titi monkeys. I analyzed data from two groups of titi monkeys (*Callicebus discolor*) in Yasuní National Park and Biosphere Reserve and quantified the affiliative social interactions between the adult male and the adult female in the group to determine 1) the frequency and type of affiliative behaviors exhibited by pairmates, 2) whether there is evidence for sex differences in maintenance of affiliative behaviors and proximity, and 3) whether there is evidence of social costs within a pair during the period when infant care is provided. The most frequent affiliative behaviors involved pairmates resting in close proximity to each other. In addition, males and females spent significantly less time within five meters of each other when they were providing direct infant care, consistent with the prediction that infant care may correlate with a decrease in affiliative behaviors between pairmates. Although no solid conclusions can be drawn from this preliminary study given the small sample size, this research provides data suggesting that the presence of a dependent infant may influence the quality of the relationship between pairmates.
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ACKNOWLEDGEMENTS

First and foremost I would like to express my deepest gratitude to my advisor, Dr. Eduardo Fernandez-Duque, without whom this thesis would never have been possible. His constant support and patient encouragement has been invaluable. I am extremely grateful and indebted to Dr. Fernandez-Duque and Dr. Anthony Di Fiore for their generous access to the Monogamous Primates database, and allowing me to contribute to their ongoing research at the Tiputini Biodiversity Station (TBS).

I would also like to thank Dr. Di Fiore for his patience and instruction in the field. I am very appreciative of the wonderful people I worked with on the Monogamous Primates Project in Tiputini, including Dr. Di Fiore, Kevin Burke, Daniel Essiambre, and Cara McGuinness. Thanks to them, my experience in the field was enjoyable, productive, and unforgettable. I would also like to thank all of the staff at the Tiputini Biodiversity Station, whose continuous hard work allowed us to focus on data collection, and always made life at TBS pleasant.

I would like to thank Dr. Pamela Sankar for her perpetual encouragement and wisdom, and without whom I would never have experienced field research! Additionally, I am grateful to Dr. Sankar and all of my colleagues at the Center for Bioethics for enriching my life and for their support throughout my graduate studies.

I would like to thank my graduate committee, Dr. Fernandez-Duque, and Dr. Robert Seyfarth, for their effort in reviewing this thesis. Their comments and insight have been incredibly helpful.
Lastly, I would like to thank my family for their love and support. My parents and brother encouraged my lifelong interest in animal behavior, and my parents provided unconditional support and guidance throughout my life. I’d like to thank my mother-in-law and father-in-law for their support and for helping to make this thesis a possibility. Finally, I would like to express my gratitude to my husband, David Aizenberg who has always pushed me to strive for more. His constant encouragement, love, patience and respect have made this achievement possible.

This research was funded through a Hewlett Award for Innovation in International Offerings Grant to Dr. E. Fernandez-Duque and National Geographic Society and Leakey Foundation society grants to Fernandez-Duque and A. Di Fiore (Anthropology, NYU).
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INTRODUCTION

The Pairbond in Titi Monkeys

The pairbond is the foundation of the small social groups of titi monkeys (Callicebus spp.), which include an adult male, an adult female, infants and juveniles (Kinzey and Wright, 1982; Mason, 1966; Wright, 1984). In addition, male and female titi monkeys participate in the joint care of infants (Fernandez-Duque et al., accepted; Fragaszy et al., 1982). Identifying the important components of pairbonds is challenging due to the variation in the nature of the pairbonds, both between and within species (Fuentes, 2002; Palombit, 1996). While captive research of titi monkeys allows for manipulation of group structure and the analysis of endocrine factors to understand pairbonds (Anzenberger, 1988; Mason and Mendoza, 1986; Fernandez-Duque et al., 1997), these approaches are more difficult to utilize in field research (Carter, 1998). In this study I used an observational approach, and thus focused on behavioral, rather than physiological, cues.

Research on other socially monogamous primates, such as gibbons and siamangs, has provided a greater understanding of pairbonds in wild primates (Palombit, 1994a; Palombit, 1994b; Palombit, 1996). To date, however, there have been few quantitative attempts at characterizing the pairbond in wild titi monkeys (Kinzey and Wright, 1982; Robinson, 1979; Robinson, 1981), and a more comprehensive understanding of titi social behavior is needed. The social and sexual components of the pairbond are often measured independently (Fuentes, 2002; Kleiman, 1977; Palombit, 1996), and below, I review the current knowledge of these aspects of the pairbond in titi monkeys. The
primary goal of my research was to examine social behaviors between pairmates in wild red titi monkeys (*Callicebus discolor*) in order to expand our understanding of the pairbond, identify the relative importance of various behaviors to the pairbond, and evaluate the potential effect of bi-parental care on the pairbond. I evaluated which affiliative behaviors were most frequently observed between pairmates, the sexual differences of participation in these behaviors, and the effect of infant care on the occurrence of these behaviors.

*The Sexual Bond*

An effective evaluation of the sexual bond between pairmates requires data on genetic relatedness of all individuals and detailed records of mating behavior (Anzenberger, 1992; Fuentes, 2002). Unfortunately, genetic analyses of paternity in wild populations of titi monkeys have not been performed, and we must rely on the behavioral aspects of the sexual bond.

Like other socially monogamous primates (Palombit, 1994b), sexual monogamy in titi monkeys is questioned by observations of wild female titi monkeys copulating with unfamiliar males during inter-group encounters (Mason, 1966). Although these extra-pair copulations are rarely observed, captive research also suggests there is a strong sexual interest in unfamiliar animals. When captive titi monkeys were introduced to an unfamiliar monkey of the opposite sex, twenty-two out of thirty-six encounters included sexual behaviors such as mounting and thrusting. On the other hand, reintroduction of pairbonded monkeys to their mates resulted in sexual behavior in only
one out of seven pairs (Anzenberger, 1988). These results were corroborated by an additional study in captivity, in which mounting and thrusting occurred more frequently in unfamiliar, than in previously bonded pairs (Fernandez-Duque et al., 2000).

However, despite this seemingly strong sexual interest in unfamiliar individuals, the pairbond endures. The infrequent observations of copulation and other sexual behaviors in most monogamous mammals and primates, suggests that sexual behaviors play a minor role in pairbond maintenance (Kleiman, 1977). Indeed, the sexual interest exhibited towards animals outside of the pairbond in both wild and captive titi pairs suggests that mating behaviors may not be a reliable indicator of pairbond strength.

It is also possible that these extra-pair copulations serve no reproductive purpose (Anzenberger, 1988; Palombit, 1994b). Pregnant titi monkeys in a captive study were just as likely to be involved in extra-pair sexual encounters as non-pregnant females (Anzenberger, 1988). The actual consequence of these extra-pair copulations in wild titi monkeys cannot be assessed until paternity tests are performed. Given the unknown genetic consequences and unavailability of genetic samples for this population, I focused on the social aspect of the pairbond in titi monkeys.

The Social Bond

Much of what we know about the social bond in titi monkeys comes from studies of captive animals. Separation studies demonstrate that the social bond is important to both males and females. For example, Mendoza and Mason (1986) found that cortisol levels (an indicator of stress) in Callicebus moloch significantly increased when
pairmates were separated. Yet there was no change in cortisol levels when adults were separated from their offspring. In contrast, when squirrel monkey (Saimiri sciureus) mothers were separated from their infants, cortisol levels rose significantly in both mothers and infants, presumably because of the bond between them (Mendoza et al., 1978). These data suggest that the pairbond is stronger than the parent-infant bond (Mendoza and Mason, 1986). A separation of pairmates for a five day period had no significant effect on the affiliation between the male and female upon reunion, providing further evidence that the bond between adult males and females is strong and enduring (Fernandez-Duque et al., 1997).

**Affiliative Behaviors in Titi Monkeys**

Affiliative behaviors in titi monkeys, such as grooming, resting in contact, and duetting, occur frequently between pairmates and rarely between unfamiliar individuals, unlike sexual behaviors (Fernandez-Duque et al., 1997; Fernandez-Duque et al., 2000). In addition, these behaviors are more frequently observed in titi pairs than sexual behaviors. Therefore, using affiliative behaviors should provide a more accessible, yet appropriate, measure of the social bond in titi monkeys. In this study, I focused on the following affiliative behaviors: resting close or in contact with a pairmate, distance between pairmates, tail-twining, grooming, duetting, nose-to-nose, coordinated movement behaviors, and food-sharing.

Proximity and contact between pairmates are frequently employed as measurements of affiliation in both wild and captive titi monkeys (Anzenberger, 1988;
Fernandez-Duque et al., 1997; Fernandez-Duque et al., 2000; Lawrence, 2007; Sendall et al., 2007). More importantly, contact between pairmates seems to act as a reliable indicator of an established bond, as captive pairmates spend more time resting in physical contact than non-mated pairs (Anzenberger, 1988; Fernandez-Duque et al., 1997; Fernandez-Duque et al., 2000). Tail-twining, a social behavior exhibited by titi monkeys in which an animal wraps its tail around that of another animal while sitting side by side, is also frequently observed (Moynihan, 1966). Manipulation of group structure in captivity demonstrates that tail-twining occurs solely within a pairbond. Established pairmates frequently tail-twine, while unfamiliar pairs never do (Anzenberger, 1988).

Wild titi monkey pairs spend many hours per day grooming (Kinzey and Wright, 1982; Moynihan, 1966). Kinzey and Wright (1982) speculate that the time spent grooming exceeds what would be necessary if it functioned solely to improve health or physical condition. In captive pairs, grooming was the only behavior which significantly increased upon reuniting after a five day separation, compared to reunification after a thirty minute separation (Fernandez-Duque et al., 1997), suggesting it is an important behavior shared between pairmates.

Another important behavior exhibited by pairmates is vocal duetting. Duetting occurs regularly in the field, and requires spatial and vocal coordination between pairmates (Robinson, 1979; Robinson, 1981). Frequency of calling increases at territorial boundaries suggesting that it has some role in cooperative territory defense.
(Robinson, 1981). In captivity, duetting occurred within one minute of reuniting for all seven pairs after they were separated (Anzenberger, 1988).

Social movement behaviors that bring individuals into contact with one another are another way to measure the proximity between individuals. Passing near, following, approaching, and leaving behaviors can provide information on the proximity of the pairmates. Hinde’s Index indicates which individual is most responsible for maintaining proximity (Hinde and Atkinson, 1970).

Food sharing is another potentially important social behavior between pairmates. Although it has never been observed in titi monkeys, it has been observed in socially monogamous owl monkeys, *Aotus azarai* (Wolovich et al., 2008). Nose-to-nose behavioral data were also collected, although there is no evidence that this behavior is frequently observed in titi monkeys. However, it was worth exploring the possibility of these behaviors in adult titi monkeys.

Most of these affiliative behaviors occur frequently within pairmates and rarely between strangers. This suggests that they act as proximate mechanisms maintaining the social bond between adult males and adult females. Therefore, this analysis, which focused on non-sexual affiliative behaviors, should provide a reliable assessment of the social relationship between pairmates.

*Biparental Care and Pairbond Maintenance*

Nearly 40% of primate genera exhibit paternal care (Kleiman and Malcolm, 1981), but males rarely provide as much direct care to infants as seen in *Callicebus spp.*
(Fernandez-Duque et al., 2009). Direct infant care by males, particularly in the form of
infant transport (Kleiman and Malcolm, 1981), is regularly observed in titi monkeys in
the field and captivity (Fernandez-Duque et al., accepted; Fragaszy et al., 1982; Tirado-
Herrera and Heymann, 2004; Wright, 1984). Adult males carry infants approximately
90% of the time during the first two months after birth (Fragaszy et al., 1982; Wright,
1984), and nearly 40% of the time in their fourth month (Wright, 1984; Fernandez-
Duque et al., accepted). The male continues to be the primary carrier until the infant
becomes independent (Wright, 1984).

In addition to providing significant amounts of direct care to their putative
offspring, males are the primary attachment figure for them (Hoffman et al., 1995).
Infants in captivity were found to approach, interact, and be in contact with their father
more than with their mother (Mendoza and Mason, 1986). When separated from their
parents, cortisol levels of infants increased significantly upon removal of the male, but
remained at baseline levels when the mother was removed (Hoffman et al., 1995).
Clearly, male investment in infant care is significant and creates a strong social bond for
the infant.

Male and female titi monkeys regularly share responsibilities in the care of the
young, but it is unclear why. One hypothesis is that infant care is very costly and male
participation in direct infant care mediates the costs incurred on the female (Tardif,
1994; Wright, 1984). Although the costs of infant care have not been adequately tested
in titi monkeys, there is some evidence in support of this hypothesis. In wild titi
monkeys, females increase the intake of food and insects during lactation, suggesting
that lactation increases the energetic demands of females (Tirado-Herrera and Heymann, 2004; Wright, 1984). Infant transport by males may relieve the female of what would have been an additional energetic burden. As a consequence, male titi monkeys should also experience energetic costs, yet males were not observed to increase their food intake during infant transport (Tirado-Herrera and Heymann, 2004), and in some cases decreased their food intake and foraging time (Wright, 1984). Still, although food intake did not increase, the male titi monkeys may have incurred unseen costs, such as weight loss (Tirado-Herrera and Heymann, 2004). For example, male cotton-top tamarins that participated in infant transport lost as much as 10% of their body weight in the months following an infant’s birth (Achenbach and Snowdon, 2002).

If there are costs associated with infant care, it is reasonable to postulate that these costs may also decrease the time available for affiliative behaviors between pairmates. Quantification of the affiliative behaviors within a pairbond allowed me to evaluate the social effects of the potential costs associated with biparental care.

**Aims and Objectives**

My research had the following specific objectives: 1 - to determine the frequency of social behaviors, 2 - to determine whether males and females differed in their participation of directional behaviors to pairmates (i.e. grooming and movement behaviors), and 3 - to determine whether affiliative behaviors decreased during intense infant care.
In order to achieve these objectives, I analyzed data collected from two pairs of red titi monkeys (*Callicebus discolor*) during the birth of three infants. I then focused on an examination of social interactions between the male and female during three temporally distinct sixteen-week periods: 1 - conception (32 to 17 weeks before birth), 2 - pre-natal (the 16 weeks prior to birth), and 3 - infant (the 16 weeks following a birth). Each of these periods should reflect qualitatively different biological and social factors, which I proposed would influence the social relationship between males and females. The conception period marked a time without intense infant care or a pregnant female, and therefore any costs associated with infant care would be low. The pre-natal period encompassed the entire pregnancy, based on a gestation of 128 days (18.3 weeks) recorded in captive titi monkeys, *C. moloch* (Valeggia et al., 1999). The pre-natal period thus reflected a time when females may have experienced costs associated with gestation, but not with lactation or infant care. The infant period incorporated the time with the most intense infant care, based on the large percentage of time males spent transporting infants during the first four months (Fernandez-Duque et al., accepted; Wright, 1984). During this period, the male and female would have incurred any costs which might be associated with infant care. Therefore, the periods provided a useful operational manner to examine whether these various social and biological factors affected the quality of the pairbond as reflected in affiliative behaviors between mates.

For each objective, I formulated several predictions regarding the presence of affiliative behaviors:
Objective 1: Affiliative behavior frequencies

- Resting behaviors (resting in contact, resting in proximity, and tail-twining) would be more frequent, overall, than active behaviors (grooming, movement, duetting, food-sharing) because they are less energetically costly.

- Affiliative behaviors will be present during each period (conception, prenatal and infant), because they are important in maintaining the pairbond.

Objective 2: Differential participation of the sexes

- Directed behaviors between the sexes, and maintenance of proximity, would not differ during the conception period or the infant period, because they experience equal energetic demands during these times.

- The male would be more responsible for proximity maintenance, and male behaviors directed toward the female would be greater than female behaviors directed toward the male in the pre-natal period, due to costs associated with gestation.

Objective 3: Affiliative behaviors before and during infant care

- Affiliative behaviors will be lowest in frequency during the infant period, due to costs of infant care.

- Active behaviors decrease in frequency more than resting behaviors during the infant care period.
METHODS

Study Site

Data were collected at the Tiputini Biodiversity Station (76° 08’ W, 0° 38’ S), which is located in the Yasuní National Park and Biosphere Reserve in Ecuador (Figure 1) (Di Fiore et al., 2007). Tiputini Biodiversity Station (TBS) encompasses 650 hectares along the left bank of the Río Tiputini. The habitat is a primary tropical rain forest, and includes an extensive trail system (Fernandez-Duque et al., 2008). TBS is home to ten genera of primates, including *C. discolor* (Di Fiore and Fleischer, 2005).

Study Population and Subjects

Red titi monkeys (*Callicebus discolor*) at TBS have been under regular observation since 2003. Like other *Callicebus* spp., *C. discolor* live in small groups including an adult male, an adult female, infants, and juveniles. Males are also heavily invested in infant care (Fernandez-Duque et al., accepted). The number of habituated groups has increased gradually over the years, and since November 2006, four groups have been consistently monitored and studied. Adults are identified between groups by uniquely colored bead-collars or radiocollars. Juveniles and infants are not usually collared, but are identifiable within the group by their smaller size.

Behavioral data have been collected on three of the four red titi monkey groups. For these three groups, behavioral data were collected during the time surrounding the birth of six infants: Group B: one infant born in 2007 (B-INF07); Group K: one infant born in 2005 (K-INF05) and one in 2007 (K-INF07); Group L: one infant born in 2006
(L-INF06), one in 2007 (L-INF07), and one in 2008 (L-INF08). Table 1 describes the group composition during the conception, pre-natal and infant periods for these groups.

Data Collection

The data presented here were collected as part of the ongoing Monogamous Primates Project, directed by Dr. Anthony Di Fiore and Dr. Eduardo Fernandez-Duque. Behavioral data were collected according to the Monogamous Primates Behavioral Data Collection Protocol (Appendix 1). I participated in the collection of behavioral data from June 6 to July 17, 2009, however the data analyzed here were collected prior to my participation in the project.

The red titi monkey groups at TBS were located using a telemetry radio receiver (TR-4 receiver, Telonics Inc). At least one individual in each group wore a radiocollar that emitted a unique frequency, allowing me to identify groups. Behavioral data were collected during twenty-minute focal samples. Observers attempted to balance time spent among groups, and focal collection among individuals within groups, in order to gather an equal amount of focal samples for every individual in each group.

Behaviors were classified as states, events, or as both, and were categorized into six general states (out-of-view, foraging, resting, moving, socializing, or other). During focal samples, the behavioral state of the focal animal was instantaneously sampled every two minutes. Between these instantaneous sampling points, all-occurrence sampling of behavioral events was performed. Proximity data were collected during group scans every four minutes within the focal samples. Each group scan recorded the
distance of all group members from the focal animal. Behaviors analyzed in this study are defined in Table 2, and distance measurements are defined in Table 3.

Prior to 2008, data collected during focal samples were entered directly into a palm data recorder. Beginning in January 2009, focal sample data were entered into a dictaphone and later transcribed to the palm data recorder. From the palm data recorder, all data were entered into the Monogamous Primates database, a relational database in Microsoft Access.

Data Analysis

Assigning and Coding Periods

All behavioral data were collected during the following periods: conception (focals collected during weeks 32 to 16 prior to the birth of an infant), pre-natal (focals collected during the 16 weeks prior to the birth of an infant), and infant (focals collected during the first 16 weeks after an infant’s birth). Because all of the periods were defined according to an infant’s birth, I first calculated the estimated birthdates of the six infants using demographic records from the Monogamous Primates database. For each group, I noted the date a new infant was first observed, and the date the group was last seen without an infant. The infant’s date of birth was assigned as the midway point between these two dates. If they were consecutive days, the date of birth was assigned as the day on which the infant was first seen. Table 4 includes this information for each of the infants born in groups B, K and L.
Next, I transferred focal data into Microsoft Excel and, utilizing the date of the focal sample and the infant’s estimated date of birth, I calculated the number of weeks in relation to the infant’s birth using this formula:

\[
\text{number of weeks} = \text{INT}\left(\left(\text{focal date} - \text{date of birth}\right) / 7\right)
\]

Lastly, I assigned focal data to the appropriate period based on the number of weeks in relation to the infant’s estimated birthdates: conception (during week “-32” to week “-17”), pre-natal (week “-16” to “-1.”), or infant (week “0” to “15”).

_Database Preparation_

In order to accurately assess the frequency of behaviors in the data, I reviewed all of the data to correct for inconsistencies. I also made several changes to the coding of behaviors, including replacing all animal ID’s (names) with the age/sex class, aligning partners with the appropriate behavior, and consolidating the behavior and partner codes. More importantly, in order to avoid errors of content, I eliminated data that were incomplete or inaccurately recorded.

_Calculating Observation Hours_

I calculated the amount of observational data available for each period. I tabulated the number of point-samples for which adult males or adult females were the focal animal within each period for each of the six infant births seen in Table 4. Instantaneous point-samples reflect a two minute period, and to determine the number of observation hours, I used the following formula:

\[
\text{Observation hours} = \left(\text{# of sample points} \times 2\right) / 60
\]
Both adult males and adult females were frequently out-of-view during point-samples. To better understand how red titi monkeys spend their time, I excluded the point-samples when the subject was out-of-view, and focused on the data that were collected while the monkeys were in-view. To do this, I tabulated the number of point-samples, excluding those in which the subject was out-of-view. Using the same calculation noted above, I was also able to determine the number of hours the adult male or adult female were in-view, and thus the number observation hours available for data analyses (Table 5).

Exclusion of Infants with Limited Data

The number of observation hours when the adult male or adult female were in-view of the observer varied among groups, ranging from 1.7 hours in B-INF07 to 53.9 hours in L-INF08. Given the unlikelihood that behavioral data representing less than 6 hours of a 48 week period could accurately reflect the behavior of the red titi monkeys at TBS, I eliminated B-INF07, K-INF05, and L-INF06 from all analyses. Therefore, all subsequent data does not reflect any contribution of data from these groups.

Additionally, there was a temporal overlap of five weeks between the infant period of L-INF06, and the conception period of L-INF07. Because the infant, L-INF06, was still dependent for weeks 11 – 15, I deleted the overlapping data from the conception period of L-INF07. All of the data presented here reflect this exclusion.
Counting Frequencies of Behavior

I created a set of codes in Microsoft Visual Basic Editor in order to efficiently count the frequency of the twenty-two identified socializing behaviors (Appendix 2) and the distance between pairmates (Appendix 3). These codes counted the frequency of behavioral states (during instantaneous sampling), events (during all-occurrence sampling), and distance between pairmates (during group scans).

Statistical Analyses

For each focal sample, frequencies of behavioral events and states were calculated as the number of instantaneous sample points (states), or sample point intervals (events) when the behavior was observed out of the total point-samples, or intervals, that an animal was in-view. For example, if the male was grooming the female during one instantaneous sample point out of five for which the subject was in view, then grooming, as a state, was scored as having a frequency of 0.2 during that focal sample. The mean frequency for each behavior was calculated by averaging across focal samples within each period for each infant. The means are expressed here as a percentage of time the animals were in-view during observation, but are termed merely as a “percentage of time.” The behaviors sampled as both states and events were analyzed separately in all data analysis.

To evaluate the distance between pairmates, I first calculated the proportion of group scan points when each specific distance was recorded in a focal sample, out of the total group scan points for which any distance was known. For example, if in 4 out of 5
possible scan points some distance was recorded, and if in 1 of those 4 points the pairmates were recorded to be within 0-5 meters, then the frequency when pairmates were within 0-5 meters for that focal was computed as 0.25.

Because of the relatively small sample sizes, only non-parametric statistics were used. All tests were two-tailed. I used the Mann-Whitney test to determine whether there was a difference of directed behaviors between males and females. Hinde’s Index was calculated for each period within each group. Differences among the three periods in proximity and affiliative behaviors were tested with the Friedman test. I could not statistically evaluate the differences between non-infant (conception and pre-natal) and infant periods. Instead, I used descriptive statistics to determine whether infant care was correlated with a decreased frequency in specific social behaviors between pairmates.

RESULTS

Objective 1: Affiliative behavior frequencies

Pairmates spent significantly more time within ten meters of each other than ten meters apart (p<.01, Wilcoxon matched-pairs test, T=0, n=9). There was no statistically significant difference between time pairmates spent within five meters of one another and greater than five meters apart (p>.05, Wilcoxon matched-pairs test, T=22, n=9). The distance between pairmates for each period is displayed in Table 6.

The most frequently observed behaviors were resting within one meter (12%, Figure 2) and resting in contact (7.5%, Figure 3). Grooming, as a state, was observed in only five of the nine periods, and never more than 5.5% of the time (Figure 4).
Grooming as an event was also observed in only five of the nine periods examined, and never observed more than 5.3% of the time (Figure 5). Tail-twining was observed in only three periods, and never exceeded 3.9% of time within a period (Figure 6). Passing within one meter of pairmates was observed during six of nine total periods (most frequently at 3.6%), and passing while touching only in four periods (never greater than 1.6% of time during focal samples). Follows, as events, occurred in seven of nine total periods, but the adult male and adult female never spent more than 2.6% of the time following each other.

Several behaviors occurred so infrequently that they were eliminated from further analyses: follows recorded as a state (0.4% in one period), sitting within one meter as an event (2.6% in only one period), tail-twining as an event (only in two periods, never exceeding 0.3% of time), duetting as a state (only in three of nine periods, never exceeding 1% of time), and duetting as an event (only in three of nine periods, never exceeding 1% of time). Furthermore, several behaviors were never observed during the study: nose-to-nose, mutual grooming, food-sharing, and sitting in contact as an event.

**Objective 2: Differential participation of the sexes**

Hinde’s Index indicated that males were frequently more responsible for maintaining proximity between pairmates. The male was more responsible for maintaining proximity in all three periods for K-INF07 (conception= 36.2; pre-natal=12.5; infant=35.7) and L-INF08 (conception=53.6; pre-natal=50; infant=35.7).
The female was only responsible for maintaining proximity in the pre-natal and infant period of L-INF07 (pre-natal= -33.3; infant= -30). The frequencies of approaches and leaves were too low to calculate Hinde’s Index for the conception period of L-INF07.

There were no marked differences between the sexes in any of the other behaviors. Follows, passing, and grooming were all similarly performed by males and females (follows: \( p=.93 \), Mann-Whitney, \( U=39.5, n_1=9, n_2=9 \); passing within 1 meter: \( p=.34 \), Mann-Whitney, \( U=29, n_1=9, n_2=9 \); passing while touching: \( p=.9 \), Mann-Whitney, \( U=39, n_1=9, n_2=9 \); grooming(state): \( p=.73 \), Mann-Whitney, \( U=36, n_1=9, n_2=9 \); grooming(event): \( p=.73 \), Mann-Whitney, \( U=36.5, n_1=9, n_2=9 \)). Due to the sample size, I was unable to test whether the sex more responsible for maintaining, or initiating, affiliative behaviors differed among the three periods.

**Objective 3: Affiliative behaviors before and during infant care**

*Among All Periods*

The spatial relationship between adult males and adult females differed markedly across all three periods. The time pairmates spent within five meters of each other was different among conception, pre-natal, and infant periods. Pairmates spent significantly more time within five meters of each other during the conception period than pre-natal and infant periods, and significantly less time within five meters of each other during the infant period (Figure 7, \( p<.05 \), Friedman test, \( Q=6; df=2 \)). However, distances between pairmates were not significantly different among all three periods for time spent in
contact (p=.097, Friedman test, Q=4.67; df=2), less than one meter (p=.715, Friedman test, Q=.67, df=2), less than three meters (p=.715, Friedman test, Q=.67, df=2).

Affiliative behaviors between males and females did not noticeably differ among all three periods. This was so with regard to the time spent resting in contact, resting within one meter, tail-twining, or grooming. There were no significant differences across these three periods for resting in contact (p=.097, Friedman test, Q=4.67, df=2), resting within one meter, (p=.715, Friedman test, Q=.67, df=2), tail-twining (p=.378, Friedman test, Q=2.17, df=2), grooming as state (p>.105, Friedman test, Q=4.5, df=2), or grooming as an event (p=.715, Friedman test, Q=.67, df=2).

*Between Non-Infant and Infant periods*

Next, I evaluated whether the two non-infant periods (pre-natal and conception) combined differed from the infant period. As mentioned above, the adult male and adult female spent significantly less time within five meters of each other during the infant period than either the conception or pre-natal periods (Figure 7). The pairmates also spent less time in contact with each other during the infant period, compared to the non-infant period, although I could not test for statistical significance (Figure 8).

There was a strong trend towards fewer affiliative behaviors during the infant period for several social behaviors. This trend was observed for resting in contact (Figure 9), resting within one meter (Figure 10), and tail-twining (Figure 11) with a pairmate. Indeed, tail-twining was never seen in any of the three infant periods. There was no apparent trend in other affiliative behaviors.
DISCUSSION

The quantification of affiliative behaviors between pairmates allowed me to evaluate the possible social effects of biparental care in titi monkey pairbonds. In support of the prediction that infant care incurs social costs, I found that paired adult males and adult females spent significantly less time within five meters of each other when they were providing care to dependent infants than when they were not. Additionally, there was a clear trend that pairs spent less time in close proximity during the period of infant care, than when dependent infants were not present. Pairs spent less time in contact during group scans, less time resting in contact or resting within one meter of a pairmate, during the infant periods. Tail-twining, although not frequently observed, never occurred when either pair was caring for infants. While there was no clear trend towards fewer grooming behaviors during infant care, the highest frequencies for grooming states and events only occurred during the conception and pre-natal periods. Overall, these results support the prediction that there are fewer affiliative interactions between pairmates during infant care.

I also predicted that active behaviors, such as grooming, would decrease more than resting behaviors while the adults were providing care to infants. This did not appear to be the case, although one contributing factor may have been the generally lower frequency of active affiliative behaviors compared to the resting affiliative behaviors during all periods.

Overall, these results are consistent with the prediction that potential energetic costs of infant care impose social costs which results in a decrease in affiliative
behaviors. However, this research design did not allow for the exclusion of alternate hypotheses. It is also possible that ecological factors affect proximity between pairmates. The distribution of food during the period of infant dependency could affect the foraging patterns between pairmates. Future research should also evaluate extrinsic environmental factors in addition to intrinsic influences on the pairbond.

I also tested sex differences in maintenance of proximity and affiliative behaviors for all three periods. Hinde’s index indicated the male was more frequently responsible for maintaining proximity. In contrast, all other behaviors tested suggest that there are no differences between the sexes in affiliative behaviors. Overall, the sex differences between pairmates is inconclusive, and likely not very different.

Quantification of proximity and affiliative behaviors indicated that, overall, the two pairs observed in this study spent significantly more time within ten meters of each other than they spent further than ten meters apart. I predicted that affiliative behaviors examined in this study would be present within all periods. Grooming was not observed much more than 5% of sample points during focal samples, and not in every period. This value is the equivalent of only three minutes per hour, which is much less frequent than has been reported in other wild titi groups (Kinzey and Wright, 1982). Furthermore, some behaviors were never observed at all. Food-sharing and nose-to-nose behaviors were never observed in these two pairs. Duetting and tail-twining, behaviors commonly observed in other titi monkeys, were infrequently recorded in these two groups.
I also predicted that resting behaviors would be more frequent overall because of their decreased energetic costs. This prediction was supported by the frequencies of resting in contact and resting within one meter, which were more frequently observed than social movement, grooming, and food sharing. While this may not result from greater energetic costs, it does suggest that resting near a pairmate is a relatively important behavioral mechanism for maintaining a pairbond.

One feature of the behavioral data that stood out during data analysis was the high frequency of some of the affiliative behaviors observed in Group K (K-INF07). Group K had some of the highest values for resting in contact, tail-twining, and grooming (state) in both the conception and pre-natal periods. This is interesting for two reasons. First, during this time, there were no infants or juveniles present in the group (Table 1). The adult male and adult female were the only group members during the conception and pre-natal periods. Second, the pair was only recently formed at this time. The former adult female disappeared in the month’s preceding the conception period for K-INF07. There are several explanations for the high frequency of affiliative behaviors in this pair. First, the adults were the only two animals in the group and did not have other animals to socialize with. Second, the pair may have been in the process of developing their bond, and it is expected that newly formed pairs will interact more frequently than established pairs (Kleiman, 1977). Third, their bond may be “stronger” than Group L, the other pair analyzed in this study. There is currently no way to distinguish between these explanations, but analyzing data from future infant births in
group K could help clarify this. Additionally, future data on newly formed pairs could provide relevant information.

There are a few weaknesses in this research. The data were collected from two groups, and thus cannot represent the entire population of titi monkeys at TBS. Another problem stems from the difficulty in observing titi monkeys. The dense foliage and cryptic behavior of titi monkeys means that they spend a large portion of time out-of-view of the observers. These analyses relied on the assumption that the behaviors recorded while the animals were in-view were representative of all behavior. However, it is possible that certain social behaviors are more likely to occur high in the canopy, or in dense vine tangles, which may be out-of-view of the observers. If this is the case, then the behaviors we have recorded do not necessarily accurately represent all social behaviors. Duetting, for instance, which usually occurs early in the morning (Robinson, 1979), may not have been adequately sampled if behavioral data collection regularly began after pairs performed their duets. Additionally, the distribution of focal samples within each sixteen week period was not evenly distributed, and this may have affected the types of behaviors recorded. For example, if most of the focal samples excluded the earliest weeks after the infant’s birth, it may have skewed the data to reflect a lower degree of infant care than actually occurred.

Clearly, no firm conclusions can be drawn from these results given the sample size and the limitations of the research design. However, these preliminary data do suggest that energetic costs associated with infant care may affect affiliative behaviors within a pairbond. The significantly lower percentage of time pairmates spent within five
meters of each other while caring for dependent infants, and the general decrease in affiliative behaviors during the infant period, lend support to this prediction and suggest it is worthy of further investigation.

The data presented here on two groups of pairbonded *C. discolor* are a useful foundation for future research. Expanding this research can provide us with a better understanding of changes within the pairbond over time, and the ability to address other critical issues. For example, long-term data could indicate that the social bond is associated with the length of a partnership. In addition, by including analysis of biparental care, we can explore if the social bond between pairmates translates to better coordination of infant care, and more importantly infant survival. Furthermore, evaluating genetic relatedness of infants can allow us to test the sexual aspect of the bond, and determine if the sexual bond and social bond are correlated. In other words, pairs with a stronger social bond may have a decreased frequency of extra pair fertilizations. Continuing to address these issues will provide a broader and more comprehensive view of the pairbond and its significance in titi monkey behavior.
REFERENCES


Fernandez-Duque E, Di Fiore A, de Luna AG. accepted. Pair-mate relationships and parenting in ecuatorial saki monkeys (*Pithecia aequatorialis*) and red titi


Figure 1: Location of Tiputini Biodiversity Station in the Yasuní National Park and Biosphere Reserve in Ecuador (Fernandez-Duque et al., accepted)
Table 1: Composition of the three *C. discolor* groups at Tiputini Biodiversity Station before (conception and pre-natal periods) and after (infant period) six infants were born.

<table>
<thead>
<tr>
<th>Group ID</th>
<th>Infant ID</th>
<th>Period</th>
<th>AM</th>
<th>AF</th>
<th>JUV</th>
<th>INF</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>INF07</td>
<td>Conception</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-natal</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>1</td>
<td>1</td>
<td>2*</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>K</td>
<td>INF05</td>
<td>Conception</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>K</td>
<td>INF07</td>
<td>Conception</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-natal</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>L</td>
<td>INF06</td>
<td>Pre-natal</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>L</td>
<td>INF07</td>
<td>Conception</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0**</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-natal</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>L</td>
<td>INF08</td>
<td>Conception</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-natal</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

AM=adult male; AF=adult female; JUV=juvenile (> 16 weeks old); INF=infant (< 16 weeks old); * = one individual disappeared during this time; ** = the juvenile was less than 16 weeks of age for a portion of time during this period; Conception = 32 - 17 weeks before infant birth; Pre-natal = 16 – 0 weeks before infant birth; Infant = 0 - 16 weeks after infant birth.
Table 2: Ethogram of behaviors analyzed in this study, adapted from the Monogamous Primate Protocol (Appendix 1).

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Sampling Method</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grooming</td>
<td>State &amp; Event</td>
<td>An individual uses the hands or mouth to manipulate the hair of another individual with gaze directed at the part of the body being manipulated.</td>
</tr>
<tr>
<td>Mutual Grooming</td>
<td>State &amp; Event</td>
<td>An individual is groomed and it grooms simultaneously.</td>
</tr>
<tr>
<td>Resting within 1 meter</td>
<td>State &amp; Event</td>
<td>An individual remains sitting or lying for at least 10 sec within 1m of another individual who is resting.</td>
</tr>
<tr>
<td>Resting in contact</td>
<td>State &amp; Event</td>
<td>An individual remains sitting or lying for at least 10 sec in contact with another individual who is resting.</td>
</tr>
<tr>
<td>Tail-twining</td>
<td>State &amp; Event</td>
<td>An individual is in physical contact with another individual sitting quietly side by side, awake or asleep, and tails are wrapped around each other for at least one turn.</td>
</tr>
<tr>
<td>Food-sharing</td>
<td>State &amp; Event</td>
<td>An individual feeds from the same piece of food another individual is feeding from.</td>
</tr>
<tr>
<td>Follow</td>
<td>State &amp; Event</td>
<td>An individual moves in the same direction as another individual within 5 sec after that individual begins to move.</td>
</tr>
<tr>
<td>Approach</td>
<td>Event</td>
<td>An individual moves to within 0.5m of a stationary individual and stays for at least 3 sec.</td>
</tr>
<tr>
<td>Leave</td>
<td>Event</td>
<td>An individual moves from within 0.5m to outside of 0.5m of another animal.</td>
</tr>
<tr>
<td>Nose to Nose</td>
<td>State &amp; Event</td>
<td>Two individuals bring their noses within a few centimeters one to the other, sometimes even touching.</td>
</tr>
<tr>
<td>Passing</td>
<td>Event</td>
<td>Locomotion that results in an individual going by another individual within a distance of 1m.</td>
</tr>
<tr>
<td>Passing and Touching</td>
<td>Event</td>
<td>Locomotion that results in an individual going by another individual and making physical contact while doing it.</td>
</tr>
<tr>
<td>Duetting</td>
<td>State &amp; Event</td>
<td>Long sequences of loud calls performed by at least two individuals simultaneously including “chirrups,” and “moans.”</td>
</tr>
</tbody>
</table>
**Table 3:** Proximity measurements analyzed in this study, adapted from the Monogamous Primate Protocol (Appendix 1).

<table>
<thead>
<tr>
<th>Distance</th>
<th>Sampling Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact</td>
<td>Group Scan</td>
<td>An individual is in contact with another individual.</td>
</tr>
<tr>
<td>&lt; 1 meter</td>
<td>Group Scan</td>
<td>An individual is zero to one meter from another individual.</td>
</tr>
<tr>
<td>&lt; 3 meters</td>
<td>Group Scan</td>
<td>An individual is zero to three meters from another individual.</td>
</tr>
<tr>
<td>&lt; 5 meters</td>
<td>Group Scan</td>
<td>An individual is zero to five meters from another individual.</td>
</tr>
<tr>
<td>&gt; 5 meters</td>
<td>Group Scan</td>
<td>An individual is more than five meters from another individual.</td>
</tr>
<tr>
<td>&lt; 10 meters</td>
<td>Group Scan</td>
<td>An individual is zero to ten meters from another individual.</td>
</tr>
<tr>
<td>&gt; 10 meters</td>
<td>Group Scan</td>
<td>An individual is more than ten meters from another individual.</td>
</tr>
</tbody>
</table>
**Table 4:** Estimated dates of birth for the six titi monkey infants.

<table>
<thead>
<tr>
<th>Group ID</th>
<th>Infant ID</th>
<th>Date last seen without infant</th>
<th>Date first seen with infant</th>
<th>Estimated date of birth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INF05</td>
<td>19-Jan-2005</td>
<td>22-Jan-2005</td>
<td>20-Jan-2005</td>
</tr>
<tr>
<td>K</td>
<td>INF07</td>
<td>2-Dec-2007</td>
<td>5-Dec-2007</td>
<td>3-Dec-2007</td>
</tr>
<tr>
<td></td>
<td>INF08</td>
<td>13-Nov-2008</td>
<td>25-Nov-2008</td>
<td>19-Nov-2008</td>
</tr>
</tbody>
</table>
Table 5: Number of observation hours when the adult male or adult female was the focal animal and in-view of observers.

<table>
<thead>
<tr>
<th>Group ID</th>
<th>Infant ID</th>
<th>Period</th>
<th>Observation time (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>INF07</td>
<td>Conception</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-natal</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>1.8</td>
</tr>
<tr>
<td>K</td>
<td>INF05</td>
<td>Conception</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>4.5</td>
</tr>
<tr>
<td>K</td>
<td>INF07</td>
<td>Conception</td>
<td>32.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-natal</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>47.4</td>
</tr>
<tr>
<td>L</td>
<td>INF06</td>
<td>Pre-natal</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>5.2</td>
</tr>
<tr>
<td>L</td>
<td>INF07</td>
<td>Conception</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-natal</td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>16.1</td>
</tr>
<tr>
<td>L</td>
<td>INF08</td>
<td>Conception</td>
<td>30.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-natal</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infant</td>
<td>9.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>53.9</td>
</tr>
</tbody>
</table>
Table 6: Percentage of time pairmates spent within a specific distance of each other.

<table>
<thead>
<tr>
<th>Period</th>
<th>Group &amp; Infant ID</th>
<th>Contact (%)</th>
<th>&lt; 1 (%)</th>
<th>&lt; 3 (%)</th>
<th>&lt; 5 (%)</th>
<th>&gt; 5 (%)</th>
<th>&lt; 10* (%)</th>
<th>&gt; 10* (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K-INF07</td>
<td>12.7</td>
<td>21.5</td>
<td>38.7</td>
<td>61.3</td>
<td>34.8</td>
<td>86.4</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>L-INF07</td>
<td>6.4</td>
<td>20.2</td>
<td>36.5</td>
<td>56.2</td>
<td>40.2</td>
<td>79.1</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>L-INF08</td>
<td>2.5</td>
<td>21.1</td>
<td>28.4</td>
<td>37.9</td>
<td>39.7</td>
<td>48.3</td>
<td>12.1</td>
</tr>
<tr>
<td>Conception</td>
<td>K-INF07</td>
<td>11.4</td>
<td>13.3</td>
<td>20.0</td>
<td>46.7</td>
<td>45.7</td>
<td>75.2</td>
<td>4.8</td>
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<tr>
<td></td>
<td>L-INF07</td>
<td>11.8</td>
<td>26.0</td>
<td>41.3</td>
<td>56.1</td>
<td>43.2</td>
<td>87.7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>L-INF08</td>
<td>6.4</td>
<td>9.8</td>
<td>17.1</td>
<td>28.5</td>
<td>37.9</td>
<td>39.6</td>
<td>8.9</td>
</tr>
<tr>
<td>Prenatal</td>
<td>K-INF07</td>
<td>1.0</td>
<td>40.1</td>
<td>41.2</td>
<td>43.2</td>
<td>37.8</td>
<td>54.4</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>L-INF07</td>
<td>5.9</td>
<td>7.6</td>
<td>14.9</td>
<td>31.4</td>
<td>63.1</td>
<td>67.0</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td>L-INF08</td>
<td>0</td>
<td>4.4</td>
<td>13.4</td>
<td>23.1</td>
<td>45.2</td>
<td>26.3</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Contact: animals were touching; <1: animals were within one meter; <3: animals were within three meters; <5: animals were within 5 meters; >5: animals were further than 5 meters from one another; <10: animals were within 10 meters; >10: animals were further than 10 meters from one another; *Pairs spent significantly more time within 10 meters of each other than greater than 10 meters.
**Figure 2:** Average percentage of time when the pairmates were resting within 1 meter of each other during conception (con), pre-natal (pre), and infant (inf) periods.
**Figure 3:** Average percentage of time when the pairmates were resting in contact during conception (con), pre-natal (pre), and infant (inf) periods.
Figure 4: Average percentage of time when the pairmates groomed each other during conception (con), pre-natal (pre), and infant (inf) periods.
**Figure 5:** The average percentage of time during focal samples the pairmates groomed each other between instantaneous sample points during conception (con), pre-natal (pre), and infant (inf) periods.

![Grooming as an Event](image)
Figure 6: Average percentage of time when the pairmates tail-twined during conception (con), pre-natal (pre), and infant (inf) periods.
Figure 7: Average percentage of time when the pairmates were within five meters of one another during conception (con), pre-natal (pre), and infant (inf) periods. Differences across these periods were statistically significant (p<.05).
Figure 8: Average percentage of time in contact in group scans during the non-infant (non) period (conception and pre-natal periods combined) and infant (inf) periods.
Figure 9: Average percentage of time when the pairmates were resting in contact with each other during the non-infant (non) period (conception and pre-natal periods combined) and infant (inf) periods.
Figure 10: Average percentage of time when the pairmates were resting within 1 meter of each other during the non-infant (non) period (conception and pre-natal periods combined) and infant (inf) periods.
Figure 11: Average percentage of time when the pairmates were tail-twining during the non-infant (non) period (conception and pre-natal periods combined) and infant (inf) periods.
APPENDIX 1: Monogamous Primate Project Protocol

Monogamous Primates Behavioral Data Collection

The following protocol describes the general procedures we use for collecting data for the "Monogamous Primates Project". This is also the basic protocol upon which the "Ateline Primates Project" protocol was based, and in the protocol description below we have tried to note the key differences between these two protocols as a matter of reference. However, if you are working on the "Atelines Primate Project" you should read and follow the information contained in that protocol as is may differ slightly from that noted here.

GENERAL CONSIDERATIONS
As this is at the heart a comparative behavioral study, some of the most important data you will collect are behavioral observations of specific individuals using FOCAL ANIMAL SAMPLING and GROUP SCAN SAMPLING. You will only be recording behavioral observations that you are 100% sure of. Any observational data that you are not totally certain of because you cannot see the animal clearly or collect data on it with confidence should be indicated as such. That is, indicate when your focal animal is OUT OF VIEW using the letters “FV”, which signifies “FUERA DE VISTA” in Spanish. There will probably be many times when you cannot see a focal animal or a group member you are trying to scan very well, but you nonetheless have a good idea of its behavior. For example, you might see an animal entering a tree crown and then hear fruits dropping, but you cannot see the focal. In this case, you can reasonably infer that the behavioral state (“condition”) of the animal is “FORAGE” and you should note its behavior as “FFV” which means, “Forragear Fuera de Vista (Forage Out of View)”. The important thing is that you should be sure of what you note: “if in doubt, leave it out”!

AGE CATEGORIES
Estimating the ages of some individuals is extremely difficult. For that reason, it is important to make a detailed description of the relative sizes of individuals that you know well (especially as we come to work with more groups) as these will allow us to make retrospective and comparative estimates of age. You may want to use or make reference to the size of other individuals of known age when describing the size of a new individual. This is particularly useful for young ones.

- Infants – Individuals between 0 and 11 months of age. Infants are morphologically and behaviorally distinguishable from the rest of the individuals in the group for all of the species under investigation, and it should not be difficult to recognize such individuals as infants. Infants are coded for data entry
as IM (infant male), IF (infant female), INF (infant of unknown sex). Note that for the "Ateline Primates Project", the INFANT class is divided into 2 subclasses, “1” and “2” (e.g., IF1, IM2) and the age range for infants is somewhat different.

- **Juveniles** – Individuals between 12 and 35 months of age. In *Aotus azarai*, they can generally be distinguished from subadults and adults, though from 24 month on, it begins to be more difficult. It has occurred that the weight of some adults was similar to the average weight of a juvenile, thus it is important to be careful. Juveniles typically differ from adults in some behaviors which may facilitate their identification. In *Aotus azarai* many aspects of their behavior even allow us to distinguish between juveniles of 2 and 3 years of age. In the other species, it is important to take notes of the size of the juvenile relative to the adults for future assessment of its age. Juveniles are coded for data entry as JM (juvenile male), JF (juvenile female), JUV (juvenile of unknown sex). Note that for the "Ateline Primates Project", the JUVENILE class is divided into 2 subclasses, “1” and “2” (e.g., JF1, JM2) and the age range for juveniles is somewhat different.

- **Subadults and Adults** – These individuals are sometimes impossible to differentiate from one another by size. In the monogamous primates, we should not assume that there are only TWO adults per group; especially given that that is one of the things we are interested in studying! If you cannot identify four different sizes (infant, juvenile, subadult and adult), then do NOT call an individual a subadult assuming there is one!!! And just make reference to their size. This implies that you could report three adult-size individuals, a juvenile and an infant. Adults are coded for data entry as AM (adult male), AF (unencumbered adult female), AFD (adult female with a dependant), and ADULT (adult of unknown sex). Subadults are coded as SM (subadult male) and SF (subadult female), SUB (subadult of unknown sex). Note that for the "Ateline Projects Project", we recognize two additional classes of adult males: BAM (big adult male) and SAM (small adult male).

- **Unknown Individuals** – If animal age cannot be determined, a classification of unknown should be given and the number of individuals described based on relative size as "Small", "Medium" or "Large".

**CATEGORIES FOR DISTANCE ESTIMATION**

- **CD** – INFANT in dorsal contact
- **CV** – INFANT in ventral contact
- **CVL** – INFANT in ventrolateral contact
- **CI** – INFANT in contact independently (i.e., use this instead of CON for an infant)
- **CON** – when the focal animal is in contact with another individual
- **<0.5** – between contact and 0.5 m
- **<1** – between 0.5 and 1 m
- **<3** – between 1 and 3 m
- **<5** – between 3 and 5 m
<10 – between 5 and 10 m
<20 – between 10 and 20 m
<50 – between 20 and 50 m
>XX – more than XX m: Example: if they are further than 20 meters, write >20

IMPORTANT NOTE:

• Be SURE to remember that the various “<” codes carry the implication that the animal is at least a certain distance away – e.g., “<10” means “5 to 10 meters away”.

GROUPS AND INDIVIDUALS TO BE STUDIED

Observations will be collected on all groups in which it is possible to identify animals individually and unequivocally, whether by their collars or natural markings. You should rotate through all members of each social group as focal subjects. In Ecuador, until more animals are captured and marked, data will be collected from all individuals in the small number of social groups already collared.
It is very important that you do NOT name an individual in the data collected until we can recognize that individual not only within its group but outside of it. For example, unless we are sure we can identify Mondika anywhere it goes, we should not name it. It could happen that Mondika disperses, gets into another group without us noticing it and we could end up collecting data from the same individual in two different groups and giving the same individual two different names.
Names should be simple to write down. For example, Dartagnan, Krustzy are prone to errors (e.g. Krustzy has been entered into the database with three different spellings already). The names of the individuals in a given group should all begin with the same letter if at all possible (e.g., Mona and Mendel belong in Group M). And the names of the groups should reflect in some way the area where they are most likely to range making reference to areas known by everyone. In Ecuador, we have now implemented standard two letter codes for all individuals on the monogamous primate project and three letter codes or full names for all individuals on the ateline project. These are listed in the “animal ids” table in the database.

We must not name individuals until we know their gender. And names should be as much as possible of general agreement for Spanish and English regarding their gender (e.g., Paul, Mary or Juan, Maria are good options, whereas Mondika or Kelly can be confusing. Mondika is thought of a female name in Spanish but may be a male name in English).

CHOICE OF SUBJECTS FOR BEHAVIORAL SAMPLING

Ideally, we would decide on a sampling order at random at the beginning of the month, but it is unlikely that we would be able to stick to such a schedule given observation
conditions. If it is possible, at the beginning of the day, choose a random order of rotation through all members of the group being studied. From there, look for your first focal animal for behavioral data sampling. When you finish with that individual, change to the next subject following the pre-established order. When you have finished sampling each individual, repeat the order as many times as possible throughout the day. It may happen that when you arrive to sample a group, they are moving, in which case you can try to start a focal sample (after you have been there 5 minutes) on whomever you can, the idea being to not lose the opportunity to collect samples just because they are moving and it may be difficult to find your pre-established focal animal.

While this plan of pre-establishing the sampling order each day is ideal, it is proving impractical to stick to such a schedule given observation conditions. In this case, you can instead, collect focal data on whichever individuals it is possible to, but with an eye to balancing the total number and order of samples among individuals. The following procedure works pretty well: wander around under the group until you see your first animal. This should be your focal for your first twenty minute sample. At the end of the sample, look around until you encounter another individual (NOT the same one) and conduct another focal sample. Do not collect successive samples on the same individual unless they are separated by more than 20 minutes (i.e., the length of a focal sample). If you see multiple other individuals right away, choose the one you sampled the longest time ago. Repeat this procedure throughout the day. In Ecuador, your goal is to eventually be able to collect 10 to 12 focal samples per group during a full-day follow for the monogamous primate project, split among the various individuals in the group.

**CHRONOGRAM AND INTENSITY OF BEHAVIORAL SAMPLING**

The unit of time over which we want to have a balanced set of samples by group and by individual is the MONTH. The main goal is to have a nice monthly balance. If a given month ended unbalanced, you will try to balance it on the following month after having checked with the other people who collected data on that group during the month. e.g., Jan, 5 male focals and 10 female focals, then on February try to do 10 male focals and 5 female focals. That is, we want roughly the same number of samples per group of the same species (where we have more than one group collared) and per individual (including INFANTS) within those groups each month. It is also important to try to balance the order of focals as much as possible, also across the month. That is, at the end of each month, all groups and all individuals forming part of the study should have been sampled at roughly similar intensities and across the hours of the day. If you are collecting data on paper, the easiest way to keep track of your sampling intensity per animals is to keep one page free in the back of your Data Book with columns for the individuals being sampled and rows for the date and then make tally marks in the appropriate cell for each complete focal for each individual. If you are collecting data on the Palm, you could keep a tally of your monthly focal samples as a Memo in the Palm Memo program. In the main Proyecto Primates Database, you can tally from the 'focal samples' table. However you do it, keep track of how many focal samples you have on
each individual and/or age-sex class of individual that you are supposed to sample. Each day, add up the number of focal samples for each animal and choose the animal with the least focal samples for the next sample.

**BEHAVIORAL DATA COLLECTION PROCEDURE**

You may begin collecting behavioral data on all identifiable individuals five minutes after you encounter a group. In Ecuador, you may also begin as early as 06:00 hours even if you have not been with the group for five minutes if you are on the second or greater day of a multiple day follow. Also, in Ecuador, all sampling should be suspended at 18:00 hours for the diurnal taxa, by which time both titi monkeys and sakis are typically in their sleep trees. Behavioral data will be collected using a combination of focal, group scan, all-occurrences, and ad libitum sampling, all being performed simultaneously. The priority for data collection is to collect focal samples. However, this is not always possible as often the animals are difficult to see or (especially for the monogamous primate project) disappear into the tops of trees for stretches of time.

In order to have a better idea of how the animals are spending their time, we have started, in Ecuador in summer 2007, to implement GROUP SCANS every 10 minutes (i.e., at 0, 10, 20, 30, 40, and 50 minutes past the hour) AT TIMES WHEN YOU ARE NOT IN THE MIDST OF A FOCAL. Again, the PRIORITY is focal samples, but at any 10 minute point during the day when you cannot, for some reason, do a focal, you should be doing a group scan. The reason for implementing a group scan procedure is because we felt that we were not getting a representative sample of the behavior of the monogamous primates throughout the day, because focal samples were concentrated only at times when the animals were easy to see. Also, without group scans, it is impossible to tell whether researchers in the field simply were not collecting focal data throughout the day OR whether focal data was not collected because of something the animals were doing.

**FOCAL SAMPLES**

Focal behavior sampling periods will last 20 minutes. During a sampling period, you will collect instantaneous records of the behavior of your FOCAL ANIMAL every two minutes, beginning at minute 0, and scan data of the behavior all GROUP MEMBERS, and their distances from your focal individual, on minutes 2, 6, 10, 14 and 18. Finally, you will record data on all-occurrences of particular events and ad libitum data on rare behaviors.

*Instantaneous Records within Focal Samples*

Set your watch to beep at two minute intervals. After locating your focal animal, wait until your watch beeps the next time (to reduce the risk of biasing the beginning a sample towards conspicuous behavior that helped you to find the animal) and then begin the sample. At the beginning of each 2 minute interval (i.e., at minutes 0, 2, 4, 6, 8, 10, 12, 14, 16, and 18, when your watch beeps) count off 5 seconds in your head and note the PREDOMINANT STATE (“condición”) that your focal individual was in, according to
the definitions listed below. In rare cases where the animal is in more than one “condition” at the beep (e.g., Kiki is STT with Kong and SNN with Kelly, i.e., tail twining with one individual and nose-to-nose with a second), you should note both behaviors separated by a SLASH (“/”) in both your data book and when you enter the data on the computer (e.g., “STT/SNN/”). In this example, you would also indicate both partners in the partner column, separated by a slash, in the same order as the behaviors recorded (e.g., “KO/KE/”). Note that every behavior code and every individual ID is followed by a slash! That slash is necessary for when we parse the text in any given cell in the database during analysis.

Also, record the identity of the nearest neighbor of your focal animal. If there is more than one equidistant nearest neighbor, note the identity of all of them (separated by SLASHES and with a slash at the end as well), while if you cannot tell the nearest neighbor, note “UNK” for “unknown”. In total, a sampling period of 20 minutes will have 10 instantaneous behavioral sampling records and 10 nearest neighbor IDs associated with it for the focal individual. Note that if your focal animal is a dependent infant/juvenile being carried you should record as the nearest neighbor the closest animal NOT carrying your focal. Similarly, if your focal animal is carrying a dependent infant/juvenile, record as the nearest neighbor the closest individual that is NOT the dependent. However, if a dependent infant/juvenile is not on another individual, simply score the closest animal as its nearest neighbor.

We have noticed a problem with how we have been recording NN data for infants, particularly for the monogamous primate project, where it is difficult to determine from the way we’ve collected data just WHO is carrying a dependent infant at any point in time under the procedures described above. To deal with this, beginning in Jan 2008, we have added a checkbox that you should check at every 2 minute instantaneous record if your focal is carrying a dependent. The checkbox does not apply to infants. If your focal is an infant and it is being carried, the behavior code used should be SRI (Social Riding) with the appropriate partner indicated.

If another monkey of a different species is the nearest neighbor of your focal animal (rare, but it happens), record the species as the nearest neighbor as well as sex/age class if possible.

If your animal persists in being out of view for three consecutive sampling points during the first 10 minutes of a focal simple (see below) and you have no idea of its behavior, then you should cancel the focal and begin anew with another individual. If this happens during the second half of a focal sample, continue trying to sample the same focal individual for the remainder of the sample period before starting on a new individual. You will enter ALL data into the database, whether you completed the focal or not.

Group Scan Data within Focal Samples
On minutes 2, 6, 10, 14 and 18 of each focal sampling period, in addition to the
instantaneous record of your focal’s behavior, you will also perform a scan of all other animals in the group, noting their identity, behavioral state (condition), and the distance of each from your focal animal using the distance categories noted above. If one of the other individuals is out of view, you will note “FV” for “fuera de vista”.

If you can see that other individuals are not within a certain distance of your focal animals, but you cannot say if it is within the next greater distance category, record the distance as “>XX”. For example, if you know that there is no other individual within 10m of your focal but you cannot see all around you between 10 and 20m, record “>10” as the distance to each other animal in the group. It is VERY IMPORTANT that you record something for all other possible individuals in the group, whether you see them or not. That is, if you do not see them, still be sure to record the distance in which you see that they are not, as in the example above.

On group scan points within focal samples, nearest neighbor data will be recorded as during other points: if your focal animal is a dependent infant/juvenile being carried you should record as the nearest neighbor the closest animal NOT carrying your focal. Similarly, if your focal animal is carrying a dependent infant/juvenile, record as the nearest neighbor the closest individual that is NOT the dependent. However, if a dependent infant/juvenile is not on another individual, simply score the closest animal as its nearest neighbor. Note that here we will indeed have data on who is carrying a dependent because if it is the focal, it will show up with the infant in contact, and if it is another animal, it will show up with the infant as SRI with the partner indicated. As of Jan 2008, we also will have the checkbox mentioned above.

GROUP SCANS
Again, every 10 minutes (at 0, 10, 20, 30, 40, and 50 minutes past the hour) AT TIMES WHEN YOU ARE NOT IN THE MIDST OF A FOCAL, you should perform a group scan. For the group scan procedure, you should look at each visible member of the group, count off 5 seconds in your head, and record its predominant behavior(s) (using the codes in the same ethogram as you use for focal sampling), nearest neighbor(s), and distance(s) to its nearest neighbor(s) (record data for all nearest neighbors if more than one are present in the nearest neighbor category). When recording NN data during group scans, for any individual who has an INFANT in contact record NN data for BOTH THE INFANT AND THE NEXT NEAREST NEIGHBOR. Thus, for a female carrying an infant whose next nearest neighbor is an adult male 5 to 10 meters away, you would note for NN: INF/AM/ and for NN Dist: CON/5-10m/. You should also check the appropriate checkbox indicating whether or not a scanned animal is carrying an infant. Note that the GROUP SCAN PROCEDURE is slightly different from that used for the "Ateline Primates Project", where you instead note the number and identities of individuals in various distance categories from the scanned individual.

THE ETHOGRAM
Below, you will read about the different behaviors included in the ethogram. The list of
behaviors and codes to record them include both behaviors that should be sampled as STATES ("CONDICIONES") and behaviors that should be sampled as EVENTS.

The description of the ethogram is organized around six main sections. Each section presents the behaviors associated with six mutually exclusive states in which you will classify your focal to be at any given sampling point. These behavioral states (or "condiciones": we use the word "condiciones" rather than "estados" to have a word that does not begin with “e” in Spanish like “eventos”) are divided in six mutually exclusive categories: 1- Active or Inactive Out of View ("Activo" o "Inactivo Fuera de Vista", AFV o IFV, or simply FV if you cannot say whether they are active or inactive), 2- Rest ("Reposar", R), 3- Forage ("Forragear", F), 4- Move ("Moverse", M), 5- Other ("Otro", O), and 6- Social ("Social", S). It is at the level of these six fundamental states that our data are completely comparable among species.

In each section of the ethogram you will find a list of behaviors and codes. All behavioral states (i.e., the six major categories) have a code consisting of three or four letters, the first of which represents the basic state (or “condition”) and the rest the subcategory of the state or additional details about that behavior. In some of the sections you will find behaviors that are listed showing two codes, one with and one without an initial CONDITION code. These are codes for behaviors that most likely will be recorded as EVENTS, but if they occur at the sampling point you will record them with the condition letter at the front of the code.

While all behaviors in the ethogram, including “EVENTS”, can be the “CONDITION” recorded on the instantaneous sampling points if they are the predominant activity for the 5 seconds after those points, not everything in the ethogram needs to be recorded as events between the instantaneous sampling points! For example, it is unnecessary to record “FBQ” (Forage Stationary Search) as an event, since these behaviors are of sufficient duration to be sampled adequately ONLY as conditions ("states"). Behaviors indicated in the ethogram with both 3-digit "CONDITION" and 2-digit "EVENT" codes thus should be scored as either "CONDITIONS" or "EVENTS" depending on whether they occur as the predominant activity on an instantaneous record point or between those points. Behaviors with a 2-letter code only (i.e., that don't also have an option listed that includes the 1-letter “CONDITION” code at the beginning) should only be scored as events. These would include, for example, “AT+”, “AT-“, and “ATX” within “Forage” or “TA”, “TS”, “EX”, and “RE” within “Move”.

Activo o Inactivo Fuera de Vista (Active or Inactive Out-of-View) (AFV o IFV o FV)
The animal cannot be seen but the observer knows that it is there and can determine at least whether it is active or inactive.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description English</th>
<th>Definition English</th>
</tr>
</thead>
<tbody>
<tr>
<td>FV</td>
<td>Out of View</td>
<td>The animal cannot be seen, the observer knows that it is there</td>
</tr>
</tbody>
</table>
but cannot determine whether it is active or inactive.

IFV  Inactive Out of View
The animal cannot be seen but the observer knows that it is there and can determine at least whether it is active or inactive. Inactive: the animal is resting or being social but is still (“quieto”). IFV will probably be used when it is clearly inactive, but you cannot tell if resting, social or other category that implies being still.

AFV  Active Out of View
The animal cannot be seen but the observer knows that it is there and can determine at least whether it is active or inactive. Active: the animal is either moving, foraging, or being social, but NOT resting or being social while remaining still (“quieto”). AFV will probably be used in circumstances when the animals is clearly active but you cannot tell if foraging, moving or social because it is out of view.

Rest/Reposo (R)
The individual is still (“quieto”). The three subcategories are: rest vigilant or “reposa vigilando” (RV), rest wait or “reposa esperando” (RES), and rest passive or “reposa pasivo” (RP). When R is scored for minutes 2, 6, 10, 14 or 18, you should note the position that the focal is resting in with respect to whatever individuals it may be in contact with using the following position codes:

- CE – Central – Focal is in contact with at least one individual on each side
- LA – Lateral – Focal is in contact with only one individual
- SO – Solitario – Focal is not in contact with any other individual

Enter the applicable position code in PARENTHESES and separated by a SPACE after the resting code. i.e., “RPA (CE)”.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description English</th>
<th>Definition English</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPA</td>
<td>Rest Passive Eyes Open</td>
<td>Still, motionless, passive with eyes open.</td>
</tr>
<tr>
<td>RPC</td>
<td>Rest Passive Eyes Closed</td>
<td>Still, motionless, passive with eyes closed.</td>
</tr>
<tr>
<td>RPX</td>
<td>Rest-Reposo Passive Undetermined</td>
<td>Still, motionless, but cannot tell if eyes are open or closed.</td>
</tr>
<tr>
<td>RVS</td>
<td>Rest Vigilant Social</td>
<td>Still, motionless, and looking in the direction of a conspecific.</td>
</tr>
<tr>
<td>RVO</td>
<td>Rest Vigilant at Observer</td>
<td>Still, motionless, and looking in the direction of the observer.</td>
</tr>
<tr>
<td>RVA</td>
<td>Rest Vigilant at</td>
<td>Still, motionless, and looking at the surrounding</td>
</tr>
</tbody>
</table>
Environment

Rest-Reposo

Vigila Unknown

Still, motionless, and looking at something unknown.

Rest Wait

Still, motionless, and waiting on another individual.

Rest Out of View

Apparently still, motionless, although cannot be seen.

Rest Undetermined

Still, motionless, but impossible to classify which subcategory.

Forage/Forrajeo (F)

The search for ("busqueda") (FB), manipulation ("manipulación") (FM), or eating ("ingestión") (FE) of food items. The second letter of the code indicates which of these three is the appropriate substate, while the third and, occasionally, fourth, letters refer to other pertinent details about the kind of search, manipulation, or ingestion seen.

Forrajeo also includes movements within the same tree crown if they are part of the search for food items within the same feeding bout (e.g., FCP). These movements must be short (a couple of seconds) and the animal must be feeding both before and after the movement. Whenever Forrajeo is recorded, you should note the species consumed or the reference number of the feeding source fed upon in the “Additional Info” section of your Focal Data (e.g., “Inga”, or “AV-05-122”).

Note that for the Atelines Project, we will also record FORAGE EVENTS for infants using same codes (minus the F) to get at infant development of foraging competence. To the "manipulate" codes will be added the suffix (H) or (M) to indicate whether with "hands" or "mouth". Successive foraging events will only be noted if the substrate manipulated changes or if the subject changes from manipulating a substrate with H to M or vice versa; multiple successive events of the same type on the same substrate are thus not recorded.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description English</th>
<th>Definition English</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEFL/EFL</td>
<td>Forage Eat Flowers</td>
<td>Takes flowers into the mouth</td>
</tr>
<tr>
<td>FEFR/EFR</td>
<td>Forage Eat Fruit</td>
<td>Takes fruit into the mouth and spits out or swallows seeds</td>
</tr>
<tr>
<td>FEML/EML</td>
<td>Forage Eat Mature Leaves</td>
<td>Takes leaves into the mouth that because of their size and color appear mature</td>
</tr>
<tr>
<td>FENL/ENL</td>
<td>Forage Eat New Leave</td>
<td>Takes leaves into the mouth that because of their size and color appear immature</td>
</tr>
<tr>
<td>FEXL/EXL</td>
<td>Forage Eat Undetermined Leaves</td>
<td>Takes leaves into the mouth of unknown degree of maturation.</td>
</tr>
<tr>
<td>FEOT/EOT</td>
<td>Forage Eat Other</td>
<td>Takes into the mouth other items, including fungus, water</td>
</tr>
<tr>
<td>FESE/ESE</td>
<td>Forage Eat Seeds</td>
<td>Takes seeds into the mouth, discarding the fruit pulp or husk</td>
</tr>
<tr>
<td>FEXX/EXX</td>
<td>Forage Eat Undetermined</td>
<td>Takes something into the mouth, but impossible to classify subcategory</td>
</tr>
<tr>
<td>FMA/MA</td>
<td>Forage Manipulate (Substrate in Search of) Animal</td>
<td>Uses the hands or the mouth to manipulate a substrate apparently in search of animal prey (e.g., unrolling dead leaves, tearing through dead wood). Include (H) or (M) as a suffix to indicate with &quot;hands&quot; or with &quot;mouth&quot;</td>
</tr>
<tr>
<td>FMP/MP</td>
<td>Forage Manipulate Plant</td>
<td>Uses the hands or the mouth to manipulate plant material prior to taking it into the mouth (e.g., removing husk from fruit). Include (H) or (M) as a suffix to indicate with &quot;hands&quot; or with &quot;mouth&quot;</td>
</tr>
<tr>
<td>FBM</td>
<td>Forage Moving Search</td>
<td>Moves the head in various directions apparently searching visually for insects or other food items while moving its body slowly</td>
</tr>
<tr>
<td>FBQ</td>
<td>Forage Stationary Search</td>
<td>Moves the head in various directions apparently searching visually for insects or other food items while remaining still (&quot;quiteto&quot;)</td>
</tr>
<tr>
<td>FCP/CP</td>
<td>Forage Change Positions</td>
<td>Moves within the same tree crown to switch from one section of a plant feeding patch to another</td>
</tr>
<tr>
<td>FFV</td>
<td>Forage Out of View</td>
<td>Apparently eating, manipulating or searching for food, although cannot be seen</td>
</tr>
<tr>
<td>FXX</td>
<td>Forage Undetermined</td>
<td>Foraging, but cannot specify if searching, manipulating, or eating</td>
</tr>
<tr>
<td>FEIN</td>
<td>Forage Eat Insects</td>
<td>Eat insects. Score what kind in “DETAILS” if possible.</td>
</tr>
<tr>
<td>AT-</td>
<td>Attack unsuccessfully</td>
<td>Quickly lunges or grabs at a prey item or at an apparent substrate for a prey item and it does NOT SUCCEED, meaning it does not take something into the mouth.</td>
</tr>
<tr>
<td>AT+</td>
<td>Attack, successfully</td>
<td>Quickly lunge or grab at a prey item or at an apparent substrate for a prey item. Success of attack should be scored as + when the animal masticates or takes something into the mouth.</td>
</tr>
<tr>
<td>ATX</td>
<td>Attack, unknown result</td>
<td>Quickly lunges or grabs at a prey item or at an apparent substrate for a prey item and it is unknown whether it succeeds or not.</td>
</tr>
</tbody>
</table>

**Move/Movimiento (M)**
Animal displaces itself some distance A to B. Does not include displacements associated with foraging bouts (see Forrageo Cambiar Posiciones, FCP). In the case of observing infants as the focal, this category will include the movements of the infant relative to other individuals, i.e. exploring.
<table>
<thead>
<tr>
<th>Code</th>
<th>Description English</th>
<th>Definition English</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT</td>
<td>Move Between</td>
<td>Changes trees but NOT within the context of the progression of a group or individual in a defined direction.</td>
</tr>
<tr>
<td>MWI</td>
<td>Move Within</td>
<td>Movement of at least one body length within a tree but NOT within the context of the progression of a group or individual in a defined direction.</td>
</tr>
<tr>
<td>MLE</td>
<td>Move Lead</td>
<td>Movement of at least one body length in the context of a group progression along the same rough path of the rest and it is the first one in the progression.</td>
</tr>
<tr>
<td>MSE</td>
<td>Move Second</td>
<td>Movement of at least one body length in the context of a group progression along the same rough path and focal is located in the 2nd position in the progression.</td>
</tr>
<tr>
<td>MCE</td>
<td>Move Central</td>
<td>Movement of at least one body length in the context of a group progression along the same rough path and focal is located in a central position in the progression.</td>
</tr>
<tr>
<td>MEN</td>
<td>Move End</td>
<td>Movement of at least one body length in the context of a group progression along the same rough path and focal is located last in the progression.</td>
</tr>
<tr>
<td>MPX</td>
<td>Move Position Undetermined</td>
<td>Movement of at least one body length within or between trees in a defined direction and the focal individual is either moving alone or is part of a group progression but its position in the progression cannot be determined.</td>
</tr>
<tr>
<td>MCI</td>
<td>Moving in Contact Infant on parent by infant</td>
<td>Infant moving on individual, perhaps exploring while remaining dependent. Not in ethogram table.</td>
</tr>
<tr>
<td>MFV</td>
<td>Move Out of View</td>
<td>Apparently moving, although cannot be seen.</td>
</tr>
<tr>
<td>MXX</td>
<td>Move Undetermined</td>
<td>Moving, but impossible to classify subcategory.</td>
</tr>
<tr>
<td>TA</td>
<td>Move-Transfer Asistida</td>
<td>The infant moves from one individual to other, remaining DEPENDENT ALL THE TIME, and with help from other individual.</td>
</tr>
<tr>
<td>TS</td>
<td>Move-Transfer Sin Asistencia</td>
<td>The infant moves from one individual to other, remaining DEPENDENT ALL THE TIME, and WITHOUT help from other individual.</td>
</tr>
<tr>
<td>EX</td>
<td>Move-Excursion</td>
<td>The infant moves from being dependent to being independent.</td>
</tr>
<tr>
<td>RE</td>
<td>Move-Regreso</td>
<td>The infant moves from being independent to being dependent.</td>
</tr>
<tr>
<td>CA</td>
<td>Move-</td>
<td></td>
</tr>
</tbody>
</table>
The behaviors considered here are relatively short in duration and occur infrequently. As such, they are best considered as events and sampled as all-occurrences between each instantaneous sample point. Nonetheless, it may occur that the predominant activity of a focal individual at an instantaneous sample point is one of the following behaviors, in which case “O” should be noted as the state (“condición”) along with the code for the event.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description English</th>
<th>Definition English</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORP/RP</td>
<td>Rub Chest/Pectoral</td>
<td>The chest region is moved with pressure and friction against the substrate by sliding the body forward. It may also be pressed in a downward motion with hands and/or arms.</td>
</tr>
<tr>
<td>ORG/RG</td>
<td>Rub Genitals</td>
<td>The anogenital region is in contact with a substrate and the body is slid forward or laterally moving the rear part of the body.</td>
</tr>
<tr>
<td>ORF/RF</td>
<td>Rub Face</td>
<td>The face is in contact with a substrate and the cheek is slid forward or laterally against the substrate.</td>
</tr>
<tr>
<td>OROP/ROP</td>
<td>Rub Over Pectoral</td>
<td>The chest region is moved with pressure and friction against the substrate by sliding the body forward after another animal did the same on that section of the substrate.</td>
</tr>
<tr>
<td>OROG/ROG</td>
<td>Rub Over Genital</td>
<td>The anogenital region is in contact with a substrate and the body is slid forward or laterally moving the rear part of the body after another animal did the same on that section of the substrate.</td>
</tr>
<tr>
<td>OROF/ROF</td>
<td>Rub Over Face</td>
<td>The face is in contact with a substrate and the cheek is slid forward or laterally against the substrate after another animal did the same on that section of the substrate.</td>
</tr>
<tr>
<td>DF</td>
<td>Defecation</td>
<td>Common usage.</td>
</tr>
<tr>
<td>UW</td>
<td>Urine Wash</td>
<td>Focal animal wets its hands with its own urine and then rubs its hands on some part of its body.</td>
</tr>
<tr>
<td>US</td>
<td>Urinate Social</td>
<td>Focal animal urinates a few drops outside of the context of normal voiding or not immediately alter getting up from sleep.</td>
</tr>
<tr>
<td>UM</td>
<td>Urinate Metabolic</td>
<td>A relatively long episode of urinating, typically associated with getting up from sleep.</td>
</tr>
</tbody>
</table>
### Solo Play (OSP/SP)
To play alone, non-stereotypic and repetitive behavior that occurs independently from another conspecific.

### Yawn (YW)
Use the hands or mouth to separate one's own fur while looking at the section of fur being examined, apparently in search of something.

### Self Groom (OGS/GS)
Use the hands or mouth to separate one's own fur while looking at the section of fur being examined, apparently in search of something.

### Ritual Scratching (RS)
Self-scratching prior to waking up or going to sleep.

### Escape Behavior (ES)
Rapid drop into lower vegetation, typically following alarm vocalization.

#### Social/Sociál (S)
This state (“condición”) includes behaviors that are readily considered states (grooming, nursing, play, proximity, contact), others that are readily considered events, and others that could be considered either states or events depending on their duration. If during the five seconds following an instantaneous scan point, the predominant activity of the focal animal is one of the behaviors listed below, record an “S” for the state, plus the appropriate code detailing the behavior.

Note that if you are doing a focal on an animal and an individual carrying an infant approaches, leaves, or passes by your focal, you should score that as your focal receiving that behavior from the carrier, but not the infant. If the focal approaches, leaves, or passes by another individual carrying an infant, score that as your focal performing the behavior to BOTH the carrier and the infant. If you are doing a focal on either a carrier or an infant and another animal approaches, leaves, or passes by them, that behavior would be relevant for both the infant and the carrier, although you would only score the behavior for the individual on whom you are doing the focal.

In the following list, two codes are listed (one with an initial “S” and one without) for codes that can be scored as either conditions or events. Only those codes listed below both ways should ever be recorded as a state.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description English</th>
<th>Definition English</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGMA/GMA</td>
<td>Social Groom Actor</td>
<td>The focal uses the hands or mouth to manipulate the hair of another individual with gaze directed at the part of the body being manipulated. Also note the context if obvious (affiliative, sexual, aggressive) in the Additional Info section.</td>
</tr>
<tr>
<td>SGMR/GMR</td>
<td>Social Groom Recipient</td>
<td>Another individual uses the hands or mouth to manipulate the hair of the focal with gaze directed at the part of the body being manipulated. Also note the context if obvious (affiliative, sexual, aggressive) in the Additional Info section.</td>
</tr>
<tr>
<td>SGMM/GMM</td>
<td>Social Groom Mutual</td>
<td>It is groomed and it grooms simultaneously.</td>
</tr>
<tr>
<td>Code</td>
<td>Category</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>SGMX/GMX</td>
<td>Social Groom</td>
<td>It is not known whether the focal is being groomed or is grooming.</td>
</tr>
<tr>
<td>SNU/NU</td>
<td>Social Nurse</td>
<td>Infant has mouth in contact with nipple or mammary tissue of female.</td>
</tr>
<tr>
<td>SPL/PL</td>
<td>Social Play</td>
<td>Continued grappling, chasing, pushing, pursuing between the focal and at least one more individual in a non-aggressive context not related to food.</td>
</tr>
<tr>
<td>SP1/P1</td>
<td>Social In Proximity 1 meter</td>
<td>Focal animal remains sitting or lying for at least 10 sec within 1m of another individual who is resting.</td>
</tr>
<tr>
<td>SPC/PC</td>
<td>Social In Contact</td>
<td>Focal animal remains sitting or lying for at least 10 sec in contact with another individual who is resting.</td>
</tr>
<tr>
<td>STT/TT</td>
<td>Social Tail Twining</td>
<td>Focal is in physical contact with another individual sitting quietly side by side, awake or asleep, and tails are wrapped around each other for at least one turn.</td>
</tr>
<tr>
<td>SFV</td>
<td>Social Out of View</td>
<td>Apparently engaged in any of the other social categories defined in the ethogram but cannot be seen (and NOT F, M, R, O).</td>
</tr>
<tr>
<td>Acronym</td>
<td>Actor</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>GPR</td>
<td>Groom Present Receiver</td>
<td>Grooms an animal that presents for grooming.</td>
</tr>
<tr>
<td>SINA/INA</td>
<td>Inspect Actor</td>
<td>Sniffing, licking, or exploring the genital area of another individual, or the urine of another individual.</td>
</tr>
<tr>
<td>SINR/INR</td>
<td>Inspect Recipient</td>
<td>Another individual sniffs, licks or explores the genital area of the focal, or the urine of the focal.</td>
</tr>
<tr>
<td>SINM/INM</td>
<td>Inspect Mutual</td>
<td>The focal and another individual are at the same time sniffing, licking or exploring each others’ genital area or urine.</td>
</tr>
<tr>
<td>SINX/INX</td>
<td>Inspect Undetermined</td>
<td>The focal and another individual are involved in an “inspect”, but it is not obvious who plays which role.</td>
</tr>
<tr>
<td>SFSA/FSA</td>
<td>Food Share Actor</td>
<td>The focal feeds from the same piece of food another individual is feeding from, with the focal being the first to be eating or manipulating the food item. In the case of an infant or a juvenile it includes when the infant manipulates the food together with another individual, when it gets food or when they share food, WITHOUT ANIMOSITY FROM EITHER. With some resistance but not aggression?</td>
</tr>
<tr>
<td>SFSR/FSR</td>
<td>Food Share Recipient</td>
<td>The focal feeds from the same piece of food another individual is feeding from, with the other individual being the first to be eating or manipulating the food item. In the case of an infant or a juvenile it includes when the infant manipulates the food together with another individual, when it gets food or when they share food, WITHOUT ANIMOSITY FROM EITHER. With some resistance but not aggression?</td>
</tr>
<tr>
<td>FRA+</td>
<td>Food Rob Actor Successful</td>
<td>The focal SUCCESSFULLY grabs a piece of food from another individual with the other individual offering resistance or trying to keep the food away from the focal with some form of aggression. In sakis this sometimes occurs together with vocalizations.</td>
</tr>
<tr>
<td>FRA-</td>
<td>Food Rob Actor Unsuccessful</td>
<td>The focal UNSUCCESSFULLY grabs a piece of food from another individual with the other individual offering resistance or trying to keep the food away from the focal with some form of aggression. In sakis this sometimes occurs together with vocalizations.</td>
</tr>
<tr>
<td>FRR+</td>
<td>Food Rob Recipient Successful</td>
<td>Another individual SUCCESSFULLY grabs a piece of food from the focal with the focal offering resistance or trying to keep the food away from the individual with some form of aggression. In sakis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>FRR-</strong></td>
<td><strong>Food Rob</strong></td>
<td><strong>Recipient</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Unsuccessful</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>another individual <strong>UNSUCCESSFULLY</strong> grabs a piece of food from the focal with the focal offering resistance or trying to keep the food away from the individual with some form of aggression. In sakis this sometimes occurs together with vocalizations.</td>
<td></td>
</tr>
<tr>
<td><strong>SFOA/FOA</strong></td>
<td><strong>Follow Actor</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>the focal moves in the same direction as another individual within 5 sec after that individual begins to move.</td>
<td></td>
</tr>
<tr>
<td><strong>SFOR/FOR</strong></td>
<td><strong>Follow</strong></td>
<td><strong>Recipient</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>someone moves in the same direction of the focal within 5 sec after the focal begins to move.</td>
<td></td>
</tr>
<tr>
<td><strong>DPA</strong></td>
<td><strong>Displace Actor</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>the focal moves to within 0.5m of another animal and stays put while the other animal moves to more than 0.5m within 3 sec.</td>
<td></td>
</tr>
<tr>
<td><strong>DPR</strong></td>
<td><strong>Displace</strong></td>
<td><strong>Recipient</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>another animal moves within 0.5 m of the focal and stays put and the focal moves to more than 0.5 m within 3 sec.</td>
<td></td>
</tr>
<tr>
<td><strong>APA</strong></td>
<td><strong>Approach Actor</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>the focal moves to within 0.5m of a stationary individual and stays for at least 3 sec.</td>
<td></td>
</tr>
<tr>
<td><strong>APR</strong></td>
<td><strong>Approach</strong></td>
<td><strong>Recipient</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>another individual moves to within 0.5m of the focal and stays for at least 3 sec.</td>
<td></td>
</tr>
<tr>
<td><strong>APX</strong></td>
<td><strong>Approach</strong></td>
<td><strong>Undetermined</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>animals are within 0.5 m of one another, approach has occurred, but who was responsible could not be recorded.</td>
<td></td>
</tr>
<tr>
<td><strong>LVA</strong></td>
<td><strong>Leave Actor</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>the focal moves from within 0.5m to outside of 0.5m of another animal.</td>
<td></td>
</tr>
<tr>
<td><strong>LVR</strong></td>
<td><strong>Leave</strong></td>
<td><strong>Recipient</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>another individual moves from within 0.5m to outside of 0.5m of the focal.</td>
<td></td>
</tr>
<tr>
<td><strong>LVX</strong></td>
<td><strong>Leave</strong></td>
<td><strong>Undetermined</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>the focal and another animal were within 0.5 m and one of the two moves so that the distance between them is now larger than 0.5m but it cannot be determined who moved.</td>
<td></td>
</tr>
<tr>
<td><strong>CHA</strong></td>
<td><strong>Chase Actor</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>the focal moves rapidly to reduce the distance between itself and another animal which at the same time moves to apparently increase the distance between itself and the first animal.</td>
<td></td>
</tr>
<tr>
<td><strong>CHR</strong></td>
<td><strong>Chase Recipient</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>another individual moves rapidly to reduce the distance between itself and the focal which at the same time moves to apparently increase the distance between itself and the first animal.</td>
<td></td>
</tr>
<tr>
<td><strong>SNN/NN</strong></td>
<td><strong>Nose to Nose</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>the focal and another individual bring their noses within a few centimeters one to the other, sometimes even touching.</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Definition</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>SAR/AR</td>
<td>Arching</td>
<td>Callicebus: To raise up on feet or feet and hands while arching the back and sometimes bouncing.</td>
</tr>
<tr>
<td>SPR/PR</td>
<td>Present</td>
<td>To offer body for mating, grooming, or inspection.</td>
</tr>
<tr>
<td>SPI/PI</td>
<td>Piloerection</td>
<td>Callicebus: Hairs of the body and tail are erect. Usually in context of intergroup encounter. Usually in context of intergroup encounter.</td>
</tr>
<tr>
<td>STL/TL</td>
<td>Tail Lashing</td>
<td>Repetitive swinging of whole tail; usually in context of intergroup encounter. Note in the Additional Info section whether is from side to side or vertical.</td>
</tr>
<tr>
<td>STC/TC</td>
<td>Teeth Chattering</td>
<td>Repeated rapid opening and closing of mouth.</td>
</tr>
<tr>
<td>COA</td>
<td>Conflict with Infant Actor</td>
<td>The infant as focal grabs, hits, or bites another individual, it can include vigorous grasping, pulling or slapping at another, this may occur together with biting.</td>
</tr>
<tr>
<td>COR</td>
<td>Conflict with Infant Recipient</td>
<td>The infant as focal is grabbed, hit, or bitten by another individual, it can include vigorous grasping, pulling or slapping at another, this may occur together with biting.</td>
</tr>
<tr>
<td>PPA</td>
<td>Pass By in Proximity Actor</td>
<td>Locomotion that results in the focal going by another animal within a distance of 1m.</td>
</tr>
<tr>
<td>PPR</td>
<td>Pass ED By in Proximity Recipient</td>
<td>Locomotion by another individual that results in that individual going by the focal within a distance of 1m.</td>
</tr>
<tr>
<td>PTA</td>
<td>Pass By Touching Actor</td>
<td>Locomotion that results in the focal going by another animal and making physical contact while doing it.</td>
</tr>
<tr>
<td>PTR</td>
<td>Pass ED By Touching Actor</td>
<td>Locomotion that results in another individual going by the focal and making physical contact while doing it.</td>
</tr>
<tr>
<td>NB</td>
<td>Nurse Begin</td>
<td>Infant goes onto nipple and begins nursing. Needs an associated time.</td>
</tr>
<tr>
<td>NEI</td>
<td>Nurse End by Infant</td>
<td>Infant goes off of nipple voluntarily. Needs an associated time.</td>
</tr>
<tr>
<td>NEM</td>
<td>Nurse End by Mother</td>
<td>Infant goes off of because mom rejects it. Needs an associated time.</td>
</tr>
<tr>
<td>NP</td>
<td>Nurse Pull</td>
<td>Infant pulls at mom’s nipple. Only scored for infant.</td>
</tr>
<tr>
<td>NA</td>
<td>Nurse Accommodate</td>
<td>Mother shifts her position (e.g., lifts arm) to accommodate nursing by infant. Only scored for mother.</td>
</tr>
<tr>
<td>NC</td>
<td>Nurse Coerce</td>
<td>Infant tries to coerce mother into nursing. Only scored for infant.</td>
</tr>
<tr>
<td>NR</td>
<td>Nurse Reject</td>
<td>Mother rebuffs nursing attempts of infant. Only scored for mother.</td>
</tr>
<tr>
<td>CN</td>
<td>Change Nipple</td>
<td>Infant changes from nursing on one nipple to nursing</td>
</tr>
</tbody>
</table>
Vocalization/Vocalización (V)

**Callicebus Vocalizations**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description English</th>
<th>Definition English</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC</td>
<td>Chirps, thrills and squeaks</td>
<td>Short, quiet high pitched calls. Very hard to distinguish among various forms of these calls. They are used in two contexts: 1. As contact calls when foraging or moving. 2. As alarm calls. Individuals VCC to birds that fly close by and to observers.</td>
</tr>
<tr>
<td>VCHI/CHI</td>
<td>Chirrup</td>
<td>High pitched, loud calls. Used when animals are disturbed as an alarm call, or as contact far calls when individuals get lost from the group or combined with other vocalizations during solo calls or duets.</td>
</tr>
<tr>
<td>OU</td>
<td>Moan</td>
<td>Moans are long, low pitched, loud vocalizations. They are used early in the morning while moving towards the territory boundary usually introducing duets. They can also be heard when animals are disturbed by other species of primates.</td>
</tr>
<tr>
<td>VDU/DU</td>
<td>Vocal Duet</td>
<td>Duets are long sequences of loud calls performed by at least two individuals simultaneously. Duets are combination of different types of vocalizations including “chirrups,” and “moans”</td>
</tr>
<tr>
<td>VWH/WH</td>
<td>Solo (CP/CRP)</td>
<td>Solo calls are calls similar to duets but only one individual performs it. Usually they include many chirrups followed by loud low pitched notes (Robinson: pumping or panting)</td>
</tr>
<tr>
<td>SC</td>
<td>Scream</td>
<td>Loud vocalization, similar to infant tantrums. Heard during group encounters, after aggressions, and when animals are darted.</td>
</tr>
<tr>
<td>SZ</td>
<td>Sneeze</td>
<td>Short, noisy, burst sounds produced when exhaling air through their nose. Heard during group encounters and when animal is disturbed.</td>
</tr>
<tr>
<td>VIT/IT</td>
<td>Infant Tantrum</td>
<td>Buzzy, high pitched screams produced when there is a conflict between an individual and the infant (e.g., pushed, from back, food not shared etc.) or when infant is in distress.</td>
</tr>
<tr>
<td>VXX</td>
<td>Vocalization Unknown</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

**Pithecia Vocalizations**
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VCV/CV</strong></td>
<td><strong>Contact Long</strong></td>
<td>Contact vocalization. This is a loud and long call made of a repetition of notes. CVs appear to be used for group member location and movement, specifically in the context of member location at greater distances.</td>
</tr>
<tr>
<td><strong>CVS</strong></td>
<td><strong>Contact short</strong></td>
<td>This call can be low in volume and short in duration (CVS= Contact Vocalize Short). CVS is often used when one individual has found a food patch and is feeding and is greater than 10 meters from the other group members. CVSs often escalate to CVs when other group members do not join the calling individual or no vocalization is given in response.</td>
</tr>
<tr>
<td><strong>TV</strong></td>
<td><strong>Trill</strong></td>
<td>Trill vocalization. Soft call. This vocalization is short in duration and steadily increasing in pitch for the female, but decreasing in pitch for the male (M group). This vocalization varies in volume. TVs seem to be used for group member location and movement as volume seems to increase with greater distance between individuals. TVs are generally preceded by several MM calls but are often followed by CVs if no response is given by other individuals. This vocalization could easily be confused with those of birds.</td>
</tr>
<tr>
<td><strong>VTer/Ter</strong></td>
<td><strong>Territorial Vocalization</strong></td>
<td>Loud long call used when group encounters a neighboring group. Incorporates a loud decreasing TV by the male and an increasing CV by the female. This is followed by the male performing a series of TWGs and ending in several HVs. This call is commonly heard during inter-group encounters and is contagious between individuals.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td><strong>MM VOC</strong></td>
<td>One note soft frequency modulated note. Sounds like a high pitch MM.</td>
</tr>
<tr>
<td><strong>AAV</strong></td>
<td><strong>Aerial Alarm Vocalization</strong></td>
<td>Aerial alarm vocalization. A 1-4 syllables alarm vocalization very high in pitch. This vocalization is performed when large birds fly overhead. Very often uttered by infants and juveniles.</td>
</tr>
<tr>
<td><strong>VAV/AV</strong></td>
<td><strong>Terrestrial Alarm Vocalization</strong></td>
<td>Long loud call. Vocalizations steadily increasing in pitch and intensity. This call lasts for a varying length of time depending on the level of distress/nervousness of the animals and other group members usually become vigilant and start vocalizing as soon as they hear it.</td>
</tr>
<tr>
<td><strong>AGV</strong></td>
<td><strong>Aggressive Vocalization</strong></td>
<td>Often heard during Food Robs.</td>
</tr>
<tr>
<td><strong>VXX</strong></td>
<td><strong>Vocalization Unknown</strong></td>
<td></td>
</tr>
</tbody>
</table>
**ALL-OCCURRENCES EVENT DATA**

In addition to data on the state of your focal animal, you should note all of the event behaviors that occur between successive instantaneous sampling points as EVENTS ("eventos") in the list of events occurring between the two minute points, or as separate records on the Palm Data Recorders.

For these, you will note each event that occurs, along with details of who was the actor and who was the recipient of the behavior (in the case of social events). You should also try to note additional information, such as the CONTEXT in which the event occurred (e.g., “in a feeding tree”, “during a copulation”, “no obvious context”, etc.) if they pertain to displacements or other interesting or unusual events (e.g., copulations, fights). These additional details should be noted in parentheses following the behavior code.

For example, if Mendel is your focal and you see him displace Mona in a feeding tree, you would record “DPA MO (in feeding tree)”. Note all events, separated by SLASHES and with a slash at the end of the line, in the order in which they occur in the Events section of the datasheet associated with the particular 2 minutes window in which they occurred. You do not need to note the times for these events as we will know those times to within 2 minutes because they are associated with a particular interval within your focal sample (on the Palm, they will get a time stamp automatically). For data entry on the computer, MAKE SURE that a SLASH separates each event WITHOUT SPACES BETWEEN EVENTS and with a slash at the end of the line. For events involving a partner, use the 2-letter or 3-letter code to refer to the partner individual AFTER the event code using a SPACE to separate the event code from the partner code and with a slash at the end of the event (example: if your focal is Mondika and Mona passes by him in proximity, you would score “PPR MO/”).

For all these EVENTS, ALWAYS, ALWAYS, ALWAYS record social/directional information with respect to your focal; e.g., if your focal is Mona and she is approached by Mondika record “APR MD” not “MD APA MO”; even though these are equivalent, for consistency of data entry and analysis we ONLY use the former.

Also, please try to note the additional specific data for the following events:

- **Scent Marking** (RP, RG, RF, ROP, ROG, ROF, ORP, ORG, ORF, OROP, OROG, OROF) – Map the location of the tree where they scent mark as “distance, compass angle, reference point” in parentheses, separated by commas, and without spaces, following the events code in the list of events section: e.g., “RP (2m,104d, Chorongo 100).
- **Sexual behavior** – Write details on who started it, duration, etc.
- **Intergroup interactions** – Try to record the locations of the different groups
- **Notes** – We encourage you to use this section for reporting unusual things that may relate to the monkeys or be external to them (e.g., tourists or student groups
are close by and being loud, workers are using a chainsaw close by, guans were heard alarming during the sample, etc.).

**Beginning in Jan 2008**, we are also going to start using the appended code (P) for any EVENT behavior where an infant is the focal and it is experiencing or doing the behavior PASSIVELY because it is on another individual or because the partner is an infant AGA, AGR, PTA, PTR, PPA, PPR, APA, APR, FOA, FOR, LVA, LVR, CA, CP. Thus, if an infant is your focal animal and it is riding on a female who approaches an adult male, you would record its behavior as "APA(P) AM".

**AD LIBUTUM DATA**
Ad libitum data are very important and you may decide to interrupt the focal to be able to describe in great detail a very unusual event like copulations, courtship, fights. For these, note the time, participants, and behavior and describe the behavior in as much detail as possible in **PP Ad Lib Data** database on the Palm Data Recorder or in the Ad Lib Data section of your Data Book if collecting data on paper.

These ad lib data sections are also where you should record a couple of other types of observations we are interested in:

- For any VDU/TerV (duets by the titi monkeys or territorial vocalizations by the sakis), record the time and duration of the calls as well as noting the identities of animals vocalizing and mapping the location where the vocalizations took place.
- If the sakis are moving with woolly monkeys, record where their position is relative to the woolly monkey group (e.g., middle, leading, or trailing edge of group; higher, lower, or at the same height in the canopy as the woolly) and if they move outside their usual home range.
- If an animal in the group you are following is displaced from a tree by an individual of a different species, this should be noted, along with the context where the displacement took place – example: Mendel DPR *Lagothrix* (feeding tree).
- Army ant feeding – feeding on army ants is an unusual behavior we have noted in the sakis, titis, and woolly monkeys, so we are trying to collect additional data on this behavior. Each time your focal group is encountered near army ants, you should...
  - Record in the *Notes* section of the AVISTAJE that the animals fed on ants that day.
  - Record detailed notes in your ad lib data about the time, location, species of ant (the two common ones are *Eciton burchellii* – larger, black body, soldiers with yellow heads – and *Eciton hamatum* – smaller, with red body), amount (e.g., small group of ants moving in lines, large swarm), if any of the monkey eat the ants, and time they leave/lose the ants.
Also note the length of time the monkeys foraged OVER the ants if they are not actually consuming them and if the animals stop eating the ants and eat fruit/seeds/leaves and if they return to the ants.

Finally, record if any ant birds are present and what species.

Repeat all this information as well, as any additional notes you might take in a MS Word document that you title "Army Ant Brief Summary Report (date)."

Collect a sample of the ants and store in a small sample vial in alcohol, noting the time, location, and identity of the group foraging with/on the ants on the vial.

If possible record video footage whenever the monkeys are with the ants.

Continue to collect as much focal data as possible while the animals are with the ants and try to get an accurate count the number of ants eaten and record this in the list of events section of the focal sample sheet (i.e., each AT+).

Finally, please record any significant/notable comments or concerns about each Avistaje in the Notes section of the AVISTAJE (e.g., Mona has a botfly, Mendel seems to be lagging behind group, sakis were with army ants today, sakis moved with Lagothrix for 4 hours, etc.) and about each Focal Sample in the Notes section for the FOCAL SAMPLE.

NOTES FOR COLLECTING DATA ON PAPER
In Ecuador, we collect all of our field data into Palm Data Recorders. However, there may come a time when your Palm breaks or ceases to function well. In this case, you MUST BE PREPARED to collect data into Data Books. The data books we use are semi-waterproof. Different books should be used for phenology and behavioral data. Each data book should get a UNIQUE NUMBER that corresponds to your last name, a space, and 2 digits (e.g., “Hurst 01”, “Hurst 02”, etc.). In the interest of uniformity and for ease in both data entry and referring back to the original data when needed, your behavioral data book ABSOLUTELY MUST be [1] arranged in a STANDARD manner, [2] be kept neat and completely LEGIBLE, and [3] contain EXACTLY the information that is entered into the computer database. Everything entered in the computer must match what is in the data books, and if something is changed or modified in the computer files (e.g., an incorrectly recorded location or tree number is “fixed” in the computer database), you MUST FIND AND CORRECT that information in ALL of the appropriate places in the data books as well!

Set up your data books in the following sections: Observer Sample Data (ca. 6 pages at beginning); Avistajes (ca. 8 pages following the Observer Sample Data), Focal Samples and Focal Data (most of the rest of the book; 2 samples per open 2 page spread), with Ad Lib Data and Notes for each focal at the bottom; Group Scans (ca. 10 pages, close to the end of the book, preceding Ranging Data); Ranging Data (ca. 8 pages, close to end of book, preceding Marked Trees); Marked Trees (ca. 3 pages,
close to end of book preceding **Feeding Bout Data**; **Feeding Bout Data** (ca. 5 pages at the end of the book); and a running Tally of FOCAL SAMPLES by date (last page). See the EXAMPLE DATA.
APPENDIX 2: Visual Basic Codes – Behavior Frequency Calculations

Private Sub NumRecords_Change()
End Sub

Private Sub TextBox1_Change()
End Sub

Private Sub CommandButton1_Click()
    Dim record(12000, 90) As Variant
    Dim focal(12000, 90) As String

    'Dim distcum As Double
    Set data = Worksheets("data")
    Set Summary = Worksheets("output")

    'defining data worksheet as record
    For i = 1 To 2000
        For j = 1 To 60
            record(i, j) = data.Cells(i + 1, j)
        Next j
    Next i

    'create a column counting behavior states per focal point
    'SPC between AM and AF
    For i = 1 To 2000
        record(i, 49) = amafSPC
        If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafSPC = 0
        If record(i, 5) = "AM" Then amafSPC = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SPC AF", ""))) / Len("SPC AF"))
        If record(i, 5) = "AF" Then amafSPC = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SPC AM", ""))) / Len("SPC AM"))
    Next i

    'SP1 between AM and AF
    For i = 1 To 2000
        record(i, 50) = amafSP1
        If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafSP1 = 0
        If record(i, 5) = "AM" Then amafSP1 = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SP1 AF", ""))) / Len("SP1 AF"))
        If record(i, 5) = "AF" Then amafSP1 = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SP1 AM", ""))) / Len("SP1 AM"))
    Next i
'STT between AM and AF
For i = 1 To 2000
    record(i, 51) = amafSTT
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafSTT = 0
    If record(i, 5) = "AM" Then amafSTT = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "STT AF", ""))) / Len("STT AF"))
    If record(i, 5) = "AF" Then amafSTT = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "STT AM", ""))) / Len("STT AM"))
Next i

'AM grooms AF
For i = 1 To 2000
    record(i, 52) = amSGMaf
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amSGMaf = 0
    If record(i, 5) = "AM" Then amSGMaf = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SGMA AF", ""))) / Len("SGMA AF"))
    If record(i, 5) = "AF" Then amSGMaf = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SGMR AM", ""))) / Len("SGMR AM"))
Next i

'AF grooms AM
For i = 1 To 2000
    record(i, 53) = afSGMam
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then afSGMam = 0
    If record(i, 5) = "AM" Then afSGMam = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SGMR AF", ""))) / Len("SGMR AF"))
    If record(i, 5) = "AF" Then afSGMam = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SGMA AM", ""))) / Len("SGMA AM"))
Next i

'AM shares food with AF
For i = 1 To 2000
    record(i, 54) = amSFSaf
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amSFSaf = 0
    If record(i, 5) = "AM" Then amSFSaf = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SFSA AF", ""))) / Len("SFSA AF"))
    If record(i, 5) = "AF" Then amSFSaf = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SFSR AM", ""))) / Len("SFSR AM"))
Next i

'AF shares food with AM
For i = 1 To 2000
    record(i, 55) = afSFSam
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then afSFSam = 0
If record(i, 5) = "AM" Then afSFSam = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SFSR AF", ""))) / Len("SFSR AF"))
If record(i, 5) = "AF" Then afSFSam = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SFSA AM", ""))) / Len("SFSA AM"))
Next i

'AM follows AF
For i = 1 To 2000
  record(i, 56) = amSFOaf
  If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amSFOaf = 0
  If record(i, 5) = "AM" Then amSFOaf = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SFOA AF", ""))) / Len("SFOA AF"))
  If record(i, 5) = "AF" Then amSFOaf = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SFOR AM", ""))) / Len("SFOR AM"))
Next i

'AF follows AM
For i = 1 To 2000
  record(i, 57) = afSFOam
  If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then afSFOam = 0
  If record(i, 5) = "AM" Then afSFOam = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SFOR AF", ""))) / Len("SFOR AF"))
  If record(i, 5) = "AF" Then afSFOam = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SFOA AM", ""))) / Len("SFOA AM"))
Next i

'AM and AF are nearest neighbors
For i = 1 To 2000
  record(i, 58) = amafNRN
  If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafNRN = 0
  If record(i, 5) = "AM" Then amafNRN = ((Len(record(i, 11)) - Len(Application.Substitute(record(i, 11), "AF", ""))) / Len("AF"))
  If record(i, 5) = "AF" Then amafNRN = ((Len(record(i, 11)) - Len(Application.Substitute(record(i, 11), "AM", ""))) / Len("AM"))
Next i

'create a column counting behavior events per focal point
'PC between AM and AF
For i = 1 To 2000
  record(i, 59) = amafPC
  If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafPC = 0
  If record(i, 5) = "AM" Then amafPC = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PC AF", ""))) / Len("PC AF"))
If record(i, 5) = "AF" Then amafPC = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PC AM", ""))) / Len("PC AM"))
Next i

'P1 between AM and AF
For i = 1 To 2000
    record(i, 60) = amafP1
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafP1 = 0
    If record(i, 5) = "AM" Then amafP1 = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "P1 AF", ""))) / Len("P1 AF"))
    If record(i, 5) = "AF" Then amafP1 = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "P1 AM", ""))) / Len("P1 AM"))
Next i

'TT between AM and AF
For i = 1 To 2000
    record(i, 61) = amafTT
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafTT = 0
    If record(i, 5) = "AM" Then amafTT = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "TT AF", ""))) / Len("TT AF"))
    If record(i, 5) = "AF" Then amafTT = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "TT AM", ""))) / Len("TT AM"))
Next i

'AM grooms as event AF
For i = 1 To 2000
    record(i, 62) = amGMaf
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amGMaf = 0
    If record(i, 5) = "AM" Then amGMaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GMA AF", ""))) / Len("GMA AF"))
    If record(i, 5) = "AF" Then amGMaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GMR AM", ""))) / Len("GMR AM"))
Next i

'AF grooms as event AM
For i = 1 To 2000
    record(i, 63) = afGMam
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then afGMam = 0
    If record(i, 5) = "AM" Then afGMam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GMR AF", ""))) / Len("GMR AF"))
    If record(i, 5) = "AF" Then afGMam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GMA AM", ""))) / Len("GMA AM"))
Next i
'AM shares food as event with AF
For i = 1 To 2000
    record(i, 64) = amFSaf
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amFSaf = 0
    If record(i, 5) = "AM" Then amFSaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "FSA AF", ""))) / Len("FSA AF"))
    If record(i, 5) = "AF" Then amFSaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "FSR AM", ""))) / Len("FSR AM"))
Next i

'AF shares food as event with AM
For i = 1 To 2000
    record(i, 65) = afFSam
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then afFSam = 0
    If record(i, 5) = "AM" Then afFSam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "FSR AF", ""))) / Len("FSR AF"))
    If record(i, 5) = "AF" Then afFSam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "FSA AM", ""))) / Len("FSA AM"))
Next i

'AM follows as event AF
For i = 1 To 2000
    record(i, 66) = amFOaf
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amFOaf = 0
    If record(i, 5) = "AM" Then amFOaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "FOA AF", ""))) / Len("FOA AF"))
    If record(i, 5) = "AF" Then amFOaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "FOR AM", ""))) / Len("FOR AM"))
Next i

'AF follows as event AM
For i = 1 To 2000
    record(i, 67) = afFOam
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then afFOam = 0
    If record(i, 5) = "AM" Then afFOam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "FOR AF", ""))) / Len("FOR AF"))
    If record(i, 5) = "AF" Then afFOam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "FOA AM", ""))) / Len("FOA AM"))
Next i

'Mutual grooming between AM and AF as state
For i = 1 To 2000
    record(i, 68) = amafSGMM
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafSGMM = 0
If record(i, 5) = "AM" Then amafSGMM = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SGMM AF", ""))) / Len("SGMM AF"))
If record(i, 5) = "AF" Then amafSGMM = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SGMM AM", ""))) / Len("SGMM AM"))
Next i

'Mutual grooming between AM and AF as EVENT
For i = 1 To 2000
    record(i, 69) = amafGMM
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafGMM = 0
    If record(i, 5) = "AM" Then amafGMM = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GMM AF", ""))) / Len("GMM AF"))
    If record(i, 5) = "AF" Then amafGMM = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GMM AM", ""))) / Len("GMM AM"))
Next i

'AM or AF out of view during state
For i = 1 To 2000
    record(i, 70) = amafFV
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafFV = 0
    If record(i, 5) = "AM" Then amafFV = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "FV", ""))) / Len("FV"))
    If record(i, 5) = "AF" Then amafFV = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "FV", ""))) / Len("FV"))
Next i

'AM and AF nose to nose with each other during state
For i = 1 To 2000
    record(i, 71) = amafSNN
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafSNN = 0
    If record(i, 5) = "AM" Then amafSNN = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SNN AF", ""))) / Len("SNN AF"))
    If record(i, 5) = "AF" Then amafSNN = ((Len(record(i, 8)) - Len(Application.Substitute(record(i, 8), "SNN AM", ""))) / Len("SNN AM"))
Next i

'AM and AF nose to nose with each other during event
For i = 1 To 2000
    record(i, 72) = amafNN
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amafNN = 0
    If record(i, 5) = "AM" Then amafNN = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "NN AF", ""))) / Len("NN AF"))
Next i
If record(i, 5) = "AF" Then amafNN = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "NN AM", ""))) / Len("NN AM"))
Next i

'AM presents for grooming to AF
For i = 1 To 2000
    record(i, 73) = amGPaf
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amGPaf = 0
    If record(i, 5) = "AM" Then amGPaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GPA AF", ""))) / Len("GPA AF"))
    If record(i, 5) = "AF" Then amGPaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GPR AM", ""))) / Len("GPR AM"))
Next i

'AF presents for grooming to AM
For i = 1 To 2000
    record(i, 74) = afGPam
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then afGPam = 0
    If record(i, 5) = "AM" Then afGPam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GPR AF", ""))) / Len("GPR AF"))
    If record(i, 5) = "AF" Then afGPam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "GPA AM", ""))) / Len("GPA AM"))
Next i

'AM passes by in proximity of AF
For i = 1 To 2000
    record(i, 75) = amPPaf
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amPPaf = 0
    If record(i, 5) = "AM" Then amPPaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PPA AF", ""))) / Len("PPA AF"))
    If record(i, 5) = "AF" Then amPPaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PPR AM", ""))) / Len("PPR AM"))
Next i

'AF passes by in proximity of AM
For i = 1 To 2000
    record(i, 76) = afPPam
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then afPPam = 0
    If record(i, 5) = "AM" Then afPPam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PPR AF", ""))) / Len("PPR AF"))
    If record(i, 5) = "AF" Then afPPam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PPA AM", ""))) / Len("PPA AM"))
Next i
'AM passes by and touches AF
For i = 1 To 2000
    record(i, 77) = amPTaf
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then amPTaf = 0
    If record(i, 5) = "AM" Then amPTaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PTA AF", ""))) / Len("PTA AF"))
    If record(i, 5) = "AF" Then amPTaf = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PTR AM", ""))) / Len("PTR AM"))
Next i

'AF passes by and touches AM
For i = 1 To 2000
    record(i, 78) = afPTam
    If record(i, 5) <> "AM" Or record(i, 5) <> "AF" Then afPTam = 0
    If record(i, 5) = "AM" Then afPTam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PTR AF", ""))) / Len("PTR AF"))
    If record(i, 5) = "AF" Then afPTam = ((Len(record(i, 10)) - Len(Application.Substitute(record(i, 10), "PTA AM", ""))) / Len("PTA AM"))
Next i

'AM is carrying infant as focal animal
For i = 1 To 2000
    record(i, 79) = amINF
    If record(i, 5) <> "AM" Then amINF = 0
    If record(i, 5) = "AM" Then amINF = ((Len(record(i, 9)) - Len(Application.Substitute(record(i, 9), "YES", ""))) / Len("YES"))
Next i

'AF is carrying infant as focal animal
For i = 1 To 2000
    record(i, 80) = afINF
    If record(i, 5) <> "AF" Then afINF = 0
    If record(i, 5) = "AF" Then afINF = ((Len(record(i, 9)) - Len(Application.Substitute(record(i, 9), "YES", ""))) / Len("YES"))
Next i

'AM is focal animal
For i = 1 To 2000
    record(i, 81) = amFOCAL
    If record(i, 5) <> "AM" Then amFOCAL = 0
    If record(i, 5) = "AM" Then amFOCAL = 1
Next i

'AF is focal animal
For i = 1 To 2000
    record(i, 82) = afFOCAL
    If record(i, 5) <> "AF" Then afFOCAL = 0
    If record(i, 5) = "AF" Then afFOCAL = 1
Next i

'assigning data and behavior counts to columns in the record
focalnum = 0
For i = 1 To 2000
    focalnum = focalnum + 1
    focal(focalnum, 1) = record(i, 44) 'period id
    focal(focalnum, 2) = record(i, 1) 'date
    focal(focalnum, 3) = record(i, 5) 'focal id
    focal(focalnum, 4) = record(i, 39) 'focal sample
    focal(focalnum, 5) = record(i, 43) 'time
    focal(focalnum, 6) = record(i, 49) 'amafSPC
    focal(focalnum, 7) = record(i, 50) 'amafSP1
    focal(focalnum, 8) = record(i, 51) 'amafSTT
    focal(focalnum, 9) = record(i, 52) 'amSGMaf
    focal(focalnum, 10) = record(i, 53) 'afSGMam
    focal(focalnum, 11) = record(i, 54) 'amSFSaf
    focal(focalnum, 12) = record(i, 55) 'afSFSam
    focal(focalnum, 13) = record(i, 56) 'amSFOaf
    focal(focalnum, 14) = record(i, 57) 'afSFOam
    focal(focalnum, 15) = record(i, 58) 'amafNRN
    focal(focalnum, 16) = record(i, 59) 'amafPC
    focal(focalnum, 17) = record(i, 60) 'amafP1
    focal(focalnum, 18) = record(i, 61) 'amafTT
    focal(focalnum, 19) = record(i, 62) 'amGMaf
    focal(focalnum, 20) = record(i, 63) 'afGMam
    focal(focalnum, 21) = record(i, 64) 'amFSaf
    focal(focalnum, 22) = record(i, 65) 'afFSam
    focal(focalnum, 23) = record(i, 66) 'amFOaf
    focal(focalnum, 24) = record(i, 67) 'afFOam
    focal(focalnum, 25) = record(i, 68) 'amafSGMM
    focal(focalnum, 26) = record(i, 69) 'amafGMM
    focal(focalnum, 27) = record(i, 70) 'amafFV
    focal(focalnum, 28) = record(i, 71) 'amafSNN
    focal(focalnum, 29) = record(i, 72) 'amafNN
    focal(focalnum, 30) = record(i, 73) 'amGPaf
    focal(focalnum, 31) = record(i, 74) 'afGPam
    focal(focalnum, 32) = record(i, 75) 'amPPaf
    focal(focalnum, 33) = record(i, 76) 'afPPam
    focal(focalnum, 34) = record(i, 77) 'amPTaf
focal(focalnum, 35) = record(i, 78) ' afPTam
focal(focalnum, 36) = record(i, 79) ' amINF
focal(focalnum, 37) = record(i, 80) ' afINF
focal(focalnum, 38) = record(i, 81) ' amFOCAL
focal(focalnum, 39) = record(i, 82) ' afFOCAL
focal(focalnum, 40) = record(i, 40) ' observer id
Next i

'routine to print out data for each focal sample
For i = 1 To focalnum
  Summary.Cells(1, 1) = "periodID"
  Summary.Cells(i + 1, 1) = focal(i, 1)
  Summary.Cells(1, 2) = "date"
  Summary.Cells(i + 1, 2) = focal(i, 2)
  Summary.Cells(1, 3) = "focalID"
  Summary.Cells(i + 1, 3) = focal(i, 3)
  Summary.Cells(1, 4) = "focalsample"
  Summary.Cells(i + 1, 4) = focal(i, 4)
  Summary.Cells(1, 5) = "time"
  Summary.Cells(i + 1, 5) = focal(i, 5)
  Summary.Cells(1, 6) = "amafSPC"
  Summary.Cells(i, 6) = focal(i, 6)
  Summary.Cells(1, 7) = "amafSP1"
  Summary.Cells(i, 7) = focal(i, 7)
  Summary.Cells(1, 8) = "amafSTT"
  Summary.Cells(i, 8) = focal(i, 8)
  Summary.Cells(1, 9) = "amSGMaf"
  Summary.Cells(i, 9) = focal(i, 9)
  Summary.Cells(1, 10) = "afSGMam"
  Summary.Cells(i, 10) = focal(i, 10)
  Summary.Cells(1, 11) = "amSFSaf"
  Summary.Cells(i, 11) = focal(i, 11)
  Summary.Cells(1, 12) = "afSFSam"
  Summary.Cells(i, 12) = focal(i, 12)
  Summary.Cells(1, 13) = "amSFOaf"
  Summary.Cells(i, 13) = focal(i, 13)
  Summary.Cells(1, 14) = "afSFOam"
  Summary.Cells(i, 14) = focal(i, 14)
  Summary.Cells(1, 15) = "amafNRN"
  Summary.Cells(i, 15) = focal(i, 15)
  Summary.Cells(1, 16) = "amafPC"
  Summary.Cells(i, 16) = focal(i, 16)
  Summary.Cells(1, 17) = "amafP1"
  Summary.Cells(i, 17) = focal(i, 17)
<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary.Cells(1, 18) = &quot;amafTT&quot;</td>
<td>Summary.Cells(i, 18) = focal(i, 18)</td>
<td>Summary.Cells(1, 19) = &quot;amGMaf&quot;</td>
<td>Summary.Cells(i, 19) = focal(i, 19)</td>
<td>Summary.Cells(1, 20) = &quot;afGMam&quot;</td>
<td>Summary.Cells(i, 20) = focal(i, 20)</td>
</tr>
<tr>
<td>Summary.Cells(1, 21) = &quot;amFSaf&quot;</td>
<td>Summary.Cells(i, 21) = focal(i, 21)</td>
<td>Summary.Cells(1, 22) = &quot;afFSam&quot;</td>
<td>Summary.Cells(i, 22) = focal(i, 22)</td>
<td>Summary.Cells(1, 23) = &quot;amFOaf&quot;</td>
<td>Summary.Cells(i, 23) = focal(i, 23)</td>
</tr>
<tr>
<td>Summary.Cells(1, 27) = &quot;amafFV&quot;</td>
<td>Summary.Cells(i, 27) = focal(i, 27)</td>
<td>Summary.Cells(1, 28) = &quot;amafSNN&quot;</td>
<td>Summary.Cells(i, 28) = focal(i, 28)</td>
<td>Summary.Cells(1, 29) = &quot;amafNN&quot;</td>
<td>Summary.Cells(i, 29) = focal(i, 29)</td>
</tr>
<tr>
<td>Summary.Cells(1, 30) = &quot;amGPaf&quot;</td>
<td>Summary.Cells(i, 30) = focal(i, 30)</td>
<td>Summary.Cells(1, 31) = &quot;afGPam&quot;</td>
<td>Summary.Cells(i, 31) = focal(i, 31)</td>
<td>Summary.Cells(1, 32) = &quot;amPPaf&quot;</td>
<td>Summary.Cells(i, 32) = focal(i, 32)</td>
</tr>
<tr>
<td>Summary.Cells(1, 33) = &quot;afPPam&quot;</td>
<td>Summary.Cells(i, 33) = focal(i, 33)</td>
<td>Summary.Cells(1, 34) = &quot;amPTaf&quot;</td>
<td>Summary.Cells(i, 34) = focal(i, 34)</td>
<td>Summary.Cells(1, 35) = &quot;afPTam&quot;</td>
<td>Summary.Cells(i, 35) = focal(i, 35)</td>
</tr>
<tr>
<td>Summary.Cells(1, 36) = &quot;amINF&quot;</td>
<td>Summary.Cells(i, 36) = focal(i, 36)</td>
<td>Summary.Cells(1, 37) = &quot;afINF&quot;</td>
<td>Summary.Cells(i, 37) = focal(i, 37)</td>
<td>Summary.Cells(1, 38) = &quot;amFOCAL&quot;</td>
<td>Summary.Cells(i, 38) = focal(i, 38)</td>
</tr>
<tr>
<td>Summary.Cells(1, 39) = &quot;afFOCAL&quot;</td>
<td>Summary.Cells(i, 39) = focal(i, 39)</td>
<td>Summary.Cells(1, 40) = &quot;amaf&quot;</td>
<td>Summary.Cells(i, 40) = focal(i, 40)</td>
<td>Summary.Cells(1, 41) = &quot;afaf&quot;</td>
<td>Summary.Cells(i, 41) = focal(i, 41)</td>
</tr>
</tbody>
</table>
Summary.Cells(1, 40) = "observer"
Summary.Cells(i + 1, 40) = focal(i, 40)
Next i
End Sub

Private Sub UserForm_Click()
End Sub
APPENDIX 3: Visual Basic Codes – Proximity Calculations
Private Sub NumRecords_Change()
End Sub

Private Sub TextBox1_Change()
End Sub

Private Sub CommandButton1_Click()
Dim record(12000, 90) As Variant
Dim focal(12000, 65) As String

'Dim distcum As Double

Set data = Worksheets("data")
Set Summary = Worksheets("output")

'defining data worksheet as record
For i = 1 To 2000
    For j = 1 To 90
        record(i, j) = data.Cells(i + 1, j)
    Next j
Next i

'Distance AF N1 N2 or N3
For i = 1 To 2000
    record(i, 49) = afa
    If record(i, 12) = "AF/" Then afa = ((Len(record(i, 14)) -
        Len(Application.Substitute(record(i, 14), "CON/", ""))) / Len("CON/"))
    If record(i, 17) = "AF/" Then afa = ((Len(record(i, 19)) -
        Len(Application.Substitute(record(i, 19), "CON/", ""))) / Len("CON/"))
    If record(i, 22) = "AF/" Then afa = ((Len(record(i, 24)) -
        Len(Application.Substitute(record(i, 24), "CON/", ""))) / Len("CON/"))
    If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then
        afa = 0
    Next i

For i = 1 To 2000
    record(i, 50) = afb
    If record(i, 12) = "AF/" Then afb = ((Len(record(i, 14)) -
        Len(Application.Substitute(record(i, 14), "<0.5", ""))) / Len("<0.5"))
    If record(i, 17) = "AF/" Then afb = ((Len(record(i, 19)) -
        Len(Application.Substitute(record(i, 19), "<0.5", ""))) / Len("<0.5"))
    If record(i, 22) = "AF/" Then afb = ((Len(record(i, 24)) -
        Len(Application.Substitute(record(i, 24), "<0.5", ""))) / Len("<0.5"))
Next i
If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then
afb = 0
Next i

For i = 1 To 2000
record(i, 51) = afc
If record(i, 12) = "AF/" Then afc = ((Len(record(i, 14)) -
Len(Application.Substitute(record(i, 14), "<01", ""))) / Len("<01"))
If record(i, 17) = "AF/" Then afc = ((Len(record(i, 19)) -
Len(Application.Substitute(record(i, 19), "<01", ""))) / Len("<01"))
If record(i, 22) = "AF/" Then afc = ((Len(record(i, 24)) -
Len(Application.Substitute(record(i, 24), "<01", ""))) / Len("<01"))
If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then
afc = 0
Next i

For i = 1 To 2000
record(i, 52) = afd
If record(i, 12) = "AF/" Then afd = ((Len(record(i, 14)) -
Len(Application.Substitute(record(i, 14), "<03", ""))) / Len("<03"))
If record(i, 17) = "AF/" Then afd = ((Len(record(i, 19)) -
Len(Application.Substitute(record(i, 19), "<03", ""))) / Len("<03"))
If record(i, 22) = "AF/" Then afd = ((Len(record(i, 24)) -
Len(Application.Substitute(record(i, 24), "<03", ""))) / Len("<03"))
If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then
afd = 0
Next i

For i = 1 To 2000
record(i, 53) = afe
If record(i, 12) = "AF/" Then afe = ((Len(record(i, 14)) -
Len(Application.Substitute(record(i, 14), "<05", ""))) / Len("<05"))
If record(i, 17) = "AF/" Then afe = ((Len(record(i, 19)) -
Len(Application.Substitute(record(i, 19), "<05", ""))) / Len("<05"))
If record(i, 22) = "AF/" Then afe = ((Len(record(i, 24)) -
Len(Application.Substitute(record(i, 24), "<05", ""))) / Len("<05"))
If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then
afe = 0
Next i

For i = 1 To 2000
record(i, 54) = aff
If record(i, 12) = "AF/" Then aff = ((Len(record(i, 14)) -
Len(Application.Substitute(record(i, 14), "<10", ""))) / Len("<10"))
If record(i, 17) = "AF/" Then aff = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<10", ""))) / Len("<10"))
If record(i, 22) = "AF/" Then aff = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<10", ""))) / Len("<10"))
If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then
aff = 0
Next i

For i = 1 To 2000
record(i, 55) = afg
If record(i, 12) = "AF/" Then afg = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "<20", ""))) / Len("<20"))
If record(i, 17) = "AF/" Then afg = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<20", ""))) / Len("<20"))
If record(i, 22) = "AF/" Then afg = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<20", ""))) / Len("<20"))
If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then
afg = 0
Next i

For i = 1 To 2000
record(i, 56) = afh
If record(i, 12) = "AF/" Then afh = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "<50", ""))) / Len("<50"))
If record(i, 17) = "AF/" Then afh = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<50", ""))) / Len("<50"))
If record(i, 22) = "AF/" Then afh = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<50", ""))) / Len("<50"))
If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then
afh = 0
Next i

For i = 1 To 2000
record(i, 57) = afi
If record(i, 12) = "AF/" Then afi = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), ">CON", ""))) / Len(">CON"))
If record(i, 17) = "AF/" Then afi = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), ">CON", ""))) / Len(">CON"))
If record(i, 22) = "AF/" Then afi = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), ">CON", ""))) / Len(">CON"))
If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then
afi = 0
Next i
For i = 1 To 2000
    record(i, 58) = afj
    If record(i, 12) = "AF/" Then afj = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), ">0.5", ""))) / Len(">0.5"))
    If record(i, 17) = "AF/" Then afj = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), ">0.5", ""))) / Len(">0.5"))
    If record(i, 22) = "AF/" Then afj = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), ">0.5", ""))) / Len(">0.5"))
    If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then afj = 0
    Next i

For i = 1 To 2000
    record(i, 59) = afk
    If record(i, 12) = "AF/" Then afk = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), ">01", ""))) / Len(">01"))
    If record(i, 17) = "AF/" Then afk = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), ">01", ""))) / Len(">01"))
    If record(i, 22) = "AF/" Then afk = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), ">01", ""))) / Len(">01"))
    If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then afk = 0
    Next i

For i = 1 To 2000
    record(i, 60) = afl
    If record(i, 12) = "AF/" Then afl = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), ">03", ""))) / Len(">03"))
    If record(i, 17) = "AF/" Then afl = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), ">03", ""))) / Len(">03"))
    If record(i, 22) = "AF/" Then afl = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), ">03", ""))) / Len(">03"))
    If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then afl = 0
    Next i

For i = 1 To 2000
    record(i, 61) = afm
    If record(i, 12) = "AF/" Then afm = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), ">05", ""))) / Len(">05"))
    If record(i, 17) = "AF/" Then afm = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), ">05", ""))) / Len(">05"))
    If record(i, 22) = "AF/" Then afm = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), ">05", ""))) / Len(">05"))
If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then afm = 0
Next i

For i = 1 To 2000
    record(i, 62) = afn
    If record(i, 12) = "AF/" Then afn = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14),">10", ""))) / Len(">10"))
    If record(i, 17) = "AF/" Then afn = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19),">10", ""))) / Len(">10"))
    If record(i, 22) = "AF/" Then afn = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24),">10", ""))) / Len(">10"))
    If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then afn = 0
    Next i

For i = 1 To 2000
    record(i, 63) = afo
    If record(i, 12) = "AF/" Then afo = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14),">20", ""))) / Len(">20"))
    If record(i, 17) = "AF/" Then afo = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19),">20", ""))) / Len(">20"))
    If record(i, 22) = "AF/" Then afo = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24),">20", ""))) / Len(">20"))
    If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then afo = 0
    Next i

For i = 1 To 2000
    record(i, 64) = afUNK
    If record(i, 12) = "AF/" Then afUNK = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14),"UNK", ""))) / Len("UNK"))
    If record(i, 17) = "AF/" Then afUNK = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19),"UNK", ""))) / Len("UNK"))
    If record(i, 22) = "AF/" Then afUNK = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24),"UNK", ""))) / Len("UNK"))
    If record(i, 12) <> "AF/" And record(i, 17) <> "AF/" And record(i, 22) <> "AF/" Then afUNK = 0
    Next i

'Distance AM N1 N2 or N3
For i = 1 To 2000
    record(i, 65) = ama
If record(i, 12) = "AM/" Then ama = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "CON/", ","))) / Len("CON/"))
If record(i, 17) = "AM/" Then ama = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "CON/", ","))) / Len("CON/"))
If record(i, 22) = "AM/" Then ama = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "CON/", ","))) / Len("CON/"))
If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
Then ama = 0
Next i

For i = 1 To 2000
record(i, 66) = amb
If record(i, 12) = "AM/" Then amb = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "<0.5", ","))) / Len("<0.5"))
If record(i, 17) = "AM/" Then amb = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<0.5", ","))) / Len("<0.5"))
If record(i, 22) = "AM/" Then amb = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<0.5", ","))) / Len("<0.5"))
If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
Then amb = 0
Next i

For i = 1 To 2000
record(i, 67) = amc
If record(i, 12) = "AM/" Then amc = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "<01", ","))) / Len("<01"))
If record(i, 17) = "AM/" Then amc = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<01", ","))) / Len("<01"))
If record(i, 22) = "AM/" Then amc = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<01", ","))) / Len("<01"))
If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
Then amc = 0
Next i

For i = 1 To 2000
record(i, 68) = amd
If record(i, 12) = "AM/" Then amd = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "<03", ","))) / Len("<03"))
If record(i, 17) = "AM/" Then amd = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<03", ","))) / Len("<03"))
If record(i, 22) = "AM/" Then amd = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<03", ","))) / Len("<03"))
If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
Then amd = 0
Next i

For i = 1 To 2000
  record(i, 69) = ame
  If record(i, 12) = "AM/"
    Then ame = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "<05", ""))) / Len("<05"))
  If record(i, 17) = "AM/"
    Then ame = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<05", ""))) / Len("<05"))
  If record(i, 22) = "AM/"
    Then ame = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<05", ""))) / Len("<05"))
  If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/"
    Then ame = 0
  Next i

For i = 1 To 2000
  record(i, 70) = amf
  If record(i, 12) = "AM/"
    Then amf = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "<10", ""))) / Len("<10"))
  If record(i, 17) = "AM/"
    Then amf = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<10", ""))) / Len("<10"))
  If record(i, 22) = "AM/"
    Then amf = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<10", ""))) / Len("<10"))
  If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/"
    Then amf = 0
  Next i

For i = 1 To 2000
  record(i, 71) = amg
  If record(i, 12) = "AM/"
    Then amg = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "<20", ""))) / Len("<20"))
  If record(i, 17) = "AM/"
    Then amg = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<20", ""))) / Len("<20"))
  If record(i, 22) = "AM/"
    Then amg = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<20", ""))) / Len("<20"))
  If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/"
    Then amg = 0
  Next i

For i = 1 To 2000
  record(i, 72) = amh
  If record(i, 12) = "AM/"
    Then amh = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "<50", ""))) / Len("<50"))
  If record(i, 17) = "AM/"
    Then amh = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "<50", ""))) / Len("<50"))
If record(i, 22) = "AM/" Then amh = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "<50", ""))) / Len("<50"))
    If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
Then amh = 0
Next i

For i = 1 To 2000
    record(i, 73) = ami
    If record(i, 12) = "AM/" Then ami = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14),">CON", ""))) / Len(">CON")
    If record(i, 17) = "AM/" Then ami = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19),">CON", ""))) / Len(">CON")
    If record(i, 22) = "AM/" Then ami = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24),">CON", ""))) / Len(">CON")
    If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
Then ami = 0
Next i

For i = 1 To 2000
    record(i, 74) = amj
    If record(i, 12) = "AM/" Then amj = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14),">0.5", ""))) / Len(">0.5")
    If record(i, 17) = "AM/" Then amj = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19),">0.5", ""))) / Len(">0.5")
    If record(i, 22) = "AM/" Then amj = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24),">0.5", ""))) / Len(">0.5")
    If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
Then amj = 0
Next i

For i = 1 To 2000
    record(i, 75) = amk
    If record(i, 12) = "AM/" Then amk = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14),">01", ""))) / Len(">01")
    If record(i, 17) = "AM/" Then amk = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19),">01", ""))) / Len(">01")
    If record(i, 22) = "AM/" Then amk = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24),">01", ""))) / Len(">01")
    If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
Then amk = 0
Next i

For i = 1 To 2000
    record(i, 76) = aml
If record(i, 12) = "AM/" Then aml = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), ">03", ""))) / Len(">03"))
If record(i, 17) = "AM/" Then aml = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), ">03", ""))) / Len(">03"))
If record(i, 22) = "AM/" Then aml = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), ">03", ""))) / Len(">03"))
If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
Then aml = 0
Next i

For i = 1 To 2000
  record(i, 77) = amm
  If record(i, 12) = "AM/" Then amm = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), ">05", ""))) / Len(">05"))
  If record(i, 17) = "AM/" Then amm = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), ">05", ""))) / Len(">05"))
  If record(i, 22) = "AM/" Then amm = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), ">05", ""))) / Len(">05"))
  If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
  Then amm = 0
  Next i

For i = 1 To 2000
  record(i, 78) = amm
  If record(i, 12) = "AM/" Then amm = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), ">10", ""))) / Len(">10"))
  If record(i, 17) = "AM/" Then amm = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), ">10", ""))) / Len(">10"))
  If record(i, 22) = "AM/" Then amm = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), ">10", ""))) / Len(">10"))
  If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
  Then amm = 0
  Next i

For i = 1 To 2000
  record(i, 79) = amo
  If record(i, 12) = "AM/" Then amo = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), ">20", ""))) / Len(">20"))
  If record(i, 17) = "AM/" Then amo = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), ">20", ""))) / Len(">20"))
  If record(i, 22) = "AM/" Then amo = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), ">20", ""))) / Len(">20"))
  If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/
  Then amo = 0
  Next i
Next i

For i = 1 To 2000
    record(i, 80) = amUNK
    If record(i, 12) = "AM/" Then amUNK = ((Len(record(i, 14)) - Len(Application.Substitute(record(i, 14), "UNK", ""))) / Len("UNK"))
    If record(i, 17) = "AM/" Then amUNK = ((Len(record(i, 19)) - Len(Application.Substitute(record(i, 19), "UNK", ""))) / Len("UNK"))
    If record(i, 22) = "AM/" Then amUNK = ((Len(record(i, 24)) - Len(Application.Substitute(record(i, 24), "UNK", ""))) / Len("UNK"))
    If record(i, 12) <> "AM/" And record(i, 17) <> "AM/" And record(i, 22) <> "AM/"
        Then amUNK = 0
        Next i

'AM is focal animal
For i = 1 To 2000
    record(i, 81) = amFOCAL
    If record(i, 5) <> "AM" Then amFOCAL = 0
    If record(i, 5) = "AM" Then amFOCAL = 1
    Next i

'AF is focal animal
For i = 1 To 2000
    record(i, 82) = afFOCAL
    If record(i, 5) <> "AF" Then afFOCAL = 0
    If record(i, 5) = "AF" Then afFOCAL = 1
    Next i

'assigning data and behavior counts to columns in the record
focalnum = 0
For i = 1 To 2000
    focalnum = focalnum + 1
    focal(focalnum, 1) = record(i, 1) 'date
    focal(focalnum, 2) = record(i, 5) 'focal id
    focal(focalnum, 3) = record(i, 39) 'focal sample
    focal(focalnum, 4) = record(i, 44) 'period
    focal(focalnum, 6) = record(i, 49) 'afa
    focal(focalnum, 7) = record(i, 50) 'afb
    focal(focalnum, 8) = record(i, 51) 'afc
    focal(focalnum, 9) = record(i, 52) 'afd
    focal(focalnum, 10) = record(i, 53) 'afe
    focal(focalnum, 11) = record(i, 54) 'aff
    focal(focalnum, 12) = record(i, 55) 'afg
focal(focalnum, 13) = record(i, 56) ' afh
focal(focalnum, 14) = record(i, 57) ' afi
focal(focalnum, 15) = record(i, 58) ' afj
focal(focalnum, 16) = record(i, 59) ' afk
focal(focalnum, 17) = record(i, 60) ' afl
focal(focalnum, 18) = record(i, 61) ' afm
focal(focalnum, 19) = record(i, 62) ' afn
focal(focalnum, 20) = record(i, 63) ' afo
focal(focalnum, 21) = record(i, 64) ' afUNK
focal(focalnum, 22) = record(i, 65) ' ama
focal(focalnum, 23) = record(i, 66) ' amb
focal(focalnum, 24) = record(i, 67) ' amc
focal(focalnum, 25) = record(i, 68) ' amd
focal(focalnum, 26) = record(i, 69) ' ame
focal(focalnum, 27) = record(i, 70) ' amf
focal(focalnum, 28) = record(i, 71) ' amg
focal(focalnum, 29) = record(i, 72) ' amh
focal(focalnum, 30) = record(i, 73) ' ami
focal(focalnum, 31) = record(i, 74) ' amj
focal(focalnum, 32) = record(i, 75) ' ank
focal(focalnum, 33) = record(i, 76) ' aml
focal(focalnum, 34) = record(i, 77) ' amm
focal(focalnum, 35) = record(i, 78) ' amn
focal(focalnum, 36) = record(i, 79) ' amo
focal(focalnum, 37) = record(i, 80) ' amUNK
focal(focalnum, 38) = record(i, 81) ' amfocal
focal(focalnum, 39) = record(i, 82) ' affocal

Next i

'routine to print out data for each focal sample
For i = 1 To focalnum
    Summary.Cells(i + 1, 1) = focal(i, 1)
    Summary.Cells(1, 1) = "date"
    Summary.Cells(i + 1, 2) = focal(i, 2)
    Summary.Cells(1, 2) = "focalID"
    Summary.Cells(i + 1, 3) = focal(i, 3)
    Summary.Cells(1, 3) = "focalsample"
    Summary.Cells(i + 1, 4) = focal(i, 4)
    Summary.Cells(1, 4) = "period"
    Summary.Cells(1, 6) = "afCON"
Summary.Cells(1, 7) = "af<.5"
Summary.Cells(1, 8) = "af<1"
Summary.Cells(1, 9) = "af<3"
Summary.Cells(1, 10) = "af<5"
Summary.Cells(1, 11) = "af<10"
Summary.Cells(1, 12) = "af<20"
Summary.Cells(1, 13) = "af<50"
Summary.Cells(1, 14) = "af>CON"
Summary.Cells(1, 15) = "af>.5"
Summary.Cells(1, 16) = "af>1"
Summary.Cells(1, 17) = "af>3"
Summary.Cells(1, 18) = "af>5"
Summary.Cells(1, 19) = "af>10"
Summary.Cells(1, 20) = "af>20"
Summary.Cells(1, 21) = "afUNK"
Summary.Cells(1, 22) = "amCON"
Summary.Cells(1, 23) = "am<.5"
Summary.Cells(1, 24) = "am<1"
Summary.Cells(1, 25) = "am<3"
Summary.Cells(1, 26) = "am<5"
Summary.Cells(1, 27) = "am<10"
Summary.Cells(1, 28) = "am<20"
Summary.Cells(1, 29) = "am<50"
Summary.Cells(1, 30) = "am>CON"
Summary.Cells(1, 31) = "am>.5"
Summary.Cells(1, 32) = "am>1"
Summary.Cells(1, 33) = "am>3"
Summary.Cells(1, 34) = "am>5"
Summary.Cells(1, 35) = "am>10"
Summary.Cells(1, 36) = "am>20"
Summary.Cells(1, 37) = "amUNK"
Summary.Cells(1, 38) = "amfocal"
Summary.Cells(1, 39) = "affocal"
For j = 6 To 39
    Summary.Cells(i, j) = focal(i, j)
    Next j
Next i

End Sub

Private Sub UserForm_Click()
End Sub