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Stand By Me: A Study of Activity Budgets, Nearest Neighbor, Social Behavior, and Home Range of the Olive Baboons (Papio Anubis) of Ndarakwai Ranch

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Abstract

Baboons are highly social primates that live in complex societies. This study attempted to reveal which individuals are engaging in what social behaviors, and with whom. Two troops of olive baboons (*Papio anubis*) were followed at Ndarakwai Private Reserve in Northern Tanzania for 19 days from November 7 to November 26, 2009 to analyze what factors influence time budgets and social behaviors, as well as to create a home range map for each troop. Troops were seen to intermingle in the ranch, covering a large area of many habitats. Time of day, habitat, weather, troop member, and age class were not seen to significantly affect activity budgets. Social behaviors differed slightly among classes, especially play behavior which was almost exclusively found in adolescents.

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Introduction

The primate order is a diverse one, including species ranging from tiny prosimians to massive great apes. There are 185 species of primates, separated into 11 families and 56 genera (Estes 449). Africa is home to 51 species from three of the four major branches of the primate tree: prosimians, Old World monkeys, and hominoids (449). 80% of primates live in rain forests, and very few have managed to adapt to the relatively treeless savanna and subdesert (450). Among these, baboons are the least specialized and thus the most widespread (451).

Baboons are the most successful primate apart from humans, adapted to live in diverse habitats from arid grasslands to lush tropical forests (Estes 510). Savanna baboons (*Papio cynocephalus*) are perhaps the most successful of the genus, because they are such generalized feeders. They consume grass, tubers, bulbs, corms, rhizomes, flowers, fruits, leaves, seeds, tree gum, insects, eggs, and meat (Melnick and Pearl 122). In the savanna ecosystem, these arid-adapted monkeys are able to survive the periods of limited rainfall by subsisting almost entirely on the rhizomes and corms of dry grasses (Estes 510). To obtain enough resources, troops in arid habitats typically have home ranges approximately 24 km^2 in size (Melnick and Pearl 122). These ranges can increase or decrease depending primarily on water availability.

Savannah baboons are divided into several subspecies. Tanzania is home to the subspecies known as the olive baboon (*P. anubis*). These baboons are highly social, and live in multimale, multifemale troops that can range from ten to two hundred individuals, averaging about fifty (Moss 197). The ratio of females to males is typically 2-3:1 (Estes 1991). Females make up the core of the troop, as olive baboons live in a matrilineal society in which dominance is passed down from mother to daughter. Females remain in the troop, creating a stable core, while males emigrate when they reach adolescence (Estes 1991).

Olive baboons are diurnal and do not follow a regular schedule of activity. Activity budgets can be season-dependent, as foraging time is correlated to the proportion of available fruits as well as mean annual temperature and rainfall seasonality (Dunbar and Hill 2002). When there is an abundance of food, time is able to be spent in other ways, such as engaging in social behavior.

This study took place on Ndarakwai Ranch, located in western Kilimanjaro, Tanzania. The ranch is home to approximately 230 olive baboons (Meseck 2009). Such high numbers are a result of abundant food and water, as well as a lack of large predators such as hyena, lion, and

leopard. The purpose of this study was to determine how difference factors such as age, sex, habitat, time of day and location affect the activity budgets of baboons. I also wanted to compare the social behaviors among male and female adults, subadults, adolescents, and infants to see which classes associated with which and for what purpose. I looked at the two largest Ndarakwai troops, the River Troop and the Casablanca Troop, analyzing differences in behavior by age and sex and creating activity budgets for each class. I analyzed what age classes spend the most time together by looking at nearest neighbors. I also looked at differences in the behavior of adults and subadults under multiple variables: troop membership, one that has a high amount of human interaction and one that has less human interaction; time of day; weather and habitat. Finally, I will use GPS mapping to determine the home ranges of the two troops, as this will show what areas and habitats of the ranch the baboons use, particularly if they rely more on the human inhabited areas or natural areas.

I predicted that there would be a higher frequency of traveling in the grasslands and of foraging in the riverine habitats, but that time of day would not affect activity budgets. Because of previous studies and the fact that the riverine habitat has so much plant diversity as well as many fruits, I predicted that more time would be spent in the riverine areas than other habitats. I also predicted that the Casablanca Troop would spend more time being vigilant than the River Troop, and that they would spend more time in human inhabited habitats. I predicted that adult females would spend the most time allogrooming and engaging in affiliative socializing, followed by subadult females. I also predicted that adult males would spend the most time engaged in agonistic behaviors, and that play behaviors would be almost exclusively found in adolescents and infants. Lastly, I predicted that conspecifics of the same age and sex would spend more time with each other, excluding adult males which I predicted to spend the most time with adult females or alone and the least time with other adult males.

Study Site

Ndarakwai Ranch is a privately owned conservation area in the Amboseli/Ngasurai Basin region of western Kilimanjaro, Tanzania (App. A). It is over 11,000 acres in size and is home to over 65 mammal and 350 bird species. The land was a former German and then British Colonial ranch until 1961, and from 1975 to 1994 suffered from unregulated grazing, tree cutting, and poaching. In 1994, Peter Jones took over the area and turned it into a conservation area. Since then the animal and vegetation populations have increased and the water table has risen (Ndarakwai Ranch Tanzania 2009).

The area is surrounded by agricultural and pastoral communities, which are occasionally allowed onto the grounds to graze cattle and collect water. There are two farms within the ranch that occasionally experience crop raiding by vervet monkeys and baboons. The tourist camp known as Casablanca includes stables and a house; baboons are frequently seen on the property foraging through hay and buckets of horse food. The river running along the edge of the ranch is an important ecological feature and provides food and water for much of the wildlife and human populations in the area. In addition, many tributaries and irrigation channels serve to extend the riverine habitat. There are many edible grasses and fruiting trees on the property that animals and people utilize frequently. Ndarakwai grounds incorporate a diversity of habitats, from riverine systems and dense woodlands to open grasslands and rocky mountains. There is also a permanent watering hole, which supports many species of wildlife including elephants, impala, zebra, warthogs, waterbuck, and others.

The abundance of food and habitats creates the perfect environment for baboons to thrive. Easy access to food and water allows for less time and energy spent foraging and more spent socializing. At the time of this study there were approximately five troops of baboons which travel throughout the reserve and into the surrounding communities (Thomas pers. comm. 2009). The largest troops are the River Troop and the Casablanca Troop, which usually can be found on opposite ends of the reserve. Each troop utilizes all the natural habitats of Ndarakwai (riverine, woodland, and grassland), but the Casablanca Troop also spends much of its time in disturbed areas and around human habitations.

Methods

This study took place from 7 November until 26 November, 2009, at Ndarakwai Ranch and surrounding communities in the Siha District, West Kilimanjaro. Baboons of this area were observed, specifically those of the River and Casablanca troops. Focal follows were conducted collecting behavioral data, and GPS mapping will be used to determine the troop's home range. Descriptive and simple statistics were used to analyze the data.

Data was collected from 7 AM to 12 PM and from 2 PM to 6 PM every day and during the midday opportunistically. Twenty minute focals were performed, alternating male and female based on looking at the seconds on a stopwatch (odd numbers are male, even are female), and selecting individuals of that sex by a random order of age classes created at the beginning of the study and rotated every day. If I could not find an individual of the proper class, I would skip that class until the next focal, until I found a subject. Six classes were used: infant, adolescent, subadult male, subadult female, adult male, and adult female. Using Kristin Meseck's (2009) definitions, adult males will be distinguished by male genitalia, large body size, and long hair. Adult females will be distinguished by female genitalia, large female body size, and distended nipples. Sub adult males have a slightly smaller body size than adult males, and shorter hair. Sub adult females have, smaller body sizes than adult females, and lack distended nipples. Adolescents will not be sexed but will be distinguished by small body size, dark skin, and short hair. Infants have the smallest body size, have light skin, dark hair, and will likely be found in close proximity to adult females. Before each focal, time of day, habitat, weather, and an initial group count and demographics were recorded. Focals were performed recording state behaviors and nearest neighbor each minute, and self-maintenance and social behaviors marked during the minute along with the age and sex of any other participants. The ethogram used and a sample data sheet can be found in Appendices B and C, respectively. To determine home range, GPS points along with physical area descriptions were recorded when the majority of visible baboons stopped for at least 5 minutes.

Over a period of 19 days, 182 focal follows were conducted. Data were analyzed using descriptive and simple statistics. Time budgets based on class, time of day, habitat, and troop membership were created using frequencies and analyzed by chi squares. Home ranges were plotted on graph paper.

Results

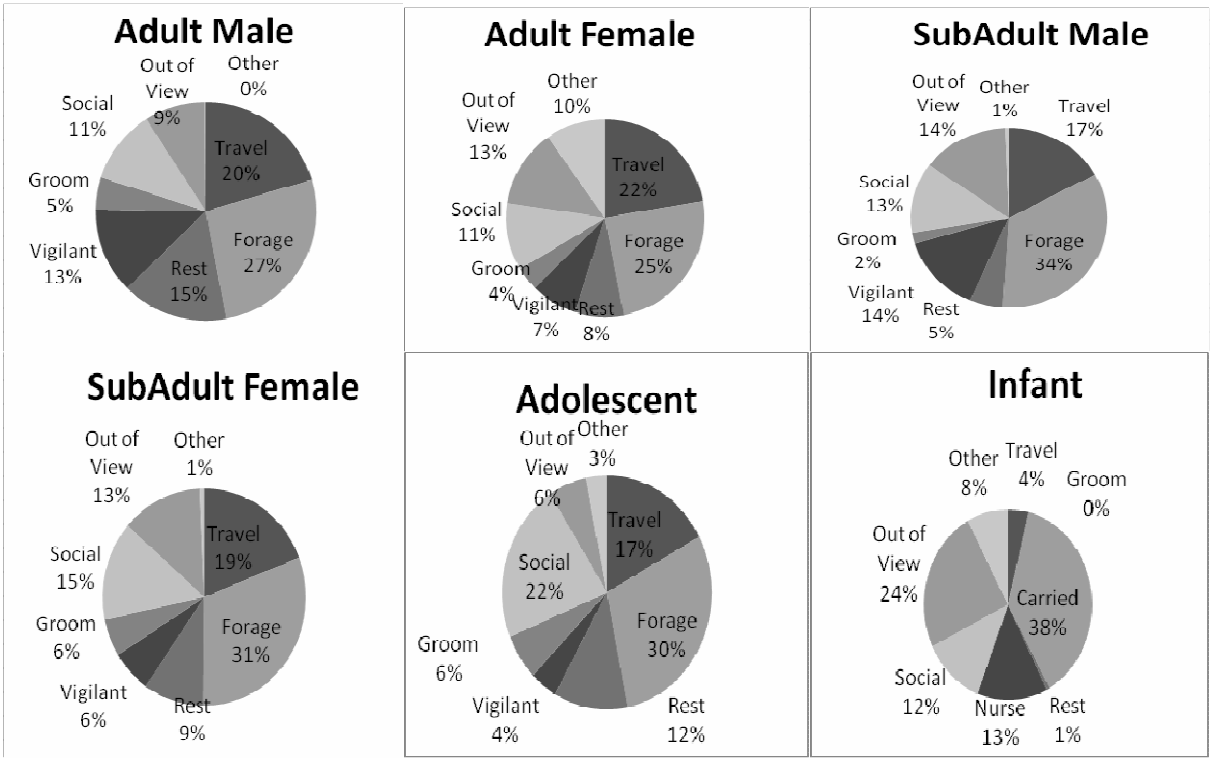

Fig. 1 Activity budgets of Ndarakwai olive baboons based on age/sex class. 7 November – 26 November, 2009.

Note: Adult Male (n=37), Adult Female (n=40), Subadult Male (n=31), Subadult Female (n=34), Adolescent (n=31), Infant (n=9)

Forage took the highest percentage of time for each class except infants, from 27% for adult males to 34% for subadult males. Adults and subadults had traveling as the next largest percentage of time, from 17% for subadult males to 22% for adult females. Adolescents spent 17% of time traveling, but spent 22% of time socializing. Adult and subadult males spent slightly more time vigilant than other classes (13% and 14% respectively), and adult females spent the most time engaged in other behavior (10%). Infants had much different time budgets from the other classes, with 38% of time being carried, 24% out of view, 13% nursing, 12% socializing, 8% other, 4% traveling, and 1% resting. (Fig. 1)

Excluding infants, class does not significantly affect behavior (chi square 3.383 < f(0.05) 41.337).

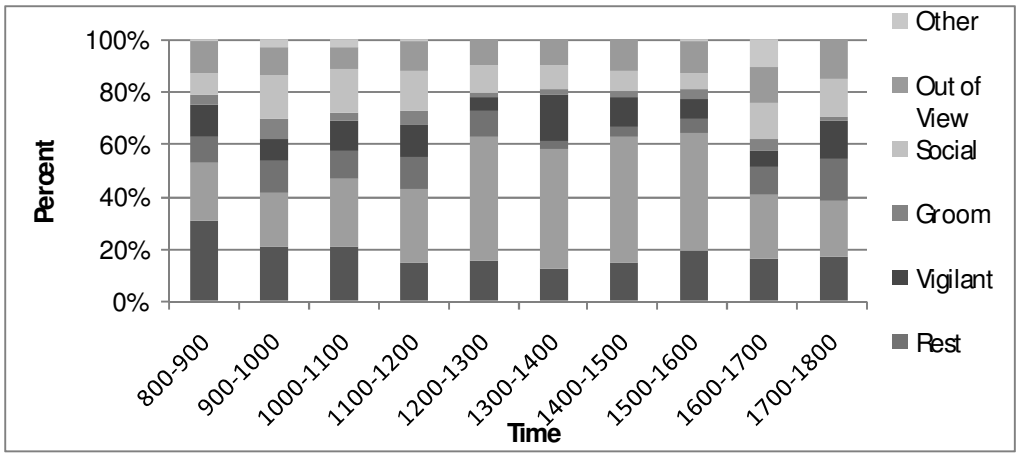

Fig. 2 Activity budgets of adult and subadult Ndarakwai baboons by time of day. 7 November – 26 November, 2009.

Note: 8:00-9:00 (n=25), 9:00-10:00 (n=20), 10:00-11:00 (n=20), 11:00-12:00 (n=6), 12:00-13:00 (n=5), 13:00-14:00 (n=5), 14:00-15:00 (n=6), 15:00-16:00 (n=19), 16:00-17:00 (n=29), 17:00-18:00 (n=9)

Activity budgets of adults and subadults were fairly consistent throughout the day with slightly more traveling between 8:00 and 9:00 and with a slight increase in foraging between 12:00 and 15:00 (Fig. 2). A chi square revealed that these differences were not significant (1.58 < f(0.05) 83.68).

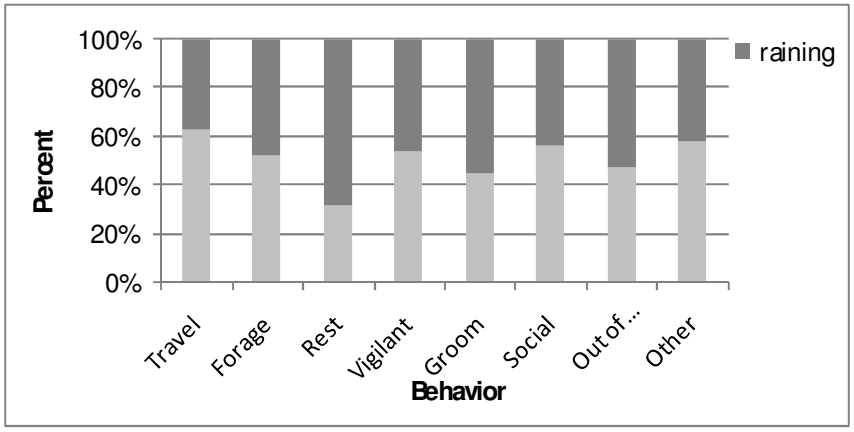

Fig. 3 Activity budgets of adult and subadult Ndarakwai baboons when raining or not raining. 7 November – 26 November, 2009.

Note: not raining (n = 124), raining (n = 17)

Activity budgets of adults and subadults were not significantly affected by rain (chi square 0.68 < f(0.05) 14.08), although resting was slightly higher when it was raining (Fig. 3).

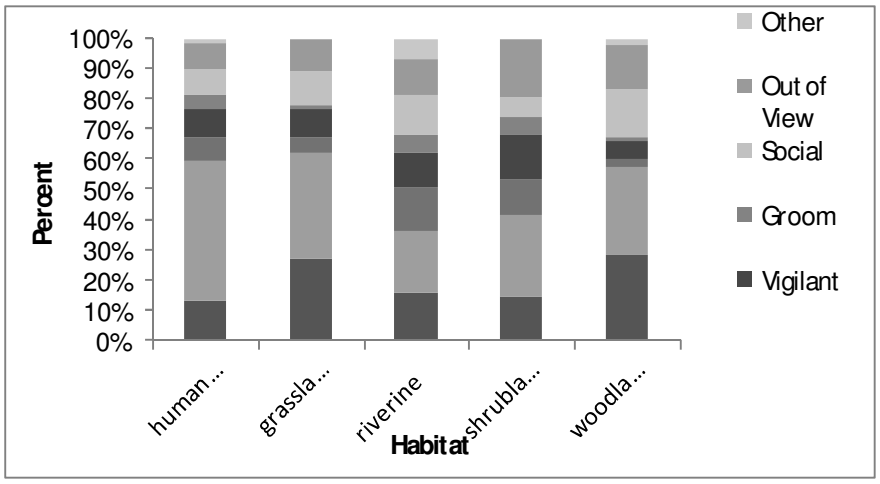

Fig. 4 Activity budgets of adult and subadult Ndarakwai baboons by habitat. 7 November – 26 November, 2009.

Note: Human inhabited (n=18), grassland (n=33), shrubland (n=9), riverine (n=62), woodland (n=20)

Activity budgets of adults and subadults were very similar by habitat (chi square 0.683 < f(0.05) 41.34), although the percentage of foraging was slightly higher in human inhabited areas and travel slightly higher in grassland and woodland habitats (Fig. 4).

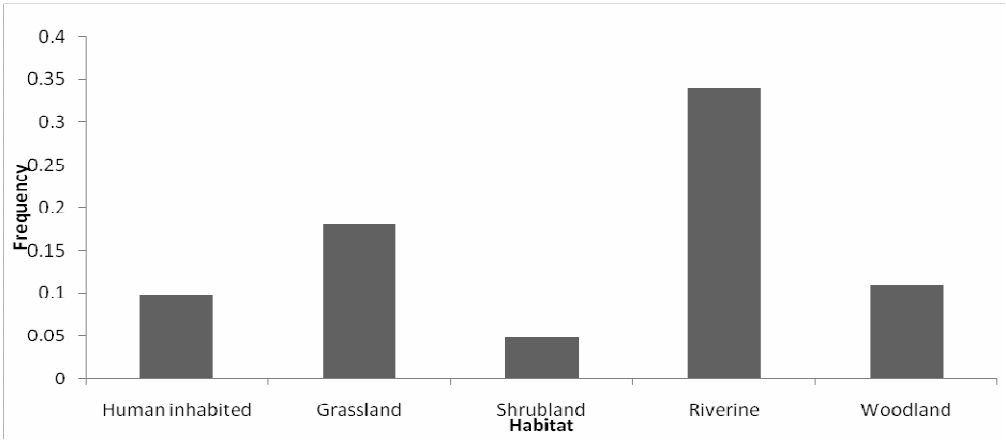

Fig. *5 Frequency Ndarakwai baboons spent in each habitat. 7 November–26 November, 2009.*

Baboons spent a higher frequency of time in the riverine habitat (0.390), followed by grassland (0.181), woodland (0.110), human inhabited (0.099) and shrubland (0.049) (Fig. 5).

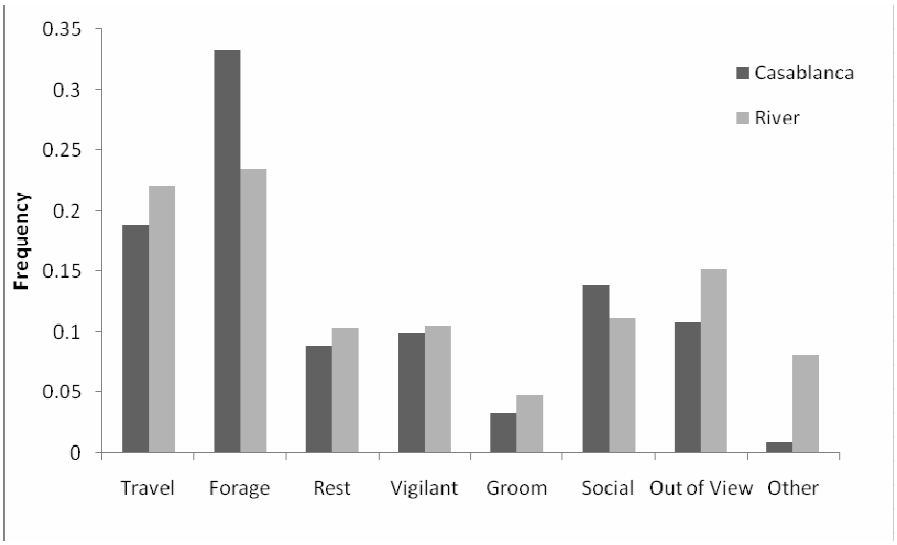

Fig. 6 Frequency of behaviors of adult and subadult Ndarakwai baboons by troop. 7 November – 26 November, 2009.

Note: Casablanca (n = 73), River (n = 47)

Troop membership did not have a significant effect on the activity budgets of adults and subadults (chi square 0.091 < f(0.05) 14.07), although Casablanca baboons were observed foraging more frequently and River baboons engaged in other behaviors more frequently (Fig. 6).

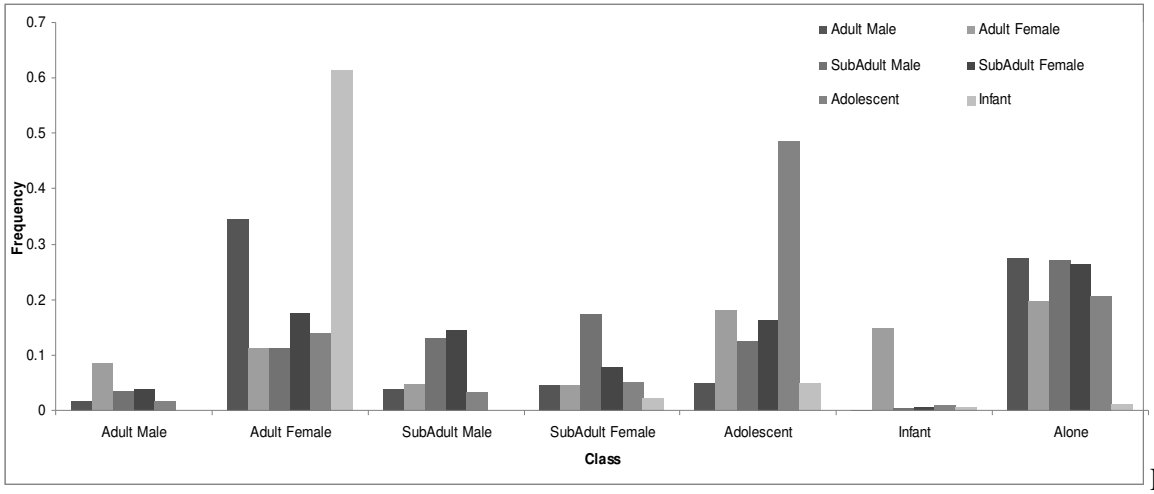

Fig. 7

Fig. 7 Frequency of nearest neighbors for different classes of Ndarakwai baboons. 7 November – 26 November, 2009.

Adult males were observed alone most frequently and near adult females more frequently than other classes. Adult females were observed near infants more frequently than other classes, followed by adult males. Subadult males were observed alone most frequently and near other subadults more frequently than other classes. Subadult females were observed alone most frequently and near subadult males more frequently than other classes. Adolescents were observed near other adolescents most frequently. Infants were observed near adult females most frequently. (Fig. 7) These differences were not significant (chi square 3.03 < f(0.05) 43.8).

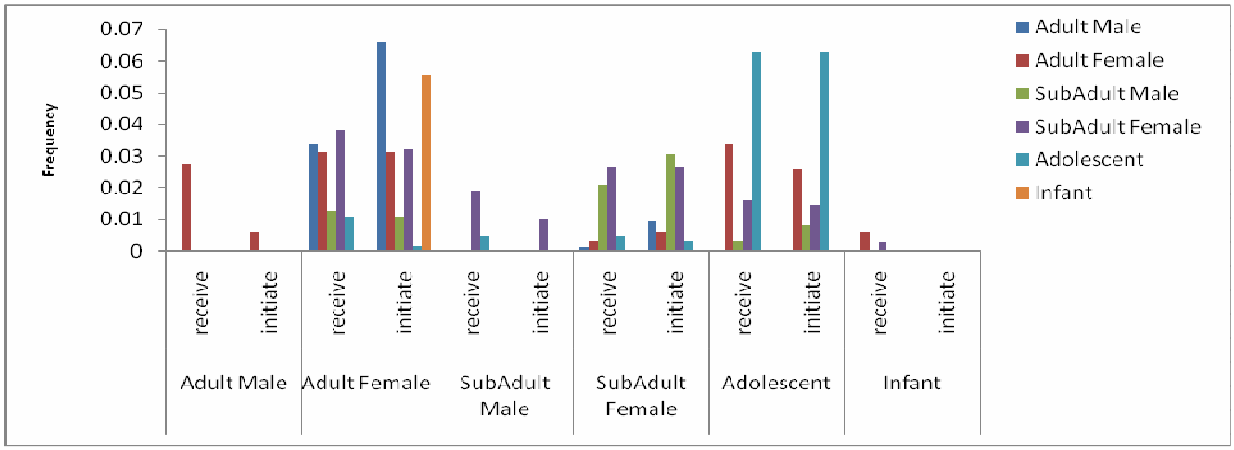

Fig. 8 Frequency of allogrooming by different classes of Ndarakwai baboons. 7 November – 26 November, 2009.

Allogrooming was not significantly affected by class (chi square 0.814 < f(0.05) 67.5). Adult males were only seen grooming with adult females, receiving more frequently than initiating. Adult females were observed allogrooming with every class, most frequently with adult males and infants. Subadult males were observed allogrooming with subadult females most frequently, and rarely with adolescents. Subadult females were observed allogrooming with all classes but most frequently with other subadults of either sex. Adolescents were observed allogrooming most frequently with other adolescents, followed by adult females. Infants were seen to receive allogrooming only, and only from adult and subadult females. (Fig. 8)

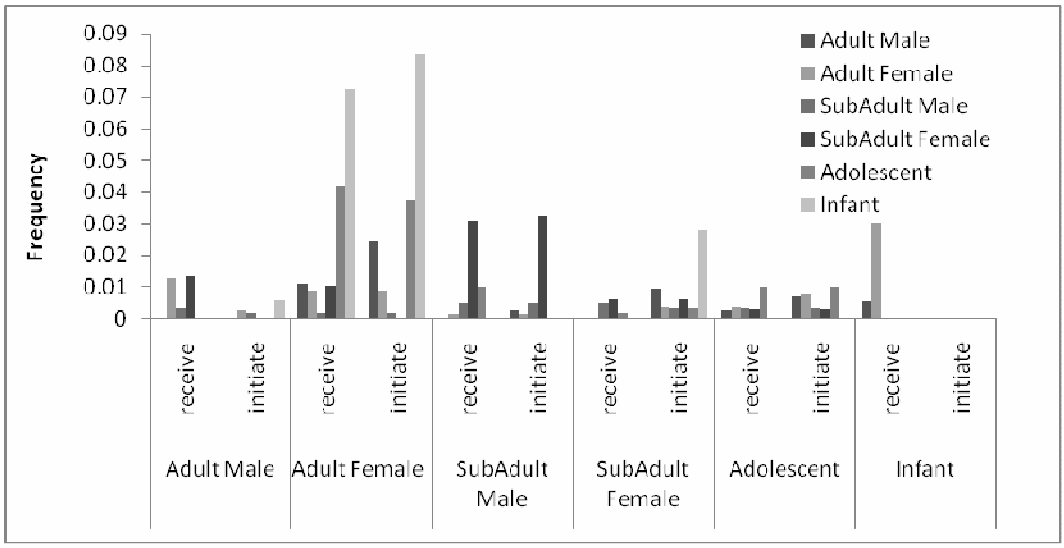

Fig. 9 Frequency of social affiliative behavior by different classes of Ndarakwai babons. 7 November –26 November, 2009.

Social affiliative behavior was not significantly affected by class (chi square 0.620 < f(0.05) 67.5). Adult males were observed receieving social affiliative behavior from adult females and subadult males and females, and initiated to subadult males and females and infants at low frequencies. Adult females were observed socially affiliating with every class, most frequently with infants and adolescents. They initiated social affiliative behavior towards adult males more than they received, and they only received behavior from subadult females and never initiated. Subadult males were observed socially affiliating with subadult females more frequently than other classes. Subadult females were observed initiating social affiliative behavior to all classes, most frequently to infants and adult males, and received from subadult males and females and adolescents at low frequencies. Adolescents were observed socially affiliating with every class, but at low frequencies. Infants received social affiliative behavior from adult females most frequently and occassionally from adult males. (Fig. 9)

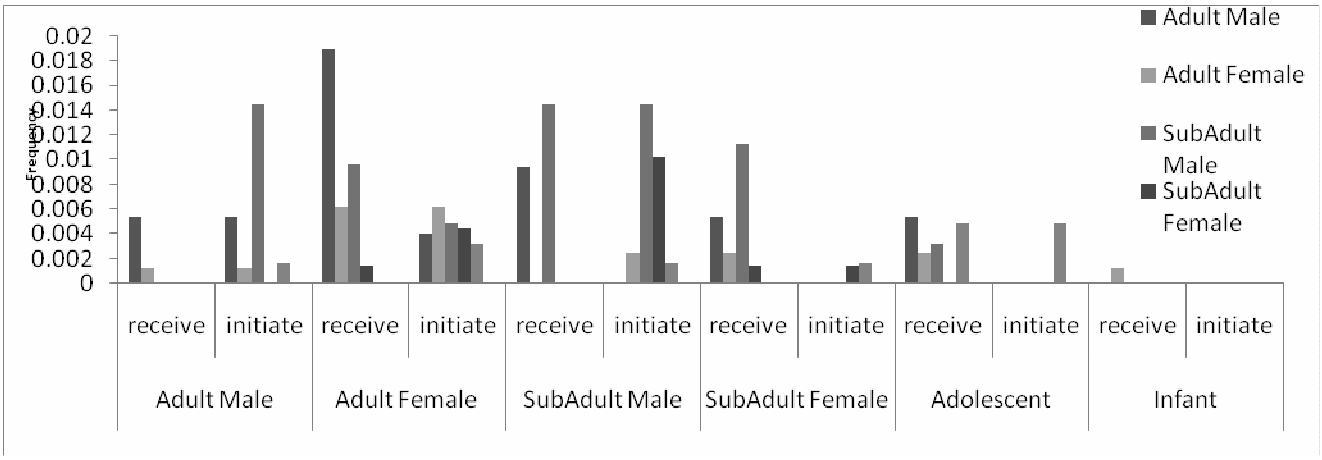

Fig. 10 Frequency of social agonistic behavior by different classes of Ndarakwai baboons. 7 November–26 November, 2009.

Social agonistic behavior was not significantly affected by class (chi square 0.162 < f(0.05) 67.5). Adult males were observed initiating social agonistic behavior towards all classes except infants and subadult females, most frequently towards subadult males, followed by adult males. Adult females were observed receiving social agonistic behavior from adult males most frequently, but also from adult females and subadult males and females. They were observed initiating to all classes except infants. Subadult males were observed receiving social agonistic behavior from subadult and adult males only, and intitiating towards subadult males and females most frequently. Subadult females were observed receiving more social agonistic behavior than they initiated, from subadult males most frequently, followed by adult males. They initiated towards subadult females and adolescents at low frequencies. Adolescents were observed receiving social agoinsitic behavior from adult males and females and subadult males, and only initiated towards other adolescents. Infants were only observed receiving social agonistic behavior from adult females at low frequencies. (Fig. 10)

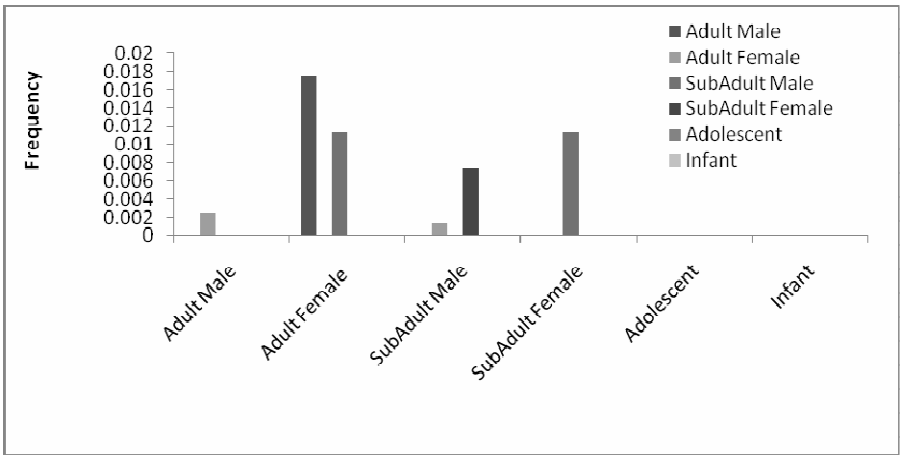

Fig. 11 Frequency of copulation by different classes of Ndarakwai baboons. 7 November – 26 November, 2009.

Copulation was not significantly affected by class (chi square 0.096 < f(0.05) 37.65), although adolescents and infants were never observed engaging in copulation. Adult males were observed copulating with adult females, but not frequently. Adult females were observed copulating with adult and subadult males. Subadult males were observed copulating with subadult females most frequently and rarely with adult females. Subadult females were only observed copulating with subadult males. (Fig. 11)

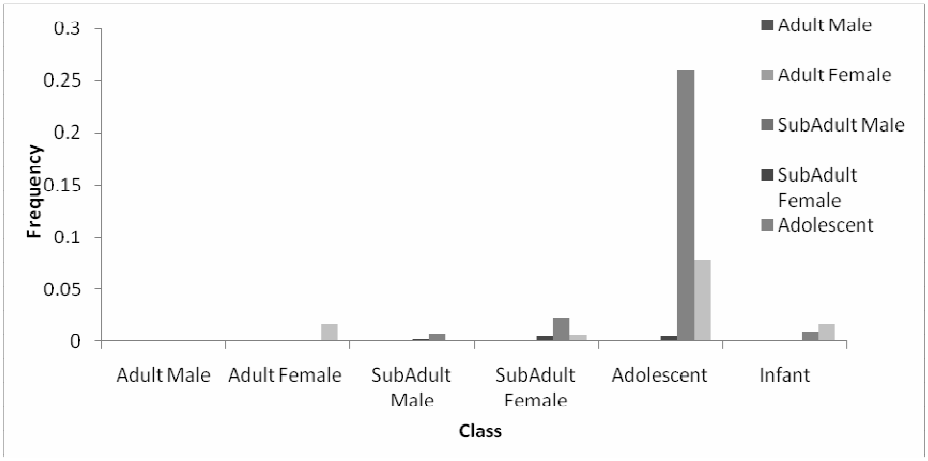

Fig. 12 Frequency of play by different classes of Ndarakwai baboons. 7 November – 26 November, 2009.

Play behavior was significantly affected by class (chi square 49.95 > f(0.05) 37.65). Adolescents played significantly more frequently than other classes (chi square 13.74 > f(0.05) 11.07), and most often with other adolescents (Fig. 12).

Discussion

Overall activity budgets were similar among age classes, with the exception of infants which have a very different schedule than the others. Because of this, infant data was disregarded in all other activity budgets. For the other classes, foraging was observed the most. For adults and subadults, the next most frequent behavior observed was travelling; for adolescents it was social behavior because of the amount of time they spend playing. Differences existed in activity budgets by class, although these were not significant. Adolescents were observed engaging in social behaviors more often than other classes, and adult males and subadult females were observed to be vigilant most often. It was surprising to find that adult females were not the most vigilant class, and that adult males engaged in the behavior so frequently. One possible explanation is that the ethogram I used did not distinguish between vigilance towards other group members and that towards external factors; adult males seemed to watch other group members more often than they would scan the surrounding areas. This could be because adult males are less sure of their position in the troop than females, and have to keep an eye both on potential rivals and on potential mates. Differences were not significant, which is unsurprising since the majority of baboon troops often engage in the same behaviors at the same time (Estes 1991). Activity budgets were not significantly affected by time of day, which was also expected because baboons do not have a set peak of activity like some other primates (Estes 1991). Activity budgets were not observed to be dependent upon habitat, which refutes my hypothesis. Supporting my hypothesis, however, was the fact that most of the observed time was spent in the riverine habitats. The baboons were seen to drink from the river and seemed to highly prefer the Ficus fruits found along the banks. Although the baboons use the human inhabited areas of the ranch and the surrounding villages, they do not spend the majority of their time there and instead concentrate on the riverine and grassland habitats.

Refuting my hypothesis, troop membership had no significant impact on activity budgets, although the River Troop was observed engaging in more "Other" behaviors, which included vocalizing and chasing vervet monkeys. One possible reason for this is that there was much less of a distinction between troops as I had anticipated; both Casablanca and River headed out into the grasslands and intermingled, and I also saw movement of adult males between the troops. While there were groups of females and offspring that seemed to always remain together, males were variable and troop size and demographics were not always the same. The sleeping sites for

both troops were also very close to each other. All of this led me to question whether there really were separate troops or if all the Ndarakwai baboons were in one large troop that sometimes split into small subtroops of related individuals. When I asked about it, the park manager Thomas assured me that not only were they separate, but there were at least five separate troops on the property. However, I did not find any data to support this. The home range map shows both troops in similar areas, along with baboons I did not recognize and so could not place in one troop or another.

Possibly due to the short time period devoted to data collection, and thus small n values, I found no significant differences in social behavior among classes with the exception of play. For the rest of the behaviors, I could only begin to see trends. I hypothesized that adult females would allogroomed the most frequently followed by subadult females, however my data showed the opposite, with subadult females allogrooming more (0.187) than adult females (0.173). The same was true for social affiliative behavior; subadult females engaged in this behavior more frequently (0.104) than did adult females (0.08). My hypothesis that adult males would have the highest frequencies of social agonistic behavior was also unsupported. Subadult males were observed to have high frequencies (0.073), followed by adult males (0.054). My hypothesis that play would be found mostly in adolescents was supported, as they engaged in play significantly more frequently (0.300) than all other classes, including infants (0.117) and subadult females (0.010) which were the only other classes observed to play. I found it interesting that adult males copulated almost exclusively with adult females (I never observed them copulating with subadult females when I was performing a focal on them, but twice observed it while watching a subadult female.), and that subadult males were observed to copulate more frequently than adult males.

There were no significant differences in nearest neighbor as related to class, but there were trends that may become significant if more time were spent or a more in-depth study was conducted. Subadults spent the most time with their age class, however females and males spent more time together than with individuals of the same sex. Adult females spent more time with adult males than with other classes excluding infants. This may have to do with the fact that many adult females were in estrus during the study, and adult males stuck close by them, but this is only speculation.

Biases and Limitations

The biggest limitation for this study was the abundance of elephants on the reserve. Data collection had to be suspended or postponed multiple times because of elephant proximity, especially when the baboons travelled far out into the grasslands. Another limitation was that the short time period made it difficult to collect enough data to see definite trends. It also made it difficult to identify troops, as I was only able to spend time enough to identify a few subgroups and had trouble determining troop membership when over 50 baboons were foraging together. Lastly, visibility was limited in the riverine and woodland habitats, where the baboons spent much of their time, and so it may be that many behaviors in these areas went unobserved.

Recommendations

It appeared that behavior of certain classes, most notably adult males, was affected by group size and demographics. It would be interesting to see if aggression by males increased with the number of males in close proximity. Another variable that I was unable to measure systematically was estrus in females. It seemed to make a difference in nearest neighbor and grooming behavior, but these factors would need to be studied in depth.

An issue I ran into during this study was the difficulty of determining troop membership, mostly because different troops seemed to sleep in approximately the same area, and multiple subgroups intermingled throughout the day. Ndarakwai employees insisted that there were at least five separate troops, but I was unable to identify them during the course of this study. Troop composition and inter/intra troop interactions would be an interesting study in Ndarakwai.

I would also recommend nuancing the definitions of each age class, especially for subadult males. This class ranged from males just out of adolescence until just before adulthood, which makes for very different looking and possibly acting individuals.

Conclusion

Twenty-minute focal follows were conducted on adult, subadult, adolescent, and infant olive baboons in Ndarakwai Ranch. Activity budgets were created and analyzed using different variables. No significant differences in behavior were seen with regards to class, time of day, weather, or habitat. Possibly longer studies would reveal more significant differences; previous SIT studies have found differences in activity budgets by habitat. Looking at social behaviors in more depth revealed trends, but no significant differences except for play behavior. Adult males and females spent more time together than with other classes, and allogroomed, affiliated, and copulated frequently. Adult females also spent much of their time with infants, and I observed alloparenting on a few occasions; once an infant was carried by three separate adult females in the space of twenty minutes. Subadult males and females socialized with each other very frequently, and adolescents socialized with other adolescents most often.

Animal social behavior is inherently interesting, but studying it can also serve a purpose. Understanding the activity budgets of animals helps wildlife managers; the baboons of Ndarakwai utilize all available habitats the ranch has to offer, relying on the riverine in particular. Although Ndarakwai employees and the village chairman told me of frequent crop-raiding by the baboons, I did not observe any crop raiding and the baboons do not seem to prefer human areas over other habitats. The health of the environment affects the animals within it, and their behavior can be indicative of any problems. Ndarakwai and the surrounding areas have recently suffered a long drought, and I expected foraging to have taken up much of the time that socializing usually takes; however the rains came and Ndarakwai was thriving, and so the baboons were able to devote time to "luxury" behaviors such as socializing. The fact that the baboons are acting as if everything is normal shows that Ndarakwai is a healthy environment.

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Appendix A not included in electronic copy.

Appendix B – Ethogram

State Behaviors	**Definition**
Auto Grooming (ATG)	Picking at or looking through fur of own body. Includes self-maintenance behaviors such as scratching and self-inspect.
Foraging (For)	Actively looking, handling, or consuming food
Traveling (Trv)	Moving from one place to another, either on the ground or in trees
Resting (Rst)	Body and head motionless, either seated, standing, or lying down
Social (Soc)	Interaction with conspecific, including copulation, allogrooming, and agonistic behaviors
Vigilance (Vig)	Body still, head moving or still, in seated or standing position while scanning area or staring intently
Other (O)	Behavior not defined by ethogram
All-Occurrence Behaviors	**Definition**
Self Maintenance (SM)	Behaviors designed to reduce physical or emotional stress such as auto-grooming, scratching, self-inspect, yawning, and masturbation.
Allo Grooming (ALG)	Picking at or looking through fur of conspecific
Social Affiliative (SAf)	Affiliative behavior towards conspecific, including genital presentation, touching, embracing, lip-smacking, mounting, and soliciting to groom or be groomed
Social Agonistic (SAg)	Agonistic behavior towards conspecific, including hit, chase, bite, displace, and threaten, possibly involving aggressive vocalizations
Social Play (ScP)	Engaging in play behavior with conspecific, including chasing, wrestling, or other interactions without aggressive vocalizations
Copulation (Cop)	Mounting a conspecific (placing hands on back of other individual and raising upper body so that genitals are aligned) and thrusting
Other (O)	Behavior not defined by ethogram

Appendix C – Sample

Date:		Time:		Class:		Habitat:		
Minute	State	Nearest Neighbor	SM	ALG	SAf	SAg	Cop	O
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
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20								
Comments								