

## Behavior and Space Utilization of Okapi in a Zoological Park

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With 14 Figures

### Abstract

The behavior of three different groups of okapi was systematically observed over a 2 year period at the San Diego Wild Animal Park. Each group was observed for varying periods of time due to periodic additions and removals of individuals. The composition of each group was as follows: Group 1 — 3 ♀♀ and 2 ♂♂; Group 2 — 3 ♀♀; and Group 3 — 2 ♂♂. Data were collected, primarily, using continuous focal animal sampling. 414 hours of data collected over 128 days were analyzed. The results showed that the predominant behaviors of each group were: standing, locomoting, feeding on provided food, foraging on natural vegetation and interacting. The major social interaction among the okapi of each group was allogrooming. Although all areas of the enclosure were utilized, those areas which provided the most cover were preferred. Mating behavior, other sexual behavior, and early development of the young are also described. Comparisons are made with known behavior of the free-living okapi. Implications for captivity are emphasized.

### Introduction

The okapi (*Okapia johnstoni*) has long been an animal of mystery. Existence of this species was first made known in 1900 in a report of their discovery by Sir HARRY JOHNSTON (BRIDGES 1937). The natural habitat of this wary and secretive animal is the dense equatorial rainforest of Zaire (NOWAK & PARADISO 1983). GIJZEN & SMUTS (1974) and, more recently, DEBOIS & VAN ELSAKER (1988) have summarized the vast amount of literature on the okapi. It was noted, however, that research on okapi behavior has been very limited. There is currently underway a long term project on okapi status, ecology and behavior in the wild from which reports are beginning to emerge (HART & HART 1988). In captivity, research on okapi behavior has primarily emphasized development (RABB 1978 and HORWICH et al. 1983) and mating displays (WALTHER 1964, 1984).

The purpose of this research was to determine the okapi's general behavioral patterns and their use of space at the San Diego Wild Animal Park. The motivation was to begin to fill the void on missing aspects of okapi behavior. This project began in November 1985. Presented here are the initial findings of this ongoing research.

### Method

#### Setting

The okapi were observed throughout a 2 year period while in their open-air outdoor exhibit at the San Diego Wild Animal Park in San Pasqual, California. Their enclosure was a natural substrate area containing grasses and several trees, primarily eucalyptus,

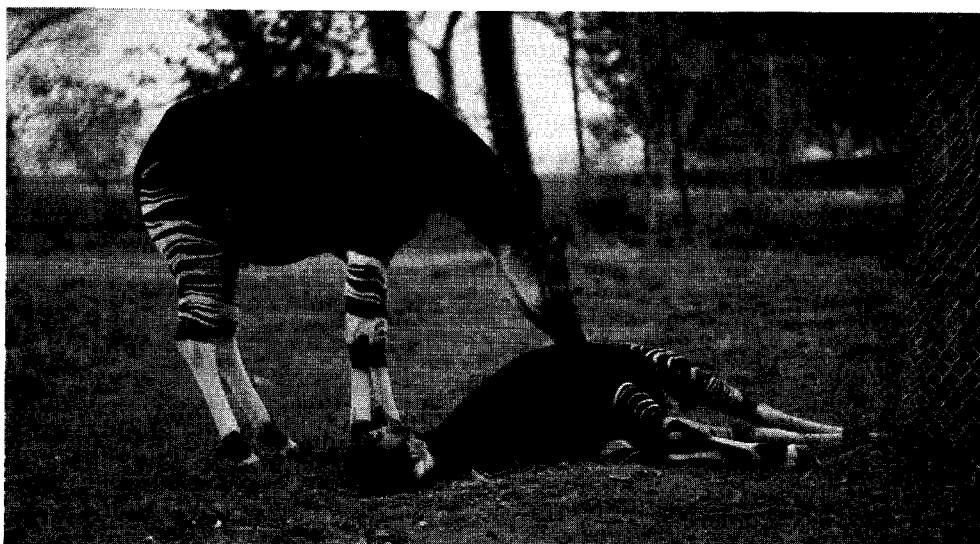


Fig. 11. ♀ okapi laid down on her side in response to the ♂ in the position termed "play dead".

### Development

Each of 2 ♀♀ calves ("*Kasai*", born May 22, 1986 and "*Katanda*", born April 24, 1988) was observed 2 days each week during their 2, 3, and 4, weeks of life. Study of their development began in their second week when each was released into the large outdoor enclosure with her dam, "*Kenge*". The calves and dam spent approximately 4 hours each day in the exhibit. During this time, 79% of each calf's observed hours was spent in Areas A-2 and A-3. These 2 areas were those closest to the barn and the gate which led into it. Also in Area A-2, near A-3, was the poled area at the fenceline (Fig. 1). Young okapi spent much of their time in this location while in the enclosure.

"*Kasai*" and "*Kenge*" spent 40% of their time in the same immediate location and 60% separated. "*Katanda*" and "*Kenge*" spent 55% of their time in the same immediate location and 45% separated. This information, however, is based on 2 different sampling methods. Observations on "*Katanda*" occurred during 630 one-minute focal sampling periods (25 to 30 minutes per hour) and on "*Kasai*" during 260 continuous 5 minute sampling periods.

Table 4 shows the general activity patterns of "*Katanda*" during her 3 week period. Her behavior was chosen to demonstrate these activities because the focal sampling method produces more detail. However, 87% of each calf's total interactions with her dam was allogrooming, initiated by the dam. This behavior included licking the anogenital region (Fig. 12). In fact, the dam had a tendency to overgroom this area of her calf, thus a coat was designed for the calf to prevent rectal injury from the dam's tongue (Fig. 13).

The duration of time each calf spent lying down and nursing was measured. During week 2 "*Kasai*" laid down for a 5 min period one day and a 10 min period the second

### Subjects

The total number of subjects during the period of the study consisted of 9 individuals. The number under observation at any given time varied throughout the study because of additions and removals. Please refer to Table 1 for the subjects' names, sex, date of birth, dam, and sire.

Table 1. The Okapi documented in this study: name, sex, date of birth, dam, and sire

Name	Sex	Birth date	Dam	Sire
"Mokolo"	♂	23. XI. 1973	"Lisette"	"Baruti"
"Kenge"	♀	5. VII. 1976	"Oseena"	"Uhuru"
"Bambasa"	♀	11. X. 1981	"Kamina"	"Mokolo"
"Dua"	♂	23. VIII. 1983	"Kamina"	"Mokolo"
"Kiri"	♀	24. XII. 1984	"Kenge"	"Mokolo"
"Kasai"	♀	22. V. 1986	"Kenge"	"Mokolo"
"Katanda"	♀	24. IV. 1988	"Kenge"	"Mokolo"
"Kivu"	♂	6. III. 1989	"Kiri"	"Chuma"
"Kabinda"	♀	29. V. 1989	"Kasai"	"Chuma"

### Procedure

Observations were recorded at weekly intervals during the period November, 1985 through November, 1987. The animals' behavior were documented from the time they were released in the morning (usually 700, but sometimes as late as 900) until 1400. Shorter periods of observation during special events have continued until the present. These events included early development of the young, introductions of new animals, introductions of dams and their offspring to other members of the group, and mating behavior.

The method employed during the first 4 months of the study was systematic recording, in which written descriptions documented consecutive 5 minute intervals of individual behaviors, social interactions, and space utilization of each of the then 5 okapi ("Mokolo", "Dua", "Kenge", "Bambasa" and "Kiri"). Throughout the remainder of the study, continuous focal animal sampling was used (ALTMANN 1974). All occurrences of behaviors were recorded during each of 15 continuous one-minute intervals when there were 3 animals in the enclosure, or 20 one-minute intervals when there were 2 animals in the enclosure, for each animal during each hour of observation. The location of each animal during their focal period was also documented. In addition, 3 scan samples were taken during each hour for the entire group on exhibit. The first observed behavior and the location of each okapi were documented during each scan.

The individual behaviors analyzed during this project were: eating provided food and licking mineral block or cement wall; foraging on natural vegetation and licking or biting tree bark or wood poles; drinking; defecating; urinating; nursing (count and duration); lying down; standing; autogrooming; walking; swift movement (such as running or galloping); rubbing against an object; vocalizations; and the ♂'s behaviors of rear-leg-cross and urinating, "down-up", and flehmen from urine on the ground. The social interactions documented were: naso-nasal, naso-anal, naso-anogenital, naso-

genital, naso-udder, allogrooming, tactile, food-sampling, rear foot kick, head butts, horn butts (♂), neck fight, chases, foreknee kick, forefoot kick, courtship behavior, mounts, and copulation. (Descriptions of these interactions occur in the Results Section.)

### Analysis

There were 414 hours of data collected over 128 days of observation. There were 23,160 one-minute periods and 1,685 5-minute periods analyzed. In addition, 3 two-day sessions of mating between "*Mokolo*" and "*Kenge*", the first month of life for one ♀ born in 1988, and nursing durations during the first month for one ♂ and the first 2 months for 2 ♀♀ born after 1987 were also analyzed.

### Results

The results are presented with the following organization:

- . Behavioral Patterns and Space Utilization of Three Okapi Groups
  - . Group 1 using systematic recording
  - . Group 2 using focal animal sampling
  - . Group 3 using focal animal sampling
- . Social Interactions
- . Mating Behavior
- . Early Developmental Behavior

#### Behavioral Patterns and Space Utilization of 3 Okapi Groups

##### Group 1 — November, 1985 through February, 1986 (Systematic Recording)

5 okapi were together during this 4 month period: "*Mokolo*", "*Dua*", "*Kenge*", "*Bambasa*" and "*Kiri*". Behaviors and locations of each animal were documented during each 5 minute period. 5 behaviors comprised the major portion of each okapi's activities. When averaged across animals, the behaviors were generally evenly distributed: interacting (27%)<sup>1</sup>, feeding on provided food (21%), locomoting (18%), foraging on natural vegetation (16%), and standing (13%). "Other" behaviors, which included, drinking, defecation, urination and lying down, accounted for 5%. The major individual difference was that "*Kenge*" spent more time standing and "*Bambasa*" spent more time locomoting than the others. (Details on their social interactions are described in a following section.)

The okapis' major behaviors were relatively evenly distributed throughout the day; however, there was a peak in feeding on provided food between 700 and 900 (Fig. 2). The animals eliminated throughout the day, but 40% of the defecations occurred between 700 and 900 (Category — Other).

The okapi utilized all areas of their enclosure. The most popular area, Area-B (35%), was the location of their provided food, their drinker, and a group of 3 fenced trees where the okapi stood for shade or attempted to secure tree bark. The other areas were relatively evenly utilized. The major individual difference when comparing across

<sup>1</sup> Because of the nature of this sampling method, both animals involved in an interaction were counted; therefore, there appeared to be a higher percent of interactions than actually occurred.

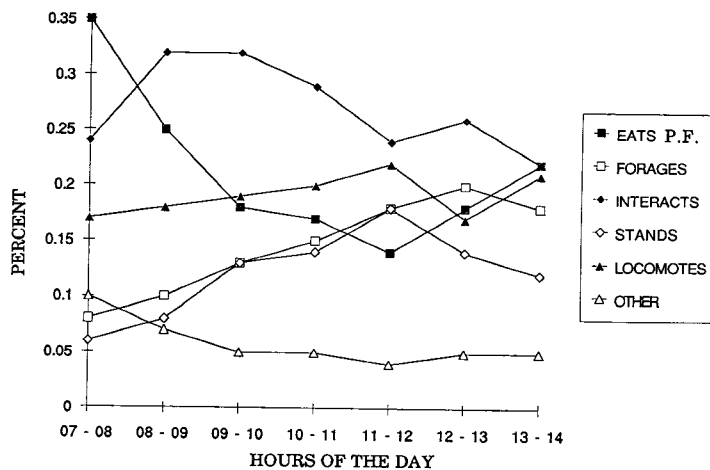


Fig. 2. The hourly activities of the aggregated group of 5 okapi — 2 ♂♂ and 3 ♀♀ — over a 4 month period when together in their outside enclosure.

animals was that “Kenge” spent less time in Area B and more time in Area C-1 than the others. “Kenge” sometimes stood alongside the gunite wall at the outside corner of C-1 or alongside the fenceline of the C-areas, which were shaded. The animals defecated most often in Areas A-2 (44%), A-1 (22%), and B (17%); and urinated in Areas B (30%), A-2 (32%), and A-1 (16%). The other areas were used from 3% to 8% for each type of elimination. Most of the eliminations occurred near a tree or the fenceline, except in Area A-1, where the animals also eliminated on a raised mound of earth. The areas where they defecated in A-2 and A-1 were those closest to the only mutual fence line of another animal enclosure.

Group 2 — August, 1986 through January, 1987 and April, 1987 through June, 1987 (Focal Sampling)

Comparisons of behavior among 3 ♀♀ — “Kenge”, “Kiri”, and “Kasai” — were made for this 9 month period across the 7 hours of daily observations (Fig. 3). 5 behaviors comprised the major portion of the okapis’ activities. When averaged across animals the results were: standing (43%), locomoting (23%), interacting, (12%), feeding on provided food (10%), and foraging on natural vegetation (10%). “Other” behavior, which included drinking, defecation, urination, lying down, vocalizing, and rubbing against objects, accounted for 2%. Statistical tests were performed on feeding on provided food, foraging on natural vegetation, locomoting, and standing (Table 2). (Social interactions are detailed in a following section.) There was a significant difference in the frequency of foraging on natural vegetation among the 3. “Kiri” and “Kasai” engaged in this behavior significantly more often than “Kenge”, but not differently from each other. Included in the foraging category is licking or biting tree bark or wood poles. The percentage of this behavior to the total foraging category for each ♀ was: “Kenge”, 19%; “Kasai”, 21%; and “Kiri”, 24%.

“Kiri” and “Kasai” each engaged more frequently in locomoting when compared to “Kenge”, who spent significantly more time standing than did the 2 younger animals.

However, each animal engaged a considerable percent of their behaviors standing. Note that standing included both standing in one location for a period of time as well as standing interspersed with locomoting. When an animal engaged in either type of standing behavior, they sometimes self groomed or slapped their body and appendages with their tongues, possibly to ward off insects. When this behavior occurred, it was recorded at the rate of one per minute of observation. The monthly average frequency with which this behavior was performed while standing was: “*Kenge*” 25% (range 8 to 48%); “*Kasai*”, 20% (range 7 to 36%); and “*Kiri*”, 30% (range 14 to 47%). An interesting note is that the maximum performance of this behavior for each animal occurred during the month of November.

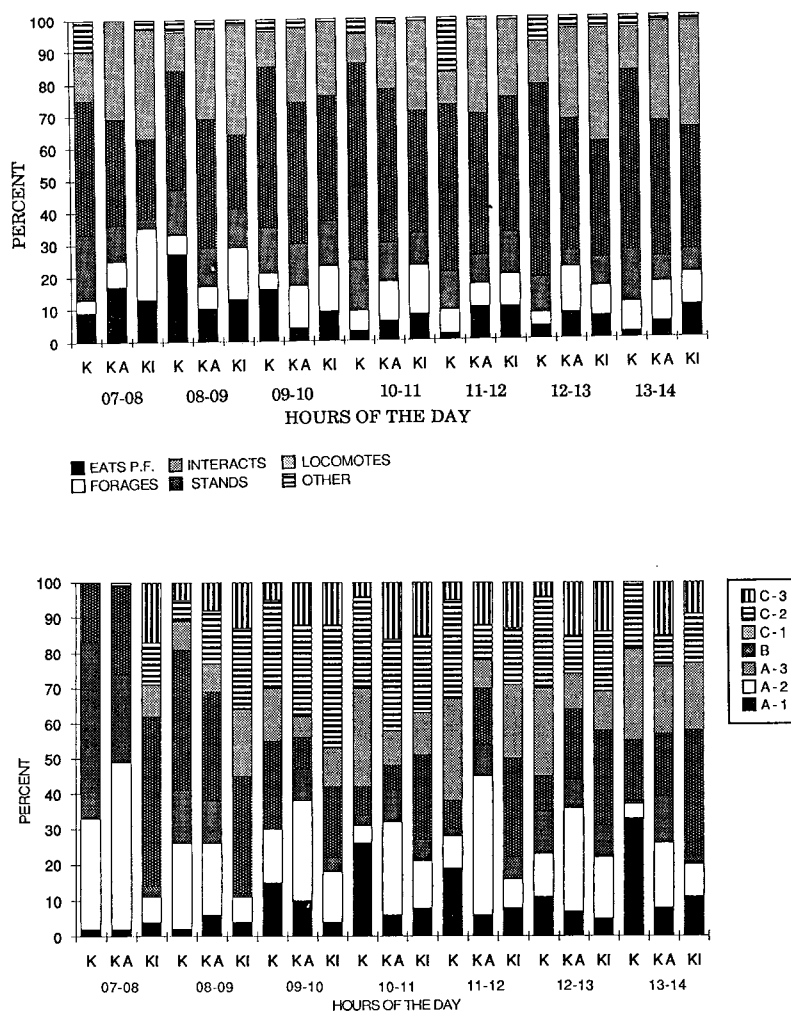


Fig. 3a. The hourly activities of 3 ♀♀ okapi — “*Kenge*” (K), “*Kasai*” (KA), and “*Kiri*” (KI) — over a 9 month period when together in their outside enclosure.

Fig. 3b. The hourly space utilization of 3 ♀♀ okapi — “*Kenge*” (K), “*Kasai*” (KA), and “*Kiri*” (KI) — over a 9 month period when together in their outside enclosure.

Table 2. Kruskal-Wallis H-values and t-tests comparing the 3 ♀♀ — “Kenge” (“K”), “Kiri” (“Ki”), and “Kasai” (“Ka”) — for each behavior and each time period across the 9 month period

Behavior	H-values	t-values		
		“K” vs “Ki”	“K” vs “Ka”	“Ki” vs “Ka”
Eating P.V.	2.56			
Foraging	*11.34	*5.68	*2.53	1.29
Standing	*15.86	*7.66	*3.03	1.93
Locomoting	*17.51	*6.01	*9.13	.89
		07—09	07—09	09—11
		vs	vs	vs
		09—11	11—13	11—13
Eating P.V.	*7.13	*2.49	*2.67	.36
Foraging	.12			
Standing	*6.67	*2.82	*2.61	.17
Locomoting	2.65			
Interacting	3.80			

H-value required for significance at the 0.05 level,  $df = 2$ , is 5.99.

t-value required for significance at the 0.05 level,  $df = 8$ , is 2.30 and  $df = 6$  is 2.44.

To compare the general activity patterns of the okapi across hours of the day, the 3 ♀♀ were grouped together and each of the 4 behavioral categories was tested during the time periods 700—900, 900—1100, and 1100—1300 (Table 2). The significant differences were that feeding on provided food occurred more frequently during the hours of 700—900, and standing occurred more frequently during the hours of 900—1300. Foraging on natural vegetation and locomoting were more evenly distributed throughout their day.

The 3 ♀♀ utilized all areas of their enclosure (Fig. 3 & 4). “Kasai” spent 41% of her time in the area closest to the barn and the poled section (A-2 and A-3), compared to “Kenge” at 24% and “Kiri” at 15%. “Kenge” spent more time in A-1 (15%) than “Kiri” and “Kasai” (each 6%). “Kiri” spent 49% of her time and “Kenge” 43% in the C-areas of the enclosure compared to “Kasai” at 36%. The C-areas were at the opposite side of the enclosure from the barn and the other animal exhibit, thus farthest from most human and other animal activities. Also, there was more vegetation to which they could reach through the fence along these areas, and more shade than in other areas of their enclosure. “Kiri” spent 30% of her time in Area B compared to 18% for “Kenge” and 17% for “Kasai”. Area B contained some natural browse and was where their provided food was located.

#### Group 3 — August through November, 1986 (Focal Sampling)

During this 4 month period, ♂♂ “Mokolo” and “Dua” spent a portion of their days together in the outdoor enclosure, separated from the ♀♀. They were normally released in the afternoon after the 3 ♀♀ — “Kenge”, “Kiri”, and “Kasai” — had been returned to the barn. The ♂♂ were observed for approximately 2 hours at weekly intervals for a total of 630 one-minute focal samples for each animal.

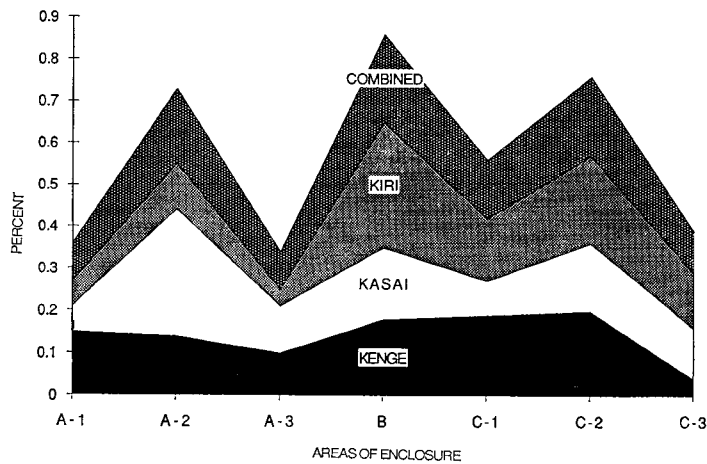


Fig. 4. Enclosure utilization for each ♀ okapi — “Kenge”, “Kasai”, and “Kiri” — when together in their outside enclosure for a 9 month period.

Their behavioral activities were: feeding on provided food, “Mokolo” (“Mo”) 7% and “Dua” (“Du”) 7%; foraging on natural vegetation, “Mo” 7% and “Du” 13%; locomoting, “Mo” 30% and “Du” 38%; standing, “Mo” 35% and “Du” 28%; interacting, “Mo” 11% and “Du” 12% and other behaviors, “Mo” 10% and “Du” 2%.

When the 2 ♂♂ entered the enclosure, after the ♀♀ had spent several hours there, they walked around the enclosure and scented the ground. Flehmen was often performed in response to their ground testing. While locomoting in the area, the older ♂, “Mokolo”, also performed 2 interesting behaviors termed “down-up” and “rear leg cross and urine dribble”. The first behavior accounted for 2.5% of his “other behaviors” and the second behavior accounted for 4.75%. During the downup behavior, “Mokolo” either began to sit down and then stood; or actually sat down, so as to be partially laying down, and then stood within a few seconds (Fig. 5). This behavior occurred in an area where a ♀ had previously eliminated, in an area where a ♀ had previously urinated and/or where “Mokolo” had urinated, and when approaching or being approached by another okapi or a human. This behavior was rarely performed by “Dua”. The rear leg cross and urine dribble occurred when “Mokolo” walked around the enclosure. This behavior was never observed being performed by “Dua”. During a later part of this study, when small bushes were present in a new okapi enclosure, “Mokolo” walked over the bushes to urinate in addition to the above behavior.

### Social Interactions

Allogrooming — licking the body surface of another individual — was the major social interaction among the okapi of the 3 groups (Fig. 6). 23% of the allogrooming behaviors in the group of 5 okapi were actually mutual allogrooming, 2 okapi grooming each other at the same time. In the group of 3 ♀♀, 10% of allogrooming was mutual and in the group of 2 ♂♂, it was 2%. The other interactions varied across groups.



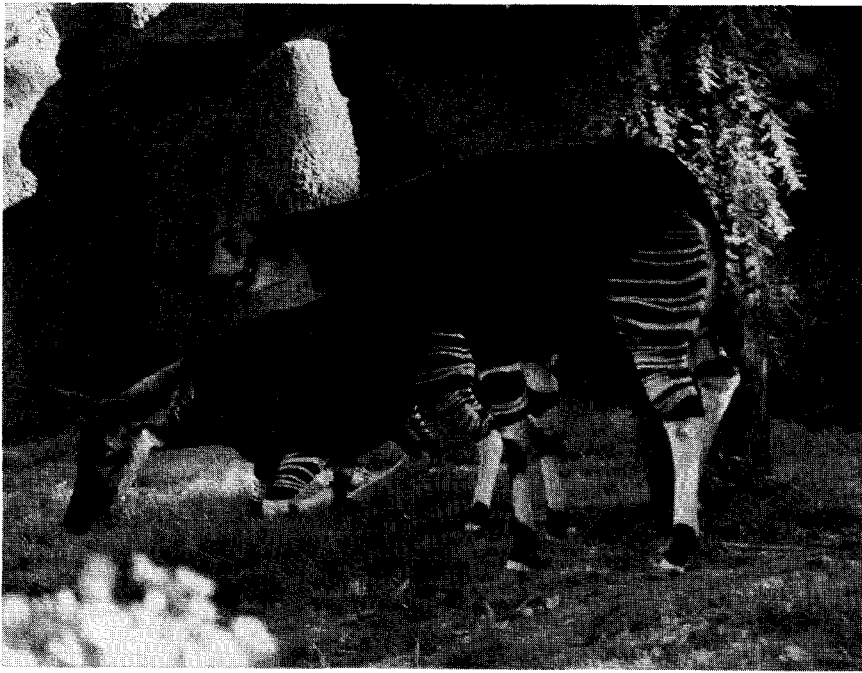


Fig. 5. The ♂ okapi ("Mokolo") performing his "down-up" behavior in response to a ♀ in the low-stretch posture.

60% of the interactions in the group of 3 ♀♀ (Group 2) was allogrooming, the majority of which were initiated by the oldest ♀ "*Kenge*" (Fig. 7). Most of their other interactions were initiated by "*Kasai*", the youngest ♀. These included a particular behavior called food sampling, in which the initiator reached up to touch the mouth of a feeding okapi, appearing to attempt to remove food from the recipient's mouth. Sometimes, 2 okapi approached each other and touched, and often licked, noses, a behavior which was distinguishable from food sampling.

The younger ♂, "*Dua*", was a major initiator of interactions when in the group of five okapi (Group 1), and also when together with only the older ♂, "*Mokolo*" (Group 3) (Fig. 7). Next to allogrooming, the second most frequent interaction of this pair was "butts", a behavior in which the initiator butted the body of the recipient with its head. Sometimes this appeared to be an invitation to be groomed. Another interesting behavior between the 2 ♂♂ also initiated by "*Dua*", and which increased in frequency over time, was naso-genital, where the initiator either licked, or butted and licked, or just butted the genital area of a ♂. Other behaviors between the 2 ♂♂ which showed an increase over time were rear foot kicking, where the initiator kicked his rear foot at the recipient, sometimes hitting its target; and naso-anal, where the initiator directed its muzzle to the anal region of the recipient and either poked and/or licked the area. It should also be noted that prior to the separation of the 2 ♂♂ in November, 1986, aggressive behaviors of butting with the horns, chasing, and mounting began to occur. "*Dua*" had reached sexual maturity.

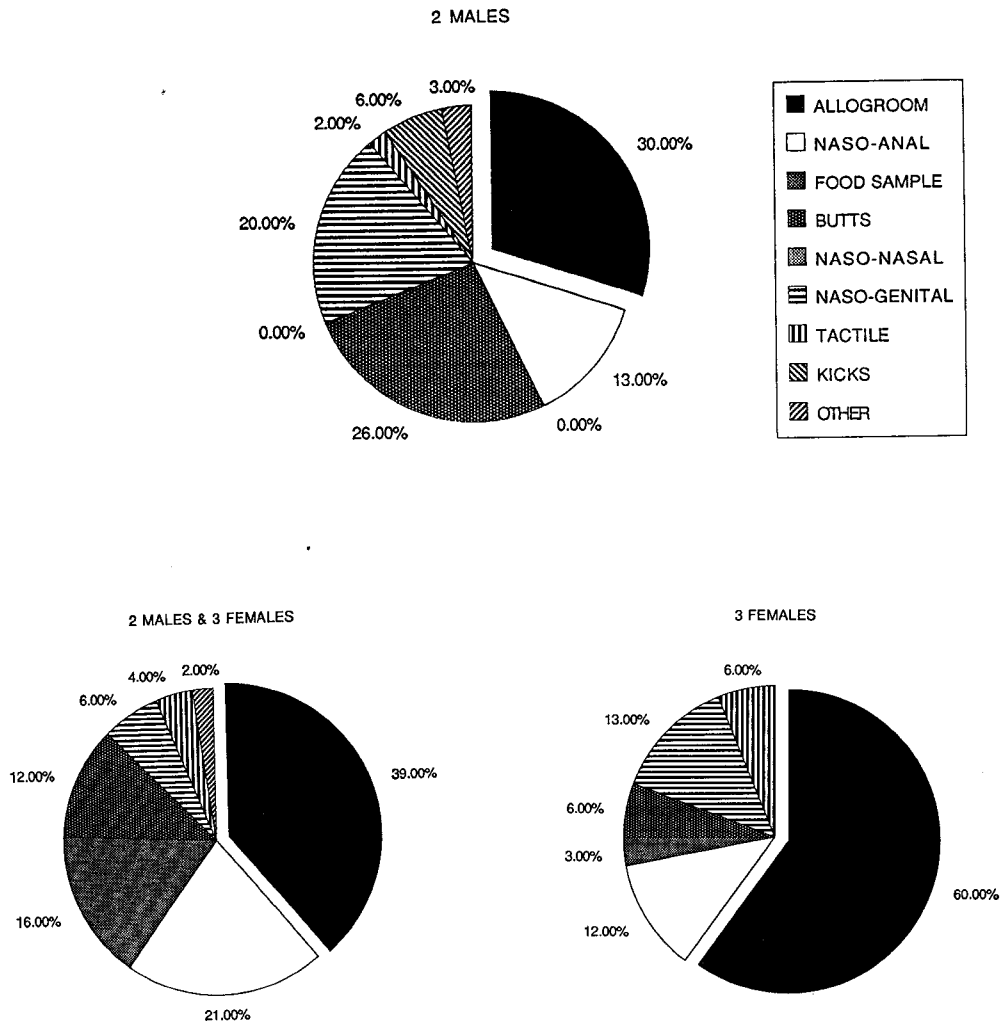


Fig. 6. Social interactions for 3 different okapi groups. Percent for each behavior is of the total number of social interactions for each group. Note: in the lower two graphs the area shaded as "naso-genital" should be shaded as "food sample".

### Mating Behavior

The "mating ceremony", in particular the various postures and displays of a breeding pair of okapi, has been aptly described by WALTHER (1960, 1984). The major exception observed in the pair at the Park was the posture of the foreleg kick performed by the ♂, or "Laufeinschlag". The ♂ at the Park consistently performed a foreknee kick with the leg bent rather than fully extended as observed by WALTHER (Fig. 8). The other postures and displays were consistent with his description, and thus were not emphasized during documentation of this research.

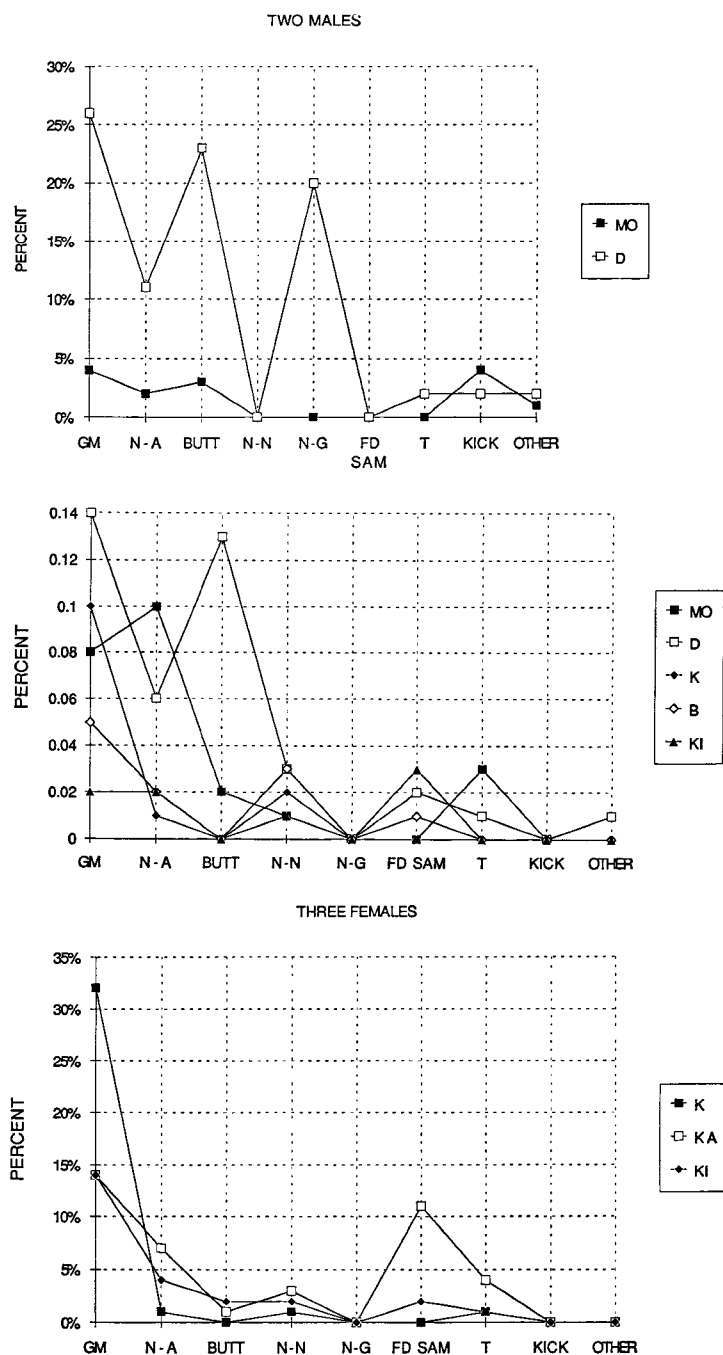


Fig. 7. Initiator for each social interaction for 3 different okapi groups. Percent for each behavior and each okapi is of the total number of social interactions for each group. Code: *Mo* — “Mokolo”; *D* — “Dua”; *K* — “Kenge”; *B* — “Bambasa”; *Ki* — “Kiri”; and *Ka* — “Kasai”.

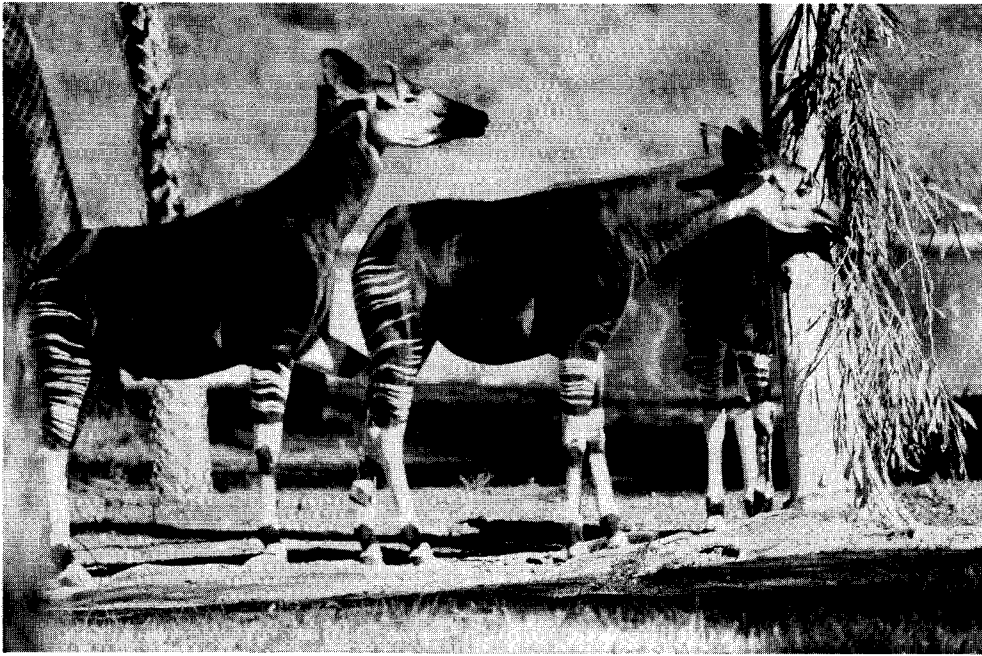


Fig. 8. ♂ okapi ("Mokolo") performing his foreknee kick to ♀ during the mating ceremony.

The mating behavior of the mature breeding pair at the Park ("Mokolo" and "Kenge") was observed during 3 different 2-day sessions: January 19 and 20, 1987; January 30 and 31, 1987; and August 22 and 23, 1988. The major sexual behaviors, for which all occurrences were documented during the one minute periods of the mating sessions, are shown in Fig. 9. The behaviors were: naso-anogenital testing; flehmen; the pair standing together with the ♂ pressed against the ♀'s rear performing foreknee kicks between her rear legs; the 2 locomoting together with the ♂ following the ♀ so maintaining contact with the ♀ in his raised-head posture (Fig. 8) or walking with his muzzle positioned to the ♀'s anogenital region, or walking a foot or more behind her; the ♀ performing naso-genital behavior to the ♂; the ♀ laying down in response to the ♂'s consistent foreknee kicks; and mounting and copulations.

A particularly interesting behavior during the mating ceremony, was the ♀ performing naso-genital to the ♂. The pair stood in reverse-parallel and the ♀ either licked or licked and butted the ♂'s genital area. The ♂ responded by moving around to stand and face her side, and then perform his foreknee kick to her flank. He worked his way around to her rear, continuing with foreknee kicks to her rear or between her rear legs. Another behavior during mating by a different pair at the Park was the emission of a low-intensity grunt or, "un-un" sound, by the ♂ when foreknee kicking while pressed against the ♀'s rear. This sound may have been emitted by "Mokolo" also, but just not heard by the researcher.

Figure 10 shows the number of times the ♂ mounted the ♀ during each hour of the day that the pair was together and mating. All occurrences of mounting were documented during each hour of observation.

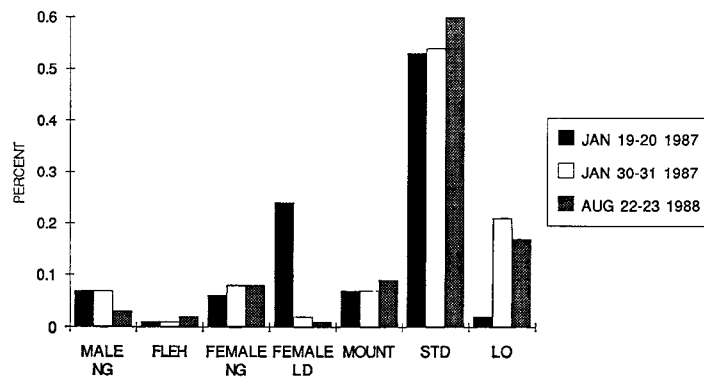


Fig. 9. Mating behaviors during each of 3 2 day sessions for "Mokolo" and "Kenge". Each behavior is the percent of the total number of mating behaviors for each 2-day session.

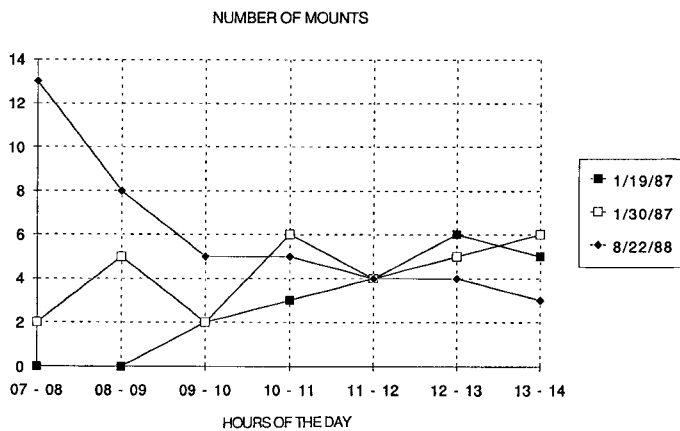
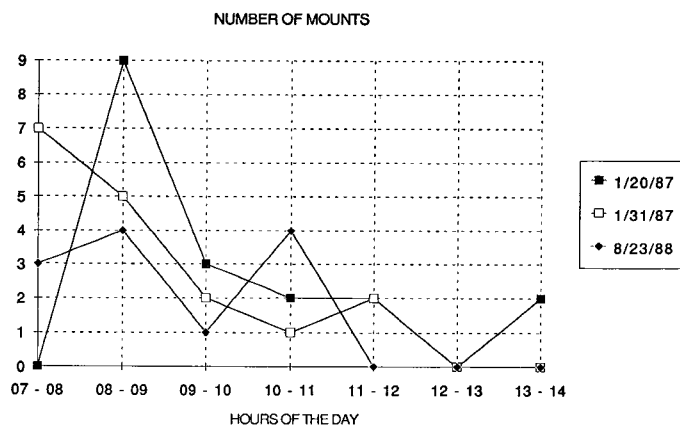


Fig. 10. The total number of times "Mokolo" mounted "Kenge" during each hour of each day of each 2-day mating sessions.

The ♀, “Kenge”, on whom the documentation was made, cycled every 11 to 13 days. At the time of this writing, she and her mate, “Mokolo”, had successfully bred and produced 5 offspring: one ♂ and 4 ♀♀. (Note: Their latest offspring, a ♀, was born 20 October 1989. Conception would have occurred in the noted breeding in this paper of 22 and 23 August 1988.)

#### Other Sexual Behavior

The ♂ and ♀ resumed their normal activities when together and not engaged in the mating ceremony. Their general behavioral patterns during the time between the 2 observed matings in January are shown in Table 3. The major sexual interest displayed by the ♂ towards the ♀ during this period was naso-anogenital testing and flehmen, which occurred one or more times a day.

Table 3. The percent of behaviors for “Kenge” and “Mokolo” during 2, 2 day periods of mating compared to 5 days inbetween when mating did not occur

Dates	Jan. 21, 26, 27, 28 & 29		Jan 19 & 20		Jan 30 & 31	
No of one min. periods	580		450		550	
Behavior	“K”	“Mo”	“K”	“Mo”	“K”	“Mo”
Feeding	14%	27%			2%	
Standing	62%	44%				
Locomoting	12%	13%				
Interacting	8%	5%				
Mating Beh.			100%	100%	98%	100%
Other	4%	11%				

See text for information on mating behavior.

On occasion, when the ♂ was together with any one of the ♀♀, a ♀ performed naso-genital to the ♂, sometimes butting only at the area with her muzzle. This behavior was performed particularly by a ♀ who was thought not to be cycling and/or an immature ♀. If the ♂ persisted in sexual behaviors, especially foreknee kicks, the ♀ either butted the ♂, kicked her rear foot towards him, ran from him, or sat and eventually laid down. The final posture displayed by the ♀ if he persisted was the “play dead” position. In this position, the ♀ laid down on her side with her head and neck stretched forward and her legs extended out from her body flat against the ground. See Fig. 11. (Note: the first time I saw this behavior I panicked because I thought the ♀ really was dead, thus, I termed it the “play dead” position.)

When a ♀ laid down in response to a ♂, the ♂ scraped her flank or back with the side of his forefoot or kicked her with his foot. If the ♀ moved her head into the nose-up posture the ♂ hit her neck with his foreknee or butted it with his head. When she moved into the “play dead” position, the ♂ either continued his body scrapes, or, more often, discontinued contact with her until she returned to a sitting position or stood.

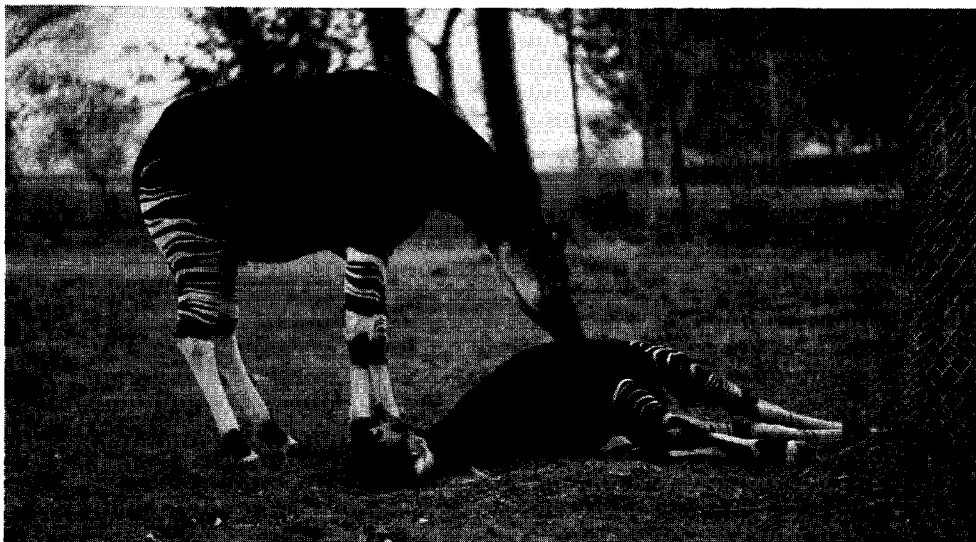


Fig. 11. ♀ okapi laid down on her side in response to the ♂ in the position termed "play dead".

### Development

Each of 2 ♀♀ calves ("*Kasai*", born May 22, 1986 and "*Katanda*", born April 24, 1988) was observed 2 days each week during their 2, 3, and 4. weeks of life. Study of their development began in their second week when each was released into the large outdoor enclosure with her dam, "*Kenge*". The calves and dam spent approximately 4 hours each day in the exhibit. During this time, 79% of each calf's observed hours was spent in Areas A-2 and A-3. These 2 areas were those closest to the barn and the gate which led into it. Also in Area A-2, near A-3, was the poled area at the fenceline (Fig. 1). Young okapi spent much of their time in this location while in the enclosure.

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Table 4 shows the general activity patterns of "*Katanda*" during her 3 week period. Her behavior was chosen to demonstrate these activities because the focal sampling method produces more detail. However, 87% of each calf's total interactions with her dam was allogrooming, initiated by the dam. This behavior included licking the anogenital region (Fig. 12). In fact, the dam had a tendency to overgroom this area of her calf, thus a coat was designed for the calf to prevent rectal injury from the dam's tongue (Fig. 13).

The duration of time each calf spent lying down and nursing was measured. During week 2 "*Kasai*" laid down for a 5 min period one day and a 10 min period the second

Table 4. Percent of total activity spent in the major behaviors by "Katanda" during her first month of life across hours she was in the outside enclosure with her dam. Also, percent of time she spent together in same immediate area with her dam or separated from her

Hours Behavior	800—900	900—1000	1000—1100	1100—1200
Nurses	4%	3%	3%	2%
Lies Down	2%	—	—	6%
Stands	41%	39%	42%	45%
Walks	41%	42%	39%	35%
Runs & Stomps	8%	8%	3%	3%
Interacts	4%	8%	13%	9%
Together with Dam	47%	63%	46%	62%
Separate from Dam	53%	37%	54%	38%



Fig. 12. ♀ okapi allogrooming the rear of her offspring.





Fig. 13. Infant okapi wearing a specially designed coat to discourage her dam from overgrooming her rear (anogenital region) and biting her tail.

day. During week 3, she laid down for a duration of 40 min each of the 2 days. The areas she chose to lay down were in the poled section or next to a tree a few yards from the poles. "*Katanda*" laid down each of 2 days during her second week, one day for 6 min and 10 min and the second day for 10 min. She laid down at the fence line between the gate and poled section. She was not seen laying down during her next 2 weeks. According to the okapi keepers, both calves were found lying down in their barn stalls, usually in a corner, during other hours of the day.

A nursing bout occurred when a calf was in nipple contact with its dam and suckling was seen. If a calf took a short break, but resumed nipple contact within a few seconds, it was considered to be a part of the same nursing bout. The average duration of nursing bouts for each calf in each of the 3 weeks were: Week 2 — "*Katanda*" 3 min 20 sec (Range: 2 min 20 sec — 5 min); "*Kasai*" 2 min 30 sec (Range: 1 min — 6 min); Week 3 — "*Katanda*" 3 min 20 sec (Range: 1 min 40 sec — 5 min); and "*Kasai*" 4 min (Range: 1 min — 5 min); and Week 4 — "*Katanda*" 3 min (Range: 1 min 20 sec —

4 min 30 sec) and "*Kasai*" 5 min (Range: 4 min — 6 min). In addition to this information, nursing durations were documented for a ♂ calf ("*Kivu*", born March 7, 1989) during his first month of life and for a 3. ♀ calf ("*Kabinda*", born May 29, 1989) during her second month of life. Nursing data, averaged each week for the ♂ and the ♀♀ is shown in Fig. 14a. Nursing data for a 9 month period for "*Kasai*" is shown in Fig. 14b.

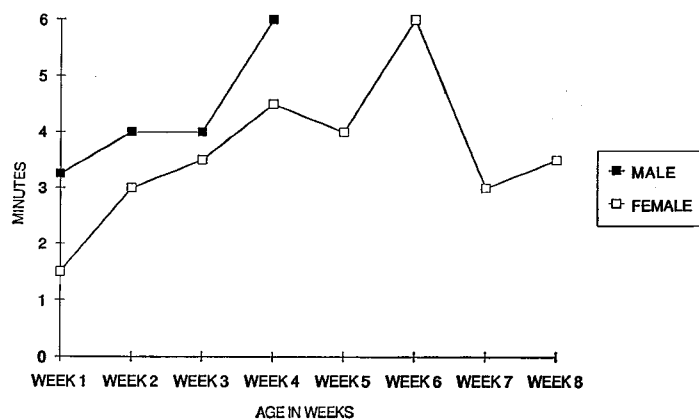


Fig. 14a. The average duration in minutes of nursing bouts for a ♂ and for 2 female okapis during each week they were observed.

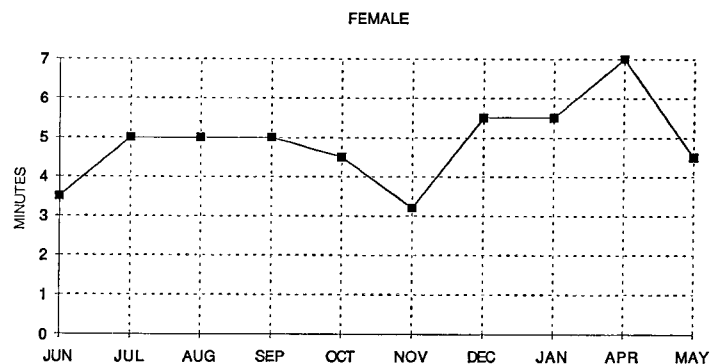


Fig. 14b. The average duration in minutes of nursing bouts for a ♀ okapi, "*Kasai*", during each of 9 months that she was observed. This began with her first month of life.

## Discussion

This study was conducted in a zoological park on 3 different groups of okapi. Each group shared a relatively large outdoor enclosure; thus, the animals could choose to be together or separate. Because the ambient temperatures of southern California are mild, the okapi at the Park were outside during all months of the year. The only times they were kept inside were during those few days of inclement weather. This unique environment for captive animals may shed new light on okapi behavior.

### General Behavior Patterns and Space Utilization

Each of the 3 groups of okapi was studied during varying periods of time, depending on the composition of the group on exhibit. However, the consistently predominant

behaviors of each group were: standing, locomoting, feeding on provided food, foraging on natural vegetation, and interacting.

Group 1 and Group 2 were studied throughout the major hours they were outside together, 700–1400. The animals of each group usually ate their provided food with one or more other members of their group, and most frequently during the period 700–900. (It should be noted that their provided food was placed in the enclosure just prior to the animals' release from the barn at 700.) Correspondingly, in the wild, a peak in feeding occurs during mid-morning (HART & HART 1988). Although the okapi were fed a special diet, they locomoted and foraged on natural vegetation throughout the day, activities in which freeranging okapi also engage throughout the daylight hours (HART & HART 1988). Thus, captive okapi residing in a large enclosure which contained natural vegetation were able to engage in this natural daily activity cycle. When the animals foraged, they sometimes did so together, especially when one animal found a fallen branch or secured a branch from one of their trees. This appeared to be a stimulus for others to join in the find. The animals usually locomoted alone, except when a calf followed its dam or during mating. When moving from one area to another, the okapi often did so along well-worn paths (SCHWANKL & BERG 1988). This behavior has also been noted as occurring in the wild (GRZIMEK 1990). When the animals stood and rested, they usually did so separated from each other, shaded at the fenceline or next to a tree. Similarly, free-ranging okapi were not found in areas removed from cover (HART & HART 1988). It can be concluded, therefore, that designing enclosures to include components that replicate the okapis' natural environment, especially having densely treed areas, is an important consideration for captivity.

The okapi utilized all areas of their enclosure. Area B was used more often than the other areas by the members of Group 1, except for "*Kenge*" who spent more time in C-1. Area B contained their provided food, drinker, and an area of three fenced trees from which they obtained shade and often licked and also secured bark. The other areas were more evenly utilized by all members of this group. Areas A-2 and A-3 were utilized more often by the young ♀ of Group 2, "*Kasai*", than the others of her group. In addition to these areas being closest to the barn, Area A-2, contained a cut-out section of thin poles at the fenceline, where immature okapi, especially, spent much of their day (see Fig. 1). A former keeper at the Park, BARBARA SCHWANKL (personal communication), stated that of the 5 okapi calves she worked with, each one chose this area to "tuck". This poled section may have fulfilled the young animals' instinct to hide in a heavily treed area, a behavior which occurs in the wild, especially during the early days of a calf's life when separated from its dam (GRZIMEK 1972, SPINAGE 1968). Having a quiet secure area for baby okapi to rest and hide is an important consideration for captivity. The 2 mature okapi of Group 2 spent more time in the C-areas, on the opposite side of the enclosure from most of the human activities and where more natural vegetation occurred over the fenceline, than the immature ♀. The animals rarely stood for extended periods of time in open areas that were closest to the monorail track.

### Interactions

The okapi is said to be primarily a solitary species. During a long term study performed on free-ranging okapi, in only 10% of the observations, were 2 animals found together (HART & HART 1988). The okapi pairs from that study included either dams

and calves or adult ♂♂ and adult ♀♀. A second, shorter term study on free-ranging okapi documented their hoof prints. These results showed that okapi associations consisted of a loose family group of adults, juvenile, and calf (BODMER & GUBISTA 1988). Thus, there is still some question as to the composition of the okapi's social structure. It was not stated in either study, if and what interactions occurred during the associations of these different groups.

Although the okapi in the current study did not engage in as many interactions as a gregarious social species they did interact more than might be expected of a truly solitary one. Biological relationships in each of the 3 different groups may have influenced their interactions. "Mokolo" sired the ♂ of Group 1 and Group 3 ("Dua") and the 2 younger ♀♀ of Group 1 ("Bambasa" and "Kiri"). "Kenge" was the dam of the youngest ♀ of Group 1 ("Kiri") and the 2 ♀♀ of Group 2 ("Kiri" and "Kasai").

Group 1 interacted during 16% of their behaviors, Group 2 interacted during 13% of their behaviors and Group 3 interacted during 12% of their behaviors. The ♂♂, especially "Dua", initiated the majority of interactions when together with the 3 ♀♀. "Dua" was also the prime initiator of interactions when together with only "Mokolo". "Kenge" was the major initiator of allogrooming when together with the 2 ♀♀, whereas "Kasai", the youngest animal, initiated most of the other interactions. This included a behavior termed food-sampling in which an okapi appeared to attempt to remove food from the other animal's mouth. Because "Kasai" was the youngest okapi of the group and her initiation of this behavior increased over time, this may be an indicator of one way a young okapi learns what to eat in the wild.

The interaction which occurred most often between members of the 3 groups of animals was allogrooming. This was also the major interaction during the first month of life for 2 different babies when together with their dam. In the latter case, the principal target of the behavior was the anogenital area. According to WALTHER (1984), young who are considered to be of the "lying-out" (or hider) species, as opposed to "followers", have their anal and genital areas intensely licked by the dam. The okapi is said to be a hider (GRZIMEK 1972, HORWICH et al. 1983, RABB 1978). This behavior may be a stimulus to encourage elimination because the baby is immobile for much of its early days. It may also be, as suggested by BENIRSCHKE (WARHOL & BENIRSCHKE 1986), an area targeted by the dam in which her own immune system obtains information on possible intestinal problems of the calf. If there is a problem, the dam's physiological system responds by producing antibodies which she delivers to her calf through her milk (WARHOL & BENIRSCHKE 1986).

The benefit of allogrooming, in general, is the removal of parasites from hard to reach areas, such as the ears. The okapi does have a long tongue and is able to reach almost all areas of their body by themselves. In fact, when documented over a 9 month period, they spent about 25% of their standing behaviors engaged in self-grooming. However, licking their own ears, the top of their head and the back of their neck present some problems. During allogrooming in the okapi, all areas of the body are targeted, but these areas seem to be 3 of the main ones. In addition to serving to remove parasites, another explanation for allogrooming may be the establishment or reestablishment of social bonds, as has been shown to occur in other ungulate species (WALTHER 1984). In this study, the major initiator of allogrooming was "Kenge", when together with her offspring, "Kiri" and "Kasai". When the 2 ♂♂ were together, "Dua" initiated this behavior most often with his sire, "Mokolo". In this case, the behavior may have

been an appeasement by the subordinate male to a dominant one, as suggested by WALTHER (1984) when discussing other ungulate species. Whatever its purpose, the okapi appeared receptive to this behavior, which they indicated by lowering their heads when being groomed or turning their heads or bodies to expose areas for the groomer. That this behavior was such a major part of the social interactions in 3 different groupings of animals at the Park, would seem to indicate that it must also be a part of this species' natural behavioral repertoire in their free-living state.

Their other interactions of naso-anal, naso-anogenital and flehmen, naso-nasal, and tactile were more typical of other ungulate species. Although head butting could be an aggressive behavior, it also occurred as an invitation to be groomed. Kicking backward with the rear foot appeared to be an attempt to stop contact by, or separate from, an animal who had approached from the rear. One of the more interesting interactions was naso-genital with a ♂ as the target animal. This behavior had many characteristics similar to nursing; the initiator usually butted the ♂'s genital area as it would a ♀'s utter during a regular nursing bout. Thus, in the contexts it was performed, it could be considered a submissive behavior. Another submissive behavior was the "play dead" position performed by a ♀ when being "harassed" by a ♂.

2 particularly interesting behaviors performed by the dominant ♂, "*Mokolo*", were "down-up" and "rear-leg-cross and urine dribble". WALTHER (1984) described a behavior observed by LANG in Epulu in which okapi ♂♂ marked bushes with urine, almost lying down in the process. "*Mokolo's*" 2 behaviors may have been tantamount to this natural marking behavior when bushes weren't present. More recently, when "*Mokolo*" spent time in a different enclosure which contained low bushes, he was observed walking over them and urinating. However, he still performed both the above behaviors in the contexts described in the Results Section. There are at least 2 questions which arise from "*Mokolo's*" "down-up" behavior. Does the ♂ impregnate his body with urine when lying down, as occurs in some other ungulate species? Is the "down-up" behavior a display of conflict between aggression and submission? There is still much to be learned about this elusive species.

The intensity of the mating ceremony which occurred between "*Mokolo*" and "*Kenge*", during approximately 2 days, was a good indication of the length of "*Kenge's*" receptive period. After this period of intensity, they each resumed their normal daily cycle with the major sexual interest being naso-anogenital and flehmen. This continuous mating behavior over approximately a 2 day period may be an indicator of that which occurs in the wild because the ♂ and ♀ are said to come together infrequently. The results of "*Mokolo*" and "*Kenge's*" mating behavior during the past 9 years has been 5 successful offspring.

Residing in a relatively large outdoor captive facility which replicates components of the okapi's natural environment, the animals at the Park have exhibited some interesting behavioral characteristics. Due to the zero mortality rate of neonates at the Park, it is hoped that information from this study can be used by other captive facilities to provide the best possible environment for this species. The details of free-ranging okapi behavior, especially social interactions, are not yet known, but we hope that one day comparisons between the 2 states can be made. In the meantime, there is still much to be learned about okapi behavior. The ongoing project at the Park will continue to shed new light on the various details of behavior, especially communication, of this fascinating species, the okapi.

### Acknowledgements

I am grateful to BARBARA SCHWANKL, LANCE AUBERY, RICH MASSENA, MIKE MOORING and RANDY RIECHES for reviewing and commenting on drafts of this paper. I thank DAVID BERG for his editing assistance. I extend my gratitude to Dr. JAMES DOLAN and LAWRENCE KILLMAR for encouraging me to conduct my research at the Park and to the Lead Keepers LANCE AUBERY, ANDY BLUE, DAVID GONZALES and SHARON JOSEPHS, plus all the Field Keepers who worked with the okapi, for their cooperation and assistance during different phases of this research project. I thank CALLIE MACK for the illustration. Last, but not least, I extend a special thanks to the okapi for allowing me to enter their secret world.

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