

REPORT II

**BEHAVIOR OF THE BARASINGHA DEER (CERVUS DUVAUCELI) AT
THE SAN DIEGO WILD ANIMAL PARK**

By

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and
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We wish to acknowledge with great appreciation

DAVID I BERG

Volunteer Data Base Consultant and Editor for this project

We thank Lawrence Killmar, SSP Coordinator for barasingha deer, for initiating this project. We also thank the Field Keepers for their input on the deer and their friendship and cooperation throughout the years. We extend a special thank you to Informix Software, Inc. for the use of their graphics software, WINGZ. Last, but not least, we thank the barasingha for the hours of enjoyment that they provided us during this project.

INTRODUCTION

This is the second report on the behavior of the barasingha deer (*Cervus duvauceli*) based on a project conducted at the San Diego Wild Animal Park in San Pasqual, California. This study began November 1987 and continued through March 1990. The first report (Berg, 1988), covered the stags' behavior during the 1987-1988 rut and the activity patterns of the entire herd during the same four months - November, December, January and February.

This current report covers the stags' behavior during the next two ruts of 1988-1989 and 1989-1990 for the same four month period as the prior rut. Also covered in this report is the space utilization and activity patterns of the entire herd during the four months of each of the two ruts plus the eight months in between - post rut: March, April, May and June; and preliminary rut (& fawning): July, August, September and October, 1989.

There will be an addendum to this report covering the results from the data collected on the fawns born during 1988 and 1989, which will be included in a manuscript for this entire project to be submitted for publication during 1992.

The major purpose of this project was to gather information on breeding behavior of barasingha living within a herd structure in a large captive environment. The results of this research will add quantified detail to our knowledge of the behavior of this endangered species, which may be comparable to what is known of their behavior in the free-living state (Martin, 1975; Schaaf, 1979; Schaller, 1967; and Walther, 1984).

The information from this project is intended to assist in the management of this species. Therefore, input from the members of the SSP Committee and others who read this report will be greatly appreciated. Please send your comments to the senior author whose address is on the front of this report.

METHODOLOGY

Setting and Subjects

The Barasingha deer resided in a 25 ha mixed-species exhibit at the San Diego Wild Animal Park (see Figure 1). This enclosure had sloped banks leading to a stream bed and two ponds in the center. There were natural rocky outcroppings and vegetation plus introduced species of trees and grasses. Other animal species which also resided in this exhibit were: *Cervus elephus*, *Cervus axis*, *Cervus nippon*, *Cervus timorensis*, *Antelope cervicapra*, *Ovis ammon*, *Bos gaurus*, *Rhinoceros unicornis*, *Gazella subquitturosa*, *Saiga tatarica*, and *Boselaphus traqocamelus*.

The general composition of the Barasingha herd at the beginning of each of the recorded ruts is shown in Table 1. The deer were recognized using the ear-notch numbering system which is the identification system used at the Park.

Procedure

Three sets of data were documented during this project using the following sampling methods: scan sampling of the entire herd, focal animal sampling of stags, and focal animal sampling of fawns. This project began in November 1987 and continued through March 1990. Periodic observations continued from March until November 1990.

Scan Sampling. The general behavior and location of the entire herd of Barasingha were scanned at the beginning of each hour of observation. The hours scanned were: 0600 through 1000 for November through February, each rut; 1400 through 1600 for the 1988-1989 rut and 1400 through 1700 for the 1989-1990 rut; 0600 through 0900 for March through October; and 1600 through 1800 for March through June and 1600 through 1900 for July through October. The information documented for each scan included the number of deer per group and their location in the exhibit (see Figure 1), plus the number of deer in each group engaged in each of six general activity categories: feeding on provided food, grazing, lying down, locomoting, standing, and interacting. The first observed behavior was the one documented. Each scan lasted approximately 10 minutes. Also recorded in each scan was with which group the stags and fawns were located.

Data Analysis. The data analyzed included the percent of the total number of deer found in each area of the enclosure for: Ruts - November, December, January and February 1988-1989 and 1989-1990 -, and the 1989 months between ruts: Post Rut - March, April, May and June; and Preliminary Rut (and Fawning) - July, August, September and October. The am locations and the pm locations were analyzed separately for each of these four month groupings. The total number of scans analyzed for this report was 864. There was an average of 27 scans (range 21 to 31) per hour of observation for each of the four month periods. The analysis for the general behavioral patterns for the herd included the percent of the total number of deer involved in each behavior during each hour of observation for each four month grouping.

Focal Animal Sampling-Stags. Documentation of the stags' behavior began during the peak of their rut, November, which was the period during which mating was first observed, and continued through February. During June (beginning with the first birth) through October, documentation emphasized the fawns' behavior. However, general notes were made if any rutting behaviors were seen during this period.

The stags' behaviors for each of the two ruts were documented at weekly intervals during the hours 0600 to 1000 and 1400 to 1700 during November and December; 0700 to 1000 and 1400 to 1700 during January; and 0700 to 1000 and 1400 to 1800 during February.

The behaviors described in Table 2 were documented onto prepared data sheets (see attached data sheet). All occurrences of these behaviors were scored during each minute of a continuous 15 minute period of each hour of observation for each of the two mature stags (two 2-year-olds) throughout the four months of the 1988-1989 rut. The starting animal was alternated each day.

Documenting each of two stags for a continuous 15 minute period during each hour of observation continued during the 1989-1990 rut when there were seven mature stags (two 3-year-olds and five 2-year-olds). To reduce individual sampling bias, the two stags to be documented each day were randomly chosen by each observer who dropped the numbers of all seven stags into a container, then drew out two numbers which then became the focal animals for that day. On the next day of observation, two of the remaining five numbers were chosen, and so forth each day until every stag had been chosen. Then the procedure started over again.

Data Analysis. The documented behaviors were lumped into categories as shown in Table 2: Feeds, Rests, Locomotes, Stands, Individual Rut Behaviors, Stag-Stag Behaviors, Stag-Hind Behaviors, and Other. The percent of the total number of behaviors for each category each month for both am and pm was analyzed separately for stags #84 and #85 during the 1988- 1989 rut. The total number of 15 minute periods analyzed for Stags #84 and #85 was 584 (292 for each stag). The average for each month was 40 am periods (range 36 to 43) and 33 pm periods (Range 22 to 40). The percent of the total number of behaviors for each category and each two month grouping (November & December, and January & February) for both am and pm was analyzed separately for each of the six stags, #85, #89, #91, #94, #95, and #99, for the 1989-1990 rut. Because stag #84 was removed in January 1990, only his November and December behaviors were analyzed. The total number of 15 minute periods

analyzed for all seven stags was 618. The average number of 15 minute periods for each stag during each two month period was: November & December (seven stags): 20 am periods (range 17 to 23) and 22 pm periods (range 18 to 27); and January & February (six stags): 24 am periods (range 21 to 27) and 30 pm periods (range 27 to 33).

Also included in the analysis is a breakdown comparing the stag-stag behaviors and the stag-hind behaviors for the two rutting periods. A further breakdown was made of the percent that each stag engaged in the total sparring matches for each two month grouping during the second rut. (Statistical analysis may be included in the publication.)

Focal Animal Sampling - Fawns. Details on this portion of the project and descriptions of the documented behaviors will be given in the addendum to this report. (See attached data sheet).

TABLE 1. Herd composition at the beginning of each rut.

1988-1989 RUT

2	Mature Stags	(born 1986)
5	Yearling Stags	(born 1987)
3	Male Fawns	(born 1988)
21	Mature Hinds	(born 1974 to 1987)
5	Yearling Hinds	(born 1987)
3	Female Fawns	(born 1988)

39 Deer

1989-1990 RUT

7	Mature Stags	(born 1986 and 1987)
3	Yearling Stags	(born 1988)
2	Male Fawns	(born 1989)
26	Mature Hinds	(born 1974 to 1988)
3	Yearling Hinds	(born 1988)
5	Female Fawns	(born 1989)
3	Mature Hinds	(born 1982 to 1988)]_ Introduced into herd
2	Yearling Hinds	(born 1988)]/ Spring of 1989.

51 Deer

TABLE 2. Documented Behavior Definitions for Stags.

GENERAL INDIVIDUAL BEHAVIORS:

FEEDS.

Feeds on Provided Food. An animal reaches for, chews and ingests food provided for them such as hay, pellets, branches and mineral block. Also includes drinking.

Grazes. An animal reaches for, chews and ingests natural grasses growing in the enclosure.
Ruminates. An animal chews its cud.

RESTS.

Lies Down. An animal rests in a reclining position. The eyes may be open or closed and behaviors such as self-grooming, scratching, ear flicking or other body and appendage movements may be performed in addition to ruminating.

LOCOMOTES.

Locomotes. Animal moves in the form of walking or running.

STANDS.

Stands. An animal is inactive while remaining in one place. The animal may perform behaviors listed with "Lies Down". Standing may also be interspersed with locomoting.

RUTTING BEHAVIORS. (See more detail in Results Section.)

INDIVIDUAL RUT BEHAVIORS.

Bugles. Rutting vocalization of the stags.

Wallows. An animal moves its body, head and antlers against the ground while lying down in water or a muddy depression.

Thrashes. Stag jabs the antlers against the ground or an inanimate object.

STAG-STAG BEHAVIOR.

Kicks. Animal raises a foreleg making a striking movement towards an opponent with its hooves.

Head-up. Stag approaches a second stag with his neck raised and nose pointing skyward.

Lowers antlers. Stag lowers his head presenting his antlers towards a second stag.

Spars. A pushing match between two stags while in a frontal position. The stags join their antlers while twisting their heads and necks.

Chases. Stag pursues another stag by running behind him over a distance of several meters.

Moves away. A Stag engaged in a sparring match turns and walks or runs away.

STAG-HIND BEHAVIOR.

Head-up. Stag approaches a hind with his neck raised and nose pointing skyward.

Low Stretch. Stag approaches a hind with his head lowered and neck extended lateral to the ground.

Naso-anogenital. Stag directs his muzzle to the anogenital region of the hind and scents, licks or pokes the area.

Flehmen. Stag directs his muzzle into a hind's anogenital region, fresh urine flow, or urine on the ground. He then raises his head and curls his lip.

Drives. A stag pokes a hind with his muzzle and tries to push her forward. If the hind attempts to retreat, he moves around her, usually in a low stretch posture, intercepting her movements.

Follows or Chases. Stag walks or runs behind a hind thus pursuing her. May be preceded by driving behavior.

Tongue Flicks. Stag flicks his tongue in and out of his mouth usually preceding an approach to a hind followed by behaviors of anogenital testing, courtship and mating behavior.

Mounts. Stag stands on his rear legs and straddles a hind's back with his forelegs while laying his head and neck along her back.

Copulation. Stag mounts a hind and makes distinct thrusting movements.

OTHER

Allogrooms. Animal licks the body, head or appendages of another animal.

Butts. Animal directs its head or antlers to the body of another animal (usually the flank or rear)

Naso-Nasal. One animal approaches a second animal and either touches noses (sometimes licking area) or attempts to do so.

Vocalizations. Any sounds emitted by the deer other than the bugle.

Eliminations. An animal defecates or urinates.

Interspecies Aggression. Behaviors occurring in the stag-stag category but directed towards another species.

Other. Behaviors not listed above which were then described on the data sheets by the observers. This is how tongue flicks became a part of our documentation. Another behavior which was seen on occasion was a stag rubbing the sides of his face, neck and antlers against an inanimate object (possibly marking with preorbital gland). This category will be looked at more closely for the publication.

Behaviors documented for the hind and fawn relationship will be described in the addendum to this report. (See attached data sheet).

RESULTS

The results are presented with the following organization:

- Space Utilization and Behavioral Patterns of the Barasingha Herd (using scan sampling).
- Information on and Descriptions of Rutting Behaviors.
- Stag Behavior (using focal animal sampling).
 - Stag-Stag Interactions
 - Stag-Hind Interactions
 - Other Behavior
- Breeding Information
- Hind-Fawn Behavior

SPACE UTILIZATION AND BEHAVIORAL PATTERNS OF THE BARASINGHA HERD

Space Utilization.

The deer were first observed in the morning at 0600 or 0630, depending on the time of the year. During each of the four month periods, an average of 93% (range: 90% to 97%) of the deer were found in sections of the enclosure near where the four areas intersected (A,B,C, and D) (see Figure 1). Specifically, they were located in the stream bed of B and D (SB2), D-1, C-3, and A-3 (see Figures 2 & 3). There was more of a distribution of deer across these four areas during the two ruts than during the other months of the year. The major difference when comparing the data over these four month periods was that fewer deer were found in Section A-3 during the 1988-1989 rut compared to the other months.

The stream bed (SB2) was the preferred location of 50% of the deer at 0600 during the months of post rut and preliminary rut (see Figure 4). This was also the area to where the majority of the deer moved before laying down at the end of their morning activities. The exception to this occurred during the 1989-1990 rut (see Figure 2). This stream bed location extended out from a small pond so that water sometimes flowed through the area. Therefore, the ground could either be moist and mushy or dry and sandy. This type of terrain was similar to that which occurs in some of the habitats of their free-living relatives (Schaller, 1967). Also in this area were grasses and other low vegetation for grazing, feeders for their provided food, mineral blocks, a natural salt lick, and a drinker. This was a place where, in addition to performing their activities, the animals could lie down and rest either on the soft barren ground or on a bed of grasses, while remaining in the open, tucked next to the bank, or in a ravine. During rut, this location provided some good wallows for the stags. Although other species came into this area, it seemed to be primarily adopted by the Barasingha.

The graphic displays illustrate the deer's movements throughout the morning hours (see Figures 2 & 3). The major movements in the morning were into those areas which provided grass for grazing. In the wild, barasingha consume grasses almost exclusively (Schaller, 1967). The herd also moved to other feeders, especially if another larger species invaded theirs. Other movements across the enclosure occurred during interactions, particularly during rut.

By the first afternoon observation, which occurred between 1400 and 1600 depending on the time of the year, a migration had occurred. The deer had moved from the middle sections of the enclosure towards the front, particularly the sections of A1 and A2. These sections were nearer the larger pond which offered the advantage of breezes blowing off the water, thus providing cool places for resting.

Then as the deer rose and began their late afternoon and evening cycle, they primarily grazed while slowly moving back towards the mid-sections and stream bed.

The major difference when comparing the afternoon space utilization of the deer across the four month time periods was that during the months of preliminary rut (& fawning), more deer utilized the C-sections, particularly C-2, than during the other times of the year. One reason for this difference is that these particular four months have the highest ambient daytime temperatures at the Park. This C-2 section contains ravines and gullies which lead to another stream bed, and thus provides cool places to rest. When the animals rose, the embankments provided abundant grasses for grazing. These areas also contained some of the hiding places where fawns were tucked for the first few days after their birth.

Behavioral Patterns

Scans of the barasingha herd engaged in each of six behavioral categories over the four month periods revealed a general pattern (see Figures 4, 5, & 6). After sunrise, the deer began to rise then move around in their enclosure, particularly while grazing and feeding. Then after three or four hours of activity, they again laid down to rest until late afternoon when once again they resumed their activities. This trend is similar to what occurs in a free-living barasingha herd (Schaller, 1964).

Specifically, at first observation (0600 or 0630) during the months of rut and preliminary rut, an average of 67% (range 62 to 71%) of the deer were lying down. The exception occurred during post rut when only 41% were lying down at this early hour and 32% were already up and grazing. In fact, during the months of post rut, more grazing occurred throughout the morning hours than during the mornings of all other times of the year. Then by 0800 during the months of the two ruts and post rut, only an average of 8% (range 5 to 12%) of the deer were resting whereas the remainder were engaged in the various activities. Also at this hour, there was a peak in eating their provided food. Then by 0900 (post and preliminary rut) or 1000 (ruts), an average of 67% (Range 60 to 78%) of the deer once again began to lay down.

During the first observation (1400 or 1600) of the afternoon for all four month periods, an average of 64% (range 52 to 69%) of the deer were lying down. Then an hour or two before sunset, the deer were primarily up and resuming their activities. The major activity was grazing. An average of 41% (range 31 to 53%) of the herd was engaged in this behavior during the last observation prior to sunset (see Figures 5 and 6).

RUTTING BEHAVIORS

The two-year-old stags had dropped their antlers by 28 March 1989, and the yearlings by the end of April. They were all out of velvet by 2 August 1989. The remaining three-year-old and the five two-year-old stags had dropped their antlers between 19 March and 4 April 1990. They were all out of velvet by 17 August 1990. (Refer to herd composition information.) The following information provides a description of the behaviors observed during rut of the Barasingha stags.

Wallowing and Thrashing. These behaviors were first observed by mid- August for each of the years 1988, 1989 and 1990. The stag would approach a muddy area, lower its head then begin thrashing its antlers by swinging its head from side to side hitting against and jabbing the antlers into the ground (see Figure 7). Then he would lie down and stretch out his head and neck, moving his antlers and head in the mud. He might also toss mud with the antlers onto his back and/or reach to his back with his antlers rubbing mud on his body. This later behavior sometimes occurred while the stag was standing.

Thrashing also occurred in non-muddy areas such as in grass or other vegetated locations so the antlers could become adorned with vegetation. Sometimes the stag thrashed against stumps and other inanimate objects. A behavior which was only sometimes seen but may have always been occurring was the stag thrashing the ground and at the same time spraying urine towards the front part of his body thus potentially hitting his forelegs, brisket, neck, head and antlers.

Rubbing. Stags rubbed the sides of their faces, ears, necks and antlers against trees, stumps and other inanimate objects. Particularly when a stag rubbed against a tree, he usually preceded the behavior by directing his muzzle to the tree (scenting).

Sparring. This behavior began in the middle of August for the years of 1988, 1989 and 1990 after the stags came out of velvet. It continued into March of the following year prior to their dropping their antlers. Stags would either come together simultaneously or one stag would approach a second stag and lower his head, thus presenting his antlers. The second stag would respond with the same posture or move away. If the two stayed together they engaged in a sparring match in which they would join their antlers while twisting their heads and necks (see Figure 7). There were both degrees of intensity and various durations to these bouts. Often a sound would be vocalized by one or both of the participants during a match. This sound is best described as "mewing".

Threat Display. When a stag approached a second stag in the 'head up' posture he "stretched the neck erect while facing the opponent with head held horizontally and ears laid back" (Schaller, 1967 p. 123). An approach in this posture is considered to be a threat. Although Schaller described this posture as it occurred in hinds, he also observed it in stags. Since the current project concentrated on stags, it was only documented in this sex. However, instead of a 'head up' posture, it should be called a 'lifted nose display' based on our observations (Walther, 1984). Often times a sound was heard in association with this posture which is best described as a "blowing" or "whooshing" sound. The potential opponent would either move away, avert his head or the two would engage in a sparring match. This behavior was also observed prior to rut, especially during the introduction of a 10 year old stag into the herd in June 1990, and was performed by this new animal when approaching other stags.

Forefoot Kicks. Both stags and hinds were observed on occasion raising a foreleg, striking with the foot towards an opponent. Stags were documented directing forefoot kicks towards other stags during aggressive encounters. This behavior was also seen during courtship by a stag directed toward a hind while driving her and by a hind directed towards a yearling attempting to mount her. On rare occasion hinds were seen standing up on their rear legs and striking towards each other with their forefeet in boxing fashion. Stags were never seen engaged in this later behavior at the Park nor in free-living Barasingha (Schaller, 1967).

Flehmen This behavior occurs in most species of ungulate (Walther, 1984). The stags performed this behavior either by directing their muzzle to urine on the ground, to a flow of a hind's urine or to a hind's vulva. The stag then raised his head and curled his lip, a behavior considered to be testing the hind's oestrous state (in Walther, 1984). Stags appeared to stimulate a hind to urinate by poking her vulva with his muzzle. Flehmen was performed by stags of all ages.

Herding. A stag would perform swift movements around a hind in the low stretch posture thus intercepting her movements. A stag may also kick a forefoot in the hind's direction. If a hind started to move in the wrong direction, the stag sometimes positioned himself at a right angle to the hind's shoulder touching her nose and stopping her movement. Herding behavior occurred during the mating sessions when a stag was following or chasing a hind.

Mounting. During mounting, a stag would position himself on the hind's rear, lay his head and neck along her back and flick his tongue. Sometimes the stag used his muzzle to hit at the hind's flank or hip while driving or positioning her prior to mounting. Mounting usually occurred more than once

during a mating sequence. During copulation, the stag made a distinct thrust, sometimes falling backward onto the ground. On occasion, more than one stag was observed following and mounting the same hind. Yearlings were tolerated by older stags but rarely were mature stags tolerated by other mature stags.

OTHER

Allogrooming. Licking portions of a second animal's body with the tongue was observed between a hind and her fawn, between hinds, between stags, and between a stag and a hind. During courtship a stag usually remained close to a hind, including lying down beside her. Allogrooming would often occur during this resting period.

BUGLING

The Barasingha bugle is aptly described by Schaller (1967 p.128) as "a series of distinct two-toned notes repeated some 10 or 25 times with the last notes dropping progressively in pitch until they are almost inaudible." Also in Schaller (1967 p.128), he gives a description from Champion of the bugle as "a rather mournful uu-aa, uu-aa or ring-hon, ring-hon". Having recorded and played this sound to a variety of people, a further statement could be made in regards to the Barasingha bugle: 'that sound really comes from a deer?'

One of the purposes of this project was to try to determine the significance of the barasingha bugle. The following information was extracted from the three rutting periods plus the introduction of a new stag in June, 1990.

During the 1987-1988 rut, there was one 10 year old stag and two yearlings. The bugle was heard only on one occasion (12 November). There were two 2-year-old stags and five yearlings during the 1988-1989 rut, but still the bugle was only documented twice. It was vocalized once by each stag (7 December and 3 February). However, during the 1989-1990 rut, when there were seven mature stags (two 3-year-olds and five 2-year-olds), the bugle was documented during 101 different periods of time (see Table 3). The bugles were almost evenly distributed between the morning and afternoon observations. Eighty three percent of the morning bugles occurred after dawn - between 0600 and 0800, and 90% of the afternoon bugles occurred prior to dusk - between 1500 and 1700 (see methodology). The time periods coincide with the information from Schaller (1967) on the hours of free-living barasingha stag bugling.

During the 1989-1990 rut, one of the two older stags (#85) performed 67% of the bugles (see Table 3). He was first recorded bugling on 30 October and continued into January. Then in early January, prior to being removed on 14 January, the second older stag (#84) was first recorded bugling. After his removal, the oldest (by 6 weeks) of the two year old stags became the bugler. In only 33% of the 101 documented bugles was a probable context recorded. The contexts were as follows: during sexual interest in a hind (15%); following a sparring match (8%); following alarm barking ("distinctive screaming and roaring bark, repeated many times and interspersed with a few short yips" as described by Schaller, 1967 p. 113) by a hind (6%); and following an aggressive approach to another stag (4%). Interestingly, a bugle in response to an alarm bark of another barasingha has also been documented as occurring in the wild (Schaller, 1967).

The following is an example of bugling after a sparring match. On 19 January, aggressive sparring occurred between stags #85 and #89 during the early morning hours. This was followed by #89 chasing #85 half way across the enclosure, then stopping and bugling. A few minutes later, a second aggressive sparring match occurred between #89 and another two-year-old. It ended with the second stag moving away and then #89 bugling.

Only periodic observations were made after the 1989-1990 rut, where primary emphasis was the introduction of a 10 year old stag into the barasingha herd. He was introduced in June 1990 and was first recorded bugling on 30 July. He continued bugling on occasion into early September. The majority of his bugles in which there was a probable context were related to a wapiti stag approaching him or in response to a wapiti stag bugle.

This newest stag had only stubs of antlers remaining since his antlers had been cut off prior to transport. The six other mature stags from the Park's herd came out of velvet by 17 August, each with his age related rack. The presence and size of a stag's antlers are thought to play an important role in the barasingha's social organization (Schaaf, 1979). This newest stag was not heard bugling after the first part of September. On 29 September, the now second oldest stag, #85, was found dead from gore wounds. During the month of October, the oldest of the three year old stags, #89, was the only stag recorded bugling.

Although a definitive statement cannot be made in regards to the purpose of the bugle in the barasingha deer, from the data collected at the Park, it appeared to be related to dominance or the attempt to become a dominant stag. This assertion is further substantiated by data collected in the wild in which it was found that, the dominant stag of a particular area bugled more frequently than the other stags (Schaller, 1967).

STAG BEHAVIOR

INTERACTIONS

Stag-Stag Behavior. Refer to Table 2 for a description of behaviors included in this category.

1988-1989 Rut The stag-stag interactions were more consistent across the documented months for Stag #84 than for Stag #85 (see Figure 8). Also, these behaviors were more evenly distributed across both the morning and afternoon hours for #84 than #85. There was only a 1% to 2% difference between #84's average am and pm behavior. There was a difference of 2% between #85's average am and pm behavior for November and December. However, there was a substantial difference between #85's morning and afternoon behaviors for January (am 5.1% and pm .19%) and February (am 12.2% and pm 1.2%).

1989-1990 Rut There were more interactions in the morning compared to the afternoon hours during the months of November and December for all stags except #89, whose interactions were more evenly distributed across both time periods. Stag #99 engaged in more of these interactions during these two months than all others (see Figure 9) However, Stag #89 participated in more sparring matches than the other stags - 20% of the total number of bouts for this period (see Figure 11).

During January and February, Stags #89 and #95 were more active in the morning hours compared to the other stags, whose interactions were more evenly distributed between morning and afternoon (see Figure 9). The five two year olds engaged in the same average percent of their total behavior in stag-stag interactions - 4% (see Figure 10). Stag #89 again participated in more sparring matches than the other stags - 28% of the total number of bouts for this period (see Figure 11).

Of the total number of sparring matches for the four month period, the following pairs of stags engaged in the greatest percentage: stags #89 and #91 - 16%, and stags #89 and #95 - 11%. The remainder of the stag pairs ranged from 1% to 7% of the total matches.

Stag-Hind Behavior. Refer to Table 2 for a description of behaviors included in this category.

1988-1989 Rut. Courtship and mating behavior were evenly distributed for each stag (#84 & #85) during the morning and afternoon hours for November and December (see Figure 8). The morning hours were more active during January for each stag: percent of all behaviors - #84 am 21.7% and pm 12.5%; #85 am 15.4% and pm 4.2%. During February, there was more sexual activity in the afternoon hours, but not by a substantial amount. The behaviors in this category began to taper off as the end of rut was occurring.

Stag #84 consistently engaged in more sexual activity than Stag #85 during the months when mating was observed (see Figure 10). Ninety percent of all observed mounting and copulations were performed by Stag #84 (see Breeding Information Section).

1989-1990 Rut. Courtship and mating behavior was more active in the morning for Stags #85 and #89 in November and December as compared to the afternoon for Stags #94, #95, and #99. These behaviors were more evenly distributed for Stags #84 and #91 across these time periods (see Figure 9). Stag #85 was more active in this category overall compared to the others (see Figure 10).

Stag #84 was removed from the herd in mid-January 1990. Then an interesting change occurred. Stag #85 who had engaged an average of 25% of his total behaviors for November and December in stag-hind interactions dropped to an average of only 3% for January and February. A reversal occurred in this category for Stag #89. His average for November and December in this category was 8% of his total behaviors; after Stag #84 was removed, his average rose to 20% for the remainder of the rut. He also became the dominant bugler during this period of increased activity with hinds, whereas the majority of bugles had been emitted by Stag #85 (see Table 3).

OTHER BEHAVIORS

Individual Rut Behaviors.

These particular behaviors of wallowing, thrashing and bugling did not play a significant role in the stags' daily activity patterns. Although they did occur, these behaviors were only an average of 1% to 3% of each stag's total behaviors across the months of documented rut (see Figures 8 & 9 and descriptions under Rutting Behaviors).

General Behavioral Patterns.

The data from this project reveals that stags use their time to feed, rest, move, and stand around in their enclosure, even during the more active hours of the day during the season of rut (see Figures 8 & 9). This information is in accordance with Schaller's (1967) observations of free-living barasingha stags during rut.

BREEDING INFORMATION.

Mating is described as observed mounting and/or copulation by mature stags to hinds. Regardless of the number of mounts for each hind during an observation session (am or pm), for the information in this section it was counted as one mating.

1987-1988 Rut. Mating of hinds was only observed during seven different sessions. Five were performed by the one 10 year old stag (#12) during November and December. Only one bugle was heard, emitted on 12 November by #12. This stag was removed from the enclosure on 23 December 1987 due to bad arthritic problems. Two matings were observed in January by the then 18-month-old stag (#84). The other young stag (#85) was not observed mating. Seven fawns were born during

1988. Five of the fawns were born from the end of June through the end of August; the other two fawns were born in mid-September and at the end of September. Unless there was a nine month gestation, one or both of the September fawns was sired by one of the 18-month-old stags, indicating sexual maturity at this age.

1988-1989 Rut. Mating of hinds by the two two-year-old stags (there were also five yearlings) was observed during 52 different sessions. Sixty one percent of these matings occurred during November and December. During only two of these mating sessions was more than one hind the object of attention for the stags. Stag #85 was seen mounting a hind during five sessions. All other mating was performed by #84. Only two bugles were recorded during this rut, one from each stag. Although bugles did not play a major role during this rut, Stag #84 appeared to be dominant due to his breeding record.

Ten of the hinds were observed being bred in more than one session, with an interval between breedings of 17 to 20 days for seven hinds and 28 to 29 days for three hinds. The oestrous cycle of Barasingha hinds from this information ranged from 17 to 29 days, although, according to Asdell (in Schaller, 1967), the Barasingha is monoestrous. However, if in fact there actually is a cycle, the range of our hinds is consistent with other species of deer.

There were nine full term successful births in 1989. Five of the nine births occurred in July, one at the end of June, two in August and one in October. The majority of successful breedings would have occurred in November and December. Four of these hinds were observed being bred. The gestation period from this information ranged from 238 to 246 days. This period of time is consistent with the information from Kenneth (in Schaller, 1967) of gestation from 240 to 250 days for this species.

1989-1990 Rut. Mating of hinds by the seven mature stags (two 3-year-olds and five 2-year-olds) was observed during 21 different sessions. The information is summarized in Table 3. Sixty seven percent of these matings occurred during November and December. Four of the hinds were observed being bred more than once, with an interval between breedings of 16 to 17 days. Stag #85 bred eight hinds as the dominant stag and three hinds along with other stags. He also performed the majority of bugles. (See information from Bugle Section). The bugle may have played a more significant role during this rut due to the competition among seven mature stags. However, as seen from the table, the dominant stag is not as evident from mating behavior as with the previous rut. There were five full term successful births during June and July 1990.

TABLE 3. Total number of observed breedings (mountings and copulations) for each observation session during the 1989-1990 rut. If more than one mounting of a hind occurred per session, it was counted as only one breeding for this table. Also included is the total number of bugles per month during rut.

Stag	Single Breeding	*Multiple Breeding	Bugles			
			Nov.	Dec.	Jan.	Feb.
84	4	-	1	-	9	-
85	8	3	51	14	2	-
89	6	3	-	-	**14	10
91	-	-	-	-	-	-
94	-	2	-	-	-	-
95	1	2	-	-	-	-
99	2	-	-	-	-	-

* Multiple breeding - more than one stag mounting the same hind during a breeding session.

** Bugling by Stag #89 occurred after Stag #84 was removed from the herd in mid- January. (See Text).

HIND AND FAWN BEHAVIOR

The following information is a synopsis of data accumulated by Rubin from observations on 11 fawns born in 1988 and 1989. Additional information from this data will be provided in an addendum to the current report. (See attached data sheet).

There were 57 timed bouts of nursing behavior with an average duration per bout of 100 sec. The ages of the fawns during these observed bouts ranged from the first day of life through three months old. The majority of bouts were terminated by the dam. During over 50% of these bouts the hind directed allogrooming to her fawn either prior to, during, or following a nursing bout. Anogenital grooming was prevalent during the first six weeks of a fawn's life; however, other areas of the fawn were also targeted during and following this time period.

According to Schaaf (1979), Barasingha fawns begin to nibble at grasses at an 'early age'. From our documentation, this early age was between five and ten days with first rumination at two to three weeks.

Although a fawn was usually isolated from the herd immediately after birth, the duration of time for this behavior was variable and could be related to the age and experience of the fawn's hind. A hind and fawn usually first joined a small group of deer when the fawn was two to four days of age. This small group consisted primarily of another hind(s) and fawn(s). The average age when a hind and fawn joined the main herd was 10 days (range: one day to three weeks). In the wild, fawns join groups of older deer at one to two weeks after birth (Schaaf, 1979).

When a hind and fawn were separated, a vocalization was the predominant signal which initially brought the two together. This was followed by scent, primarily in the form of naso-nasal testing. According to Schaaf (1979), recognition between hinds and their fawns is by odor.

DISCUSSION

The barasingha deer utilized all areas of their enclosure; however, the most frequently used sections contained habitat components similar to that of their free-living relatives. According to Schaller (1967), although barasingha herds can be found in various habitats throughout India - forests, marshes and grasslands - there are certain attributes chosen by the deer which apply to each. Within each habitat the deer utilize open areas, water, and both flat and 'moderately' hilly terrain. Although not as thickly vegetated at the Park as the habitat of their wild cousins, the stream bed location, in particular, provided the deer with a marshy terrain of soft mushy soil and dry sand like marshes in the wild. The muddy areas also made good wallows for the stags during rut. Because this species is primarily a grazer, abundant grasses spread throughout the enclosure provided the deer with both a natural resource as well as a stimulus for movement. Even in a smaller captive facility, most of these same components can be provided for the deer.

The barasingha's patterns of activity and inactivity were consistent with that of wild herds. According to Schaller (1967), during all seasons of the year, except the rainy season, there are early to mid-morning and late afternoon to evening peaks in the deer's activities, with rest occurring during the other hours of the day. This cycle is similar to that of the Park's herd.

The data from this study revealed that barasingha stags take time to graze and rest even during the active periods of rut. This pattern is not unlike what occurs in the wild (Schaaf, 1979; and Schaller, 1967). In both states, this species inhabits a much milder climate as compared to some of their relatives (Nowak & Paradiso, 1983). Also, the barasingha does not have a harem structure during rut like some of the other species of *Cervus*, such as those of *Cervus elephas* (Dolan, 1988).

Therefore, less time is needed and less energy is expended to hold a group of hinds and to defend them against other stags than that which occurs in a harem structure. Instead, the barasingha stags test, herd, then copulate with any cycling receptive hind.

The major purpose of sparring matches between barasingha stags is to establish or re-establish a stag's position in the dominance hierarchy (Schaaf, 1979). Also in the wild, age, and thus age-related antlers, was the important determinant of dominance (Schaller, 1967). However at the Park, because the stags were relatively young and close together in age, there wasn't a clear cut age related structure. During the 1989-1990 rut, there were seven competing stags (two 3 year olds and five 2 year olds). One of the two-year-old stags, #89, engaged in a greater percentage of sparring matches than the other stags. From the data analysis of this rut, one of the three-year-old stags (#85) engaged in more stag-hind activity and was also the dominant bugler during the first two months of breeding. However, after the second three-year-old stag (#84) was removed from the herd, a reversal occurred and #89 became more sexually active and also became the dominant bugler. He also became more aggressive towards Stag #85.

Although data was not collected during the 1990-1991 rut, the observations that were made during preliminary rut suggested that there was an increase in aggressive behavior by #89 directed to #85. Stag #85 was found dead from gore wounds at the beginning of this rut. It is not known which species or individual gored the stag.

COMMENTS

It appears from our data and the prior records from the Park, that the greater the number of competing mature stags, the fewer the number of successful births. Of course, there may be other variables which enter into this equation. However, due to the inverse proportion of stag-stag aggression and births, it is suggested that the number of mature stags, even in a large captive environment as the Park, be reduced. The behavior of all remaining stags should be closely monitored for increased aggression during the rut.

It is hoped that the results from this research project will not only contribute information which can be used towards the preservation of this endangered species but will also stimulate more research on endangered species of deer.

For the final publication, some additional data will be extracted from that already accumulated over the three years of the project. Specifically, there will be information on grouping behavior of the herd throughout the year, the potential marking behavior of the stags, and the fawn's behavior. If, from those of you who review this report, there is any additional information that you think would be beneficial to this species, your comments would be greatly appreciated. Please send this information to the senior author whose address appears on the front of the report.

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ENCLOSURE

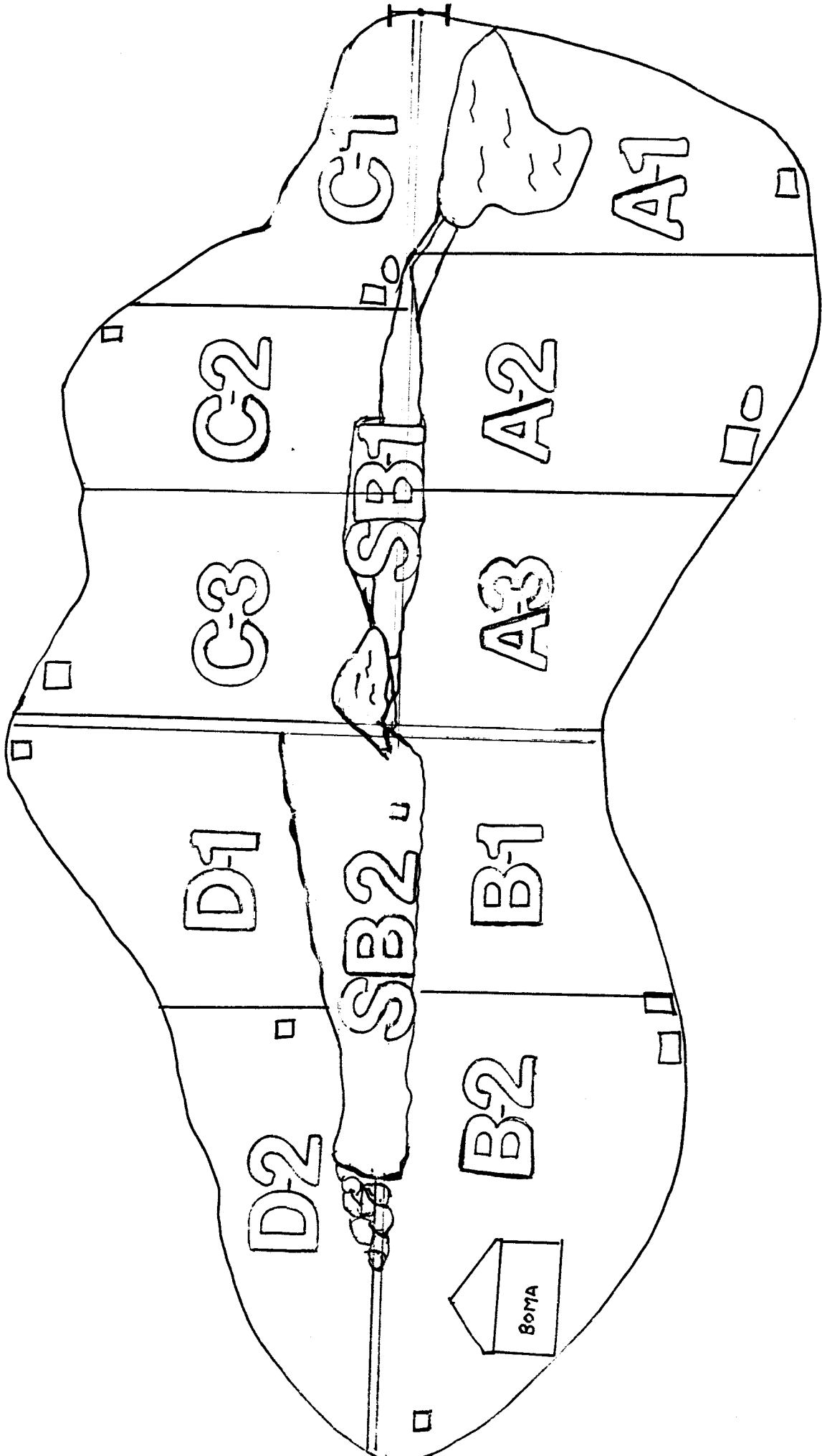
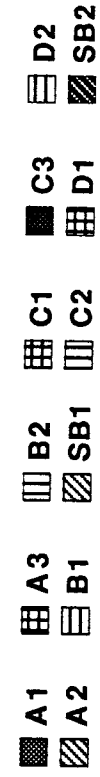
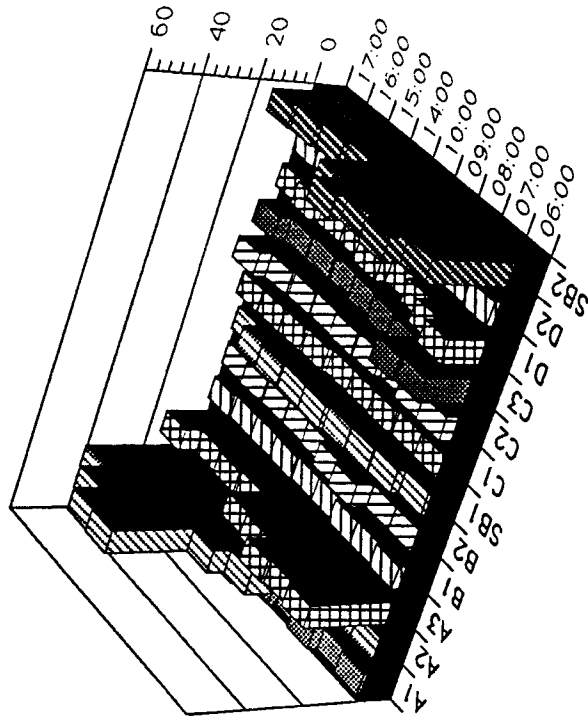


Figure 1. Illustration of the barasingha enclosure.

SPACE UTILIZATION BY HOUR, Nov 1989 - Feb 1990



SPACE UTILIZATION BY HOUR, Nov 1988 - Feb 1989

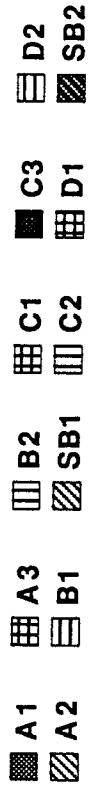
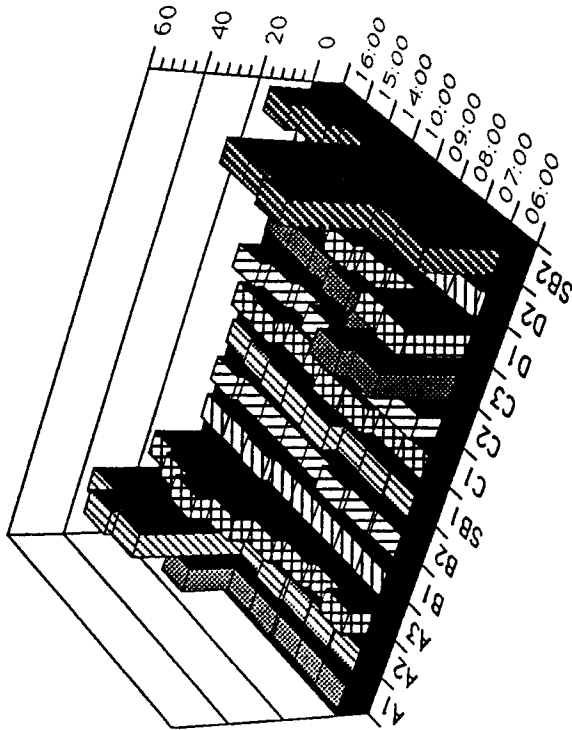
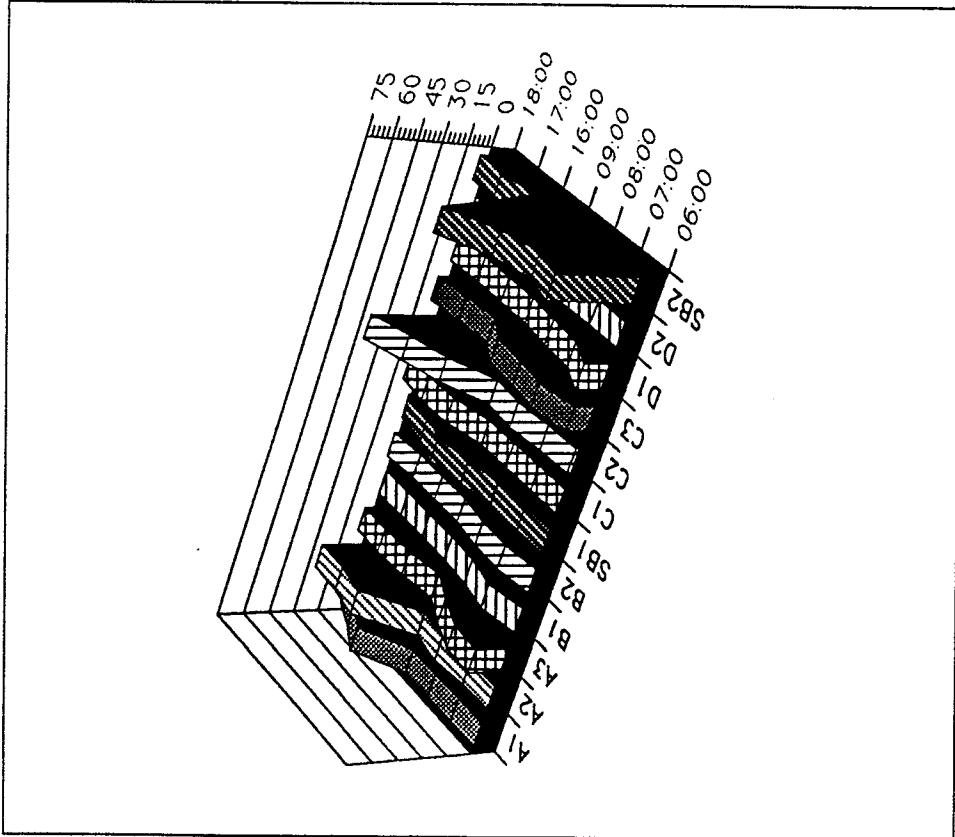


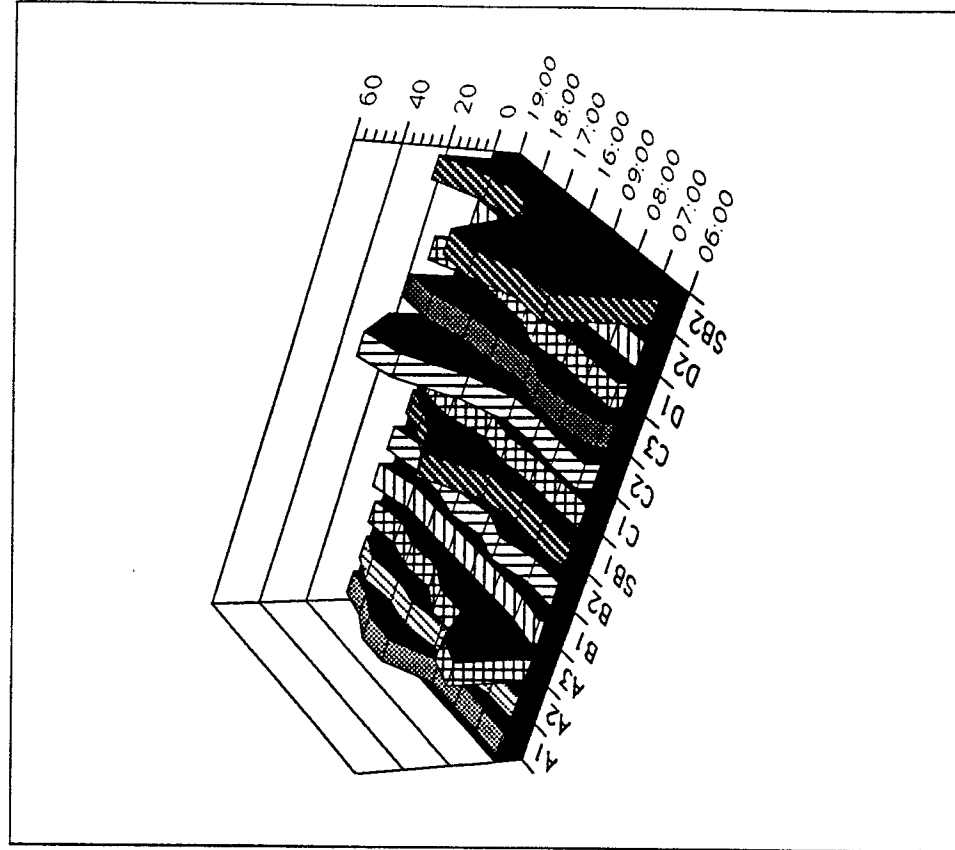
Figure 2. The percent of the total number of barasingha found in each area of the enclosure for each hour of observation during each of the two ruts.

SPACE UTILIZATION BY HOUR, Mar - Jun 1989



- A1
- A2
- A3
- B1
- B2
- B3
- SB1
- SB2
- C1
- C2
- C3
- D1
- D2
- SB2

SPACE UTILIZATION BY HOUR, Jul - Oct 1989



- A1
- A2
- A3
- B1
- B2
- B3
- SB1
- SB2
- C1
- C2
- C3
- D1
- D2
- SB2

Figure 3. The percent of the total number of barasingha found in each area of the enclosure for each hour of observation during post rut and preliminary rut.

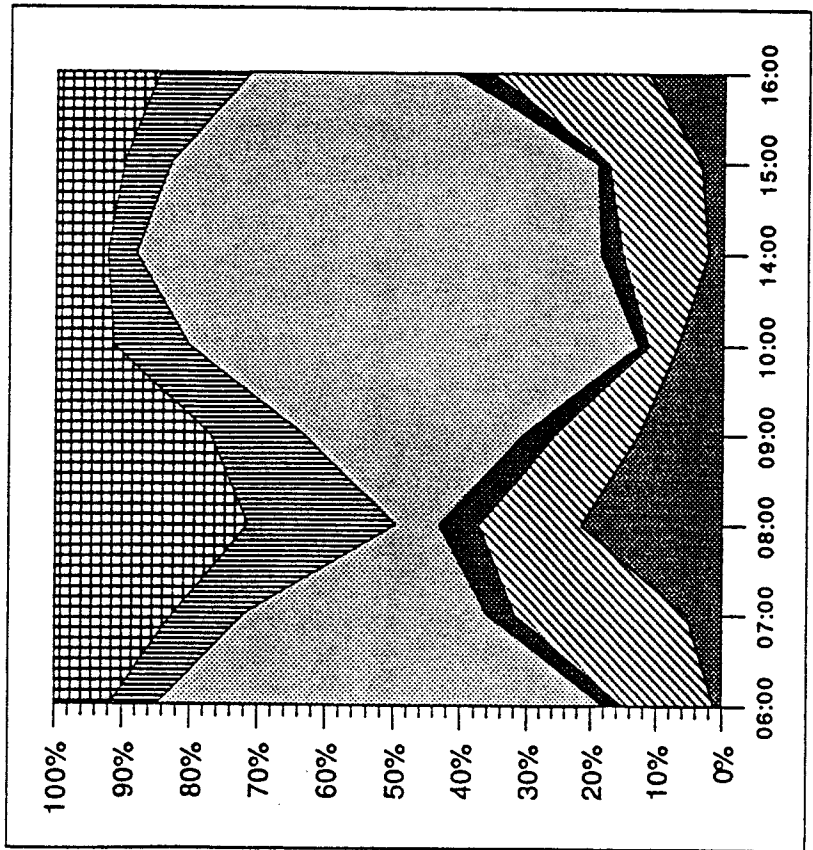


Figure 4a. Photos of the barasingha enclosure depicting behavior.



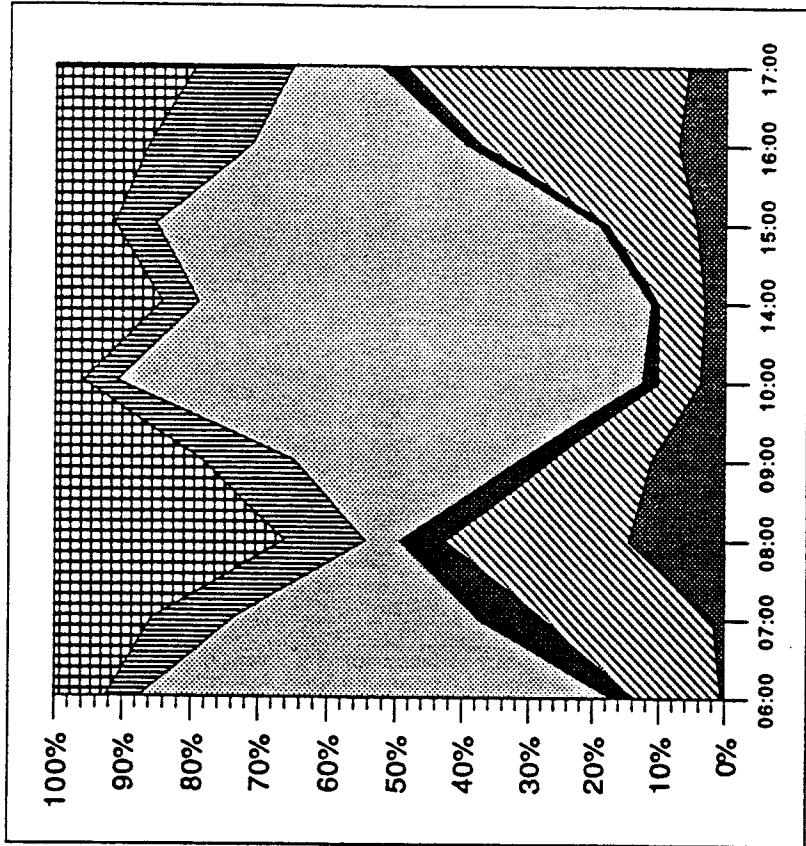
Figure 4b. Photos depicting the habitat of Stream 3ed 2.

BEHAVIORS BY HOUR, Nov 1988 - Feb 1989



- ATE PROVIDED FOOD
- ▨ GRAZED
- INTERACTED
- ▨ LAID DOWN
- ▨ LOCOMOTED
- ▨ STOOD

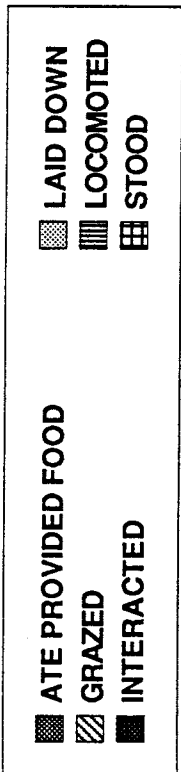
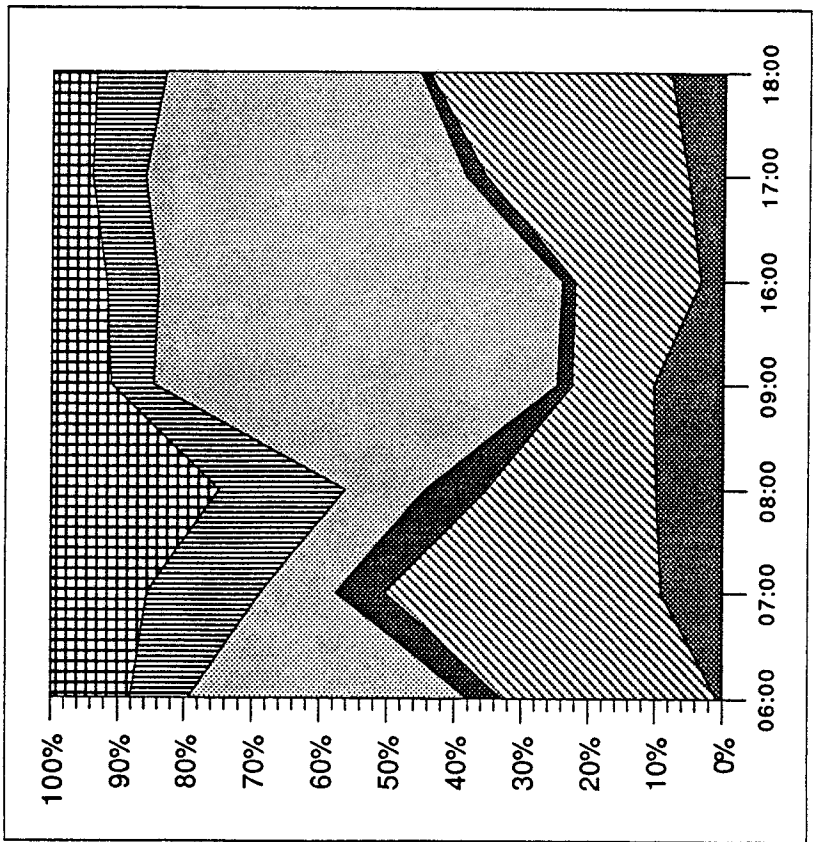
BEHAVIORS BY HOUR, Nov 1989 - Feb 1990



- ATE PROVIDED FOOD
- ▨ GRAZED
- INTERACTED
- ▨ LAID DOWN
- ▨ LOCOMOTED
- ▨ STOOD

Figure 5. The percent of the total number of barasingha involved in each of six behavioral categories for each hour of observation during the two ruts.

BEHAVIORS BY HOUR, Mar - Jun 1989



BEHAVIORS BY HOUR, Jul - Oct 1989

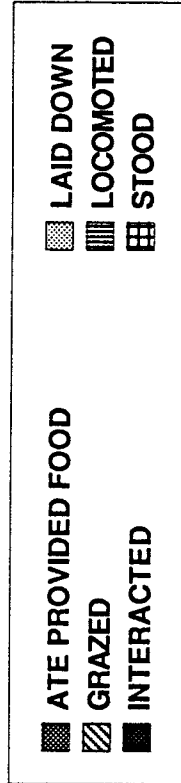
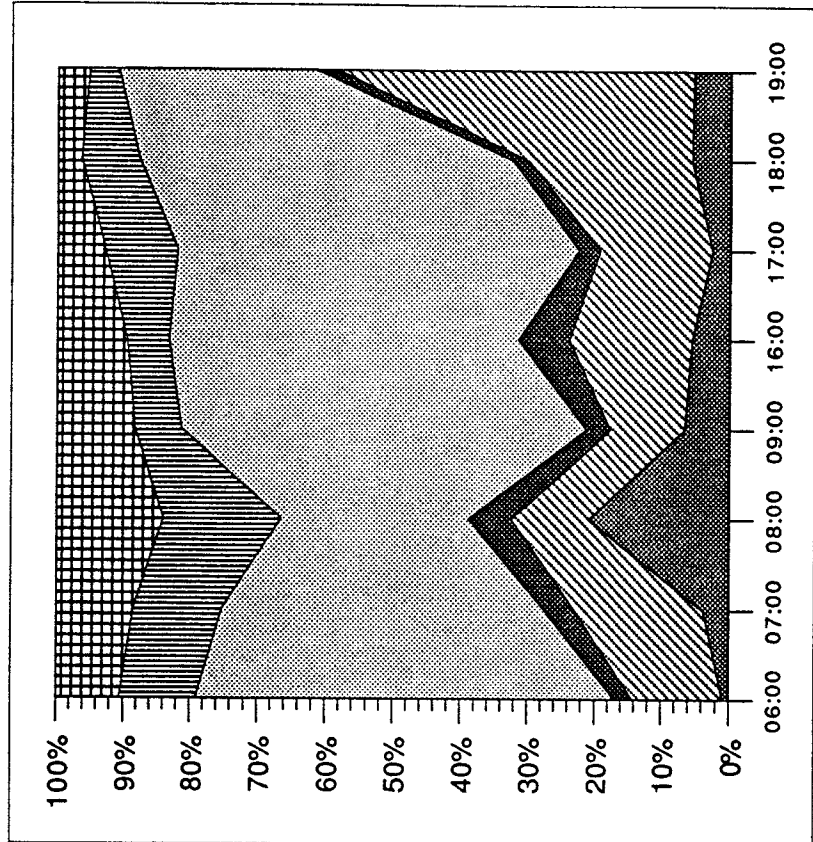


Figure 6. The percent of the total number of barasingha involved in each of six behavioral categories for each hour of observation during post rut and preliminary rut.



Figure 7a. Photos of Stag thrashing behavior.



Figure 7b. Photos of two stags engaged in a sparring match.

STAG BEHAVIOR, 1988 - 1989 RUT

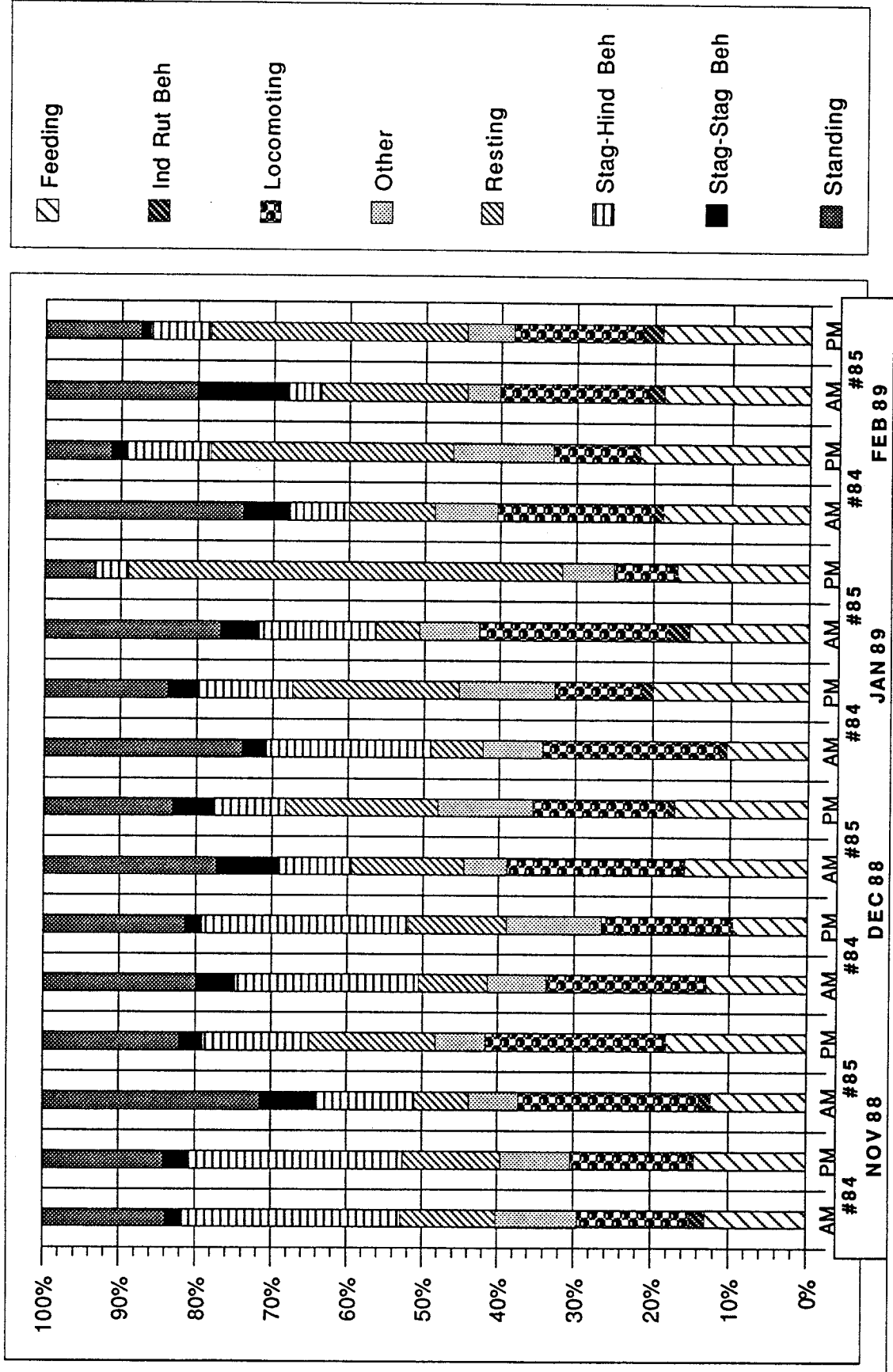


Figure 8. The percent of the total number of behaviors for each category each month for both am and pm for stags #84 and #85.

STAG BEHAVIOR, 1989 - 1990 RUT

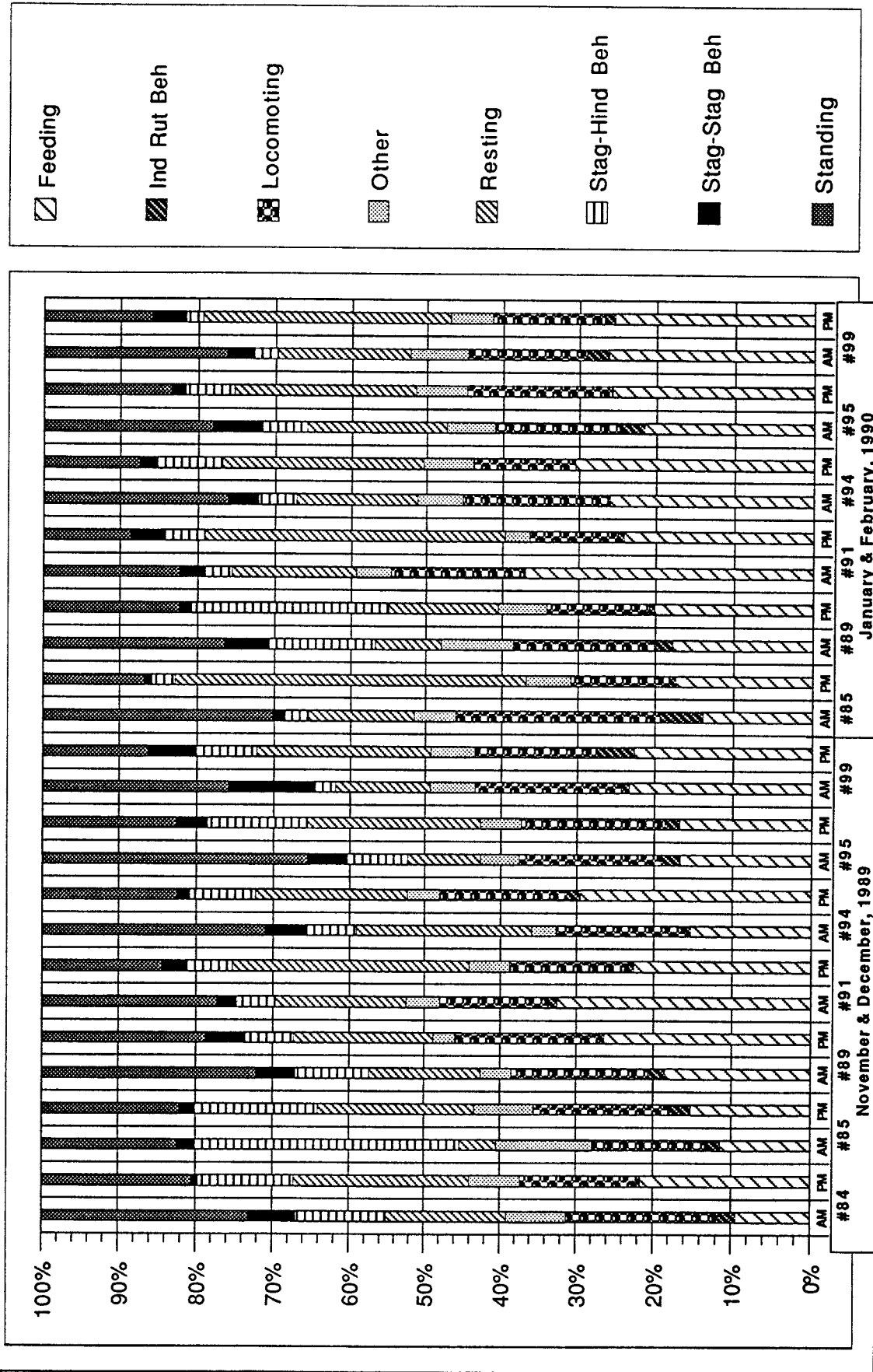
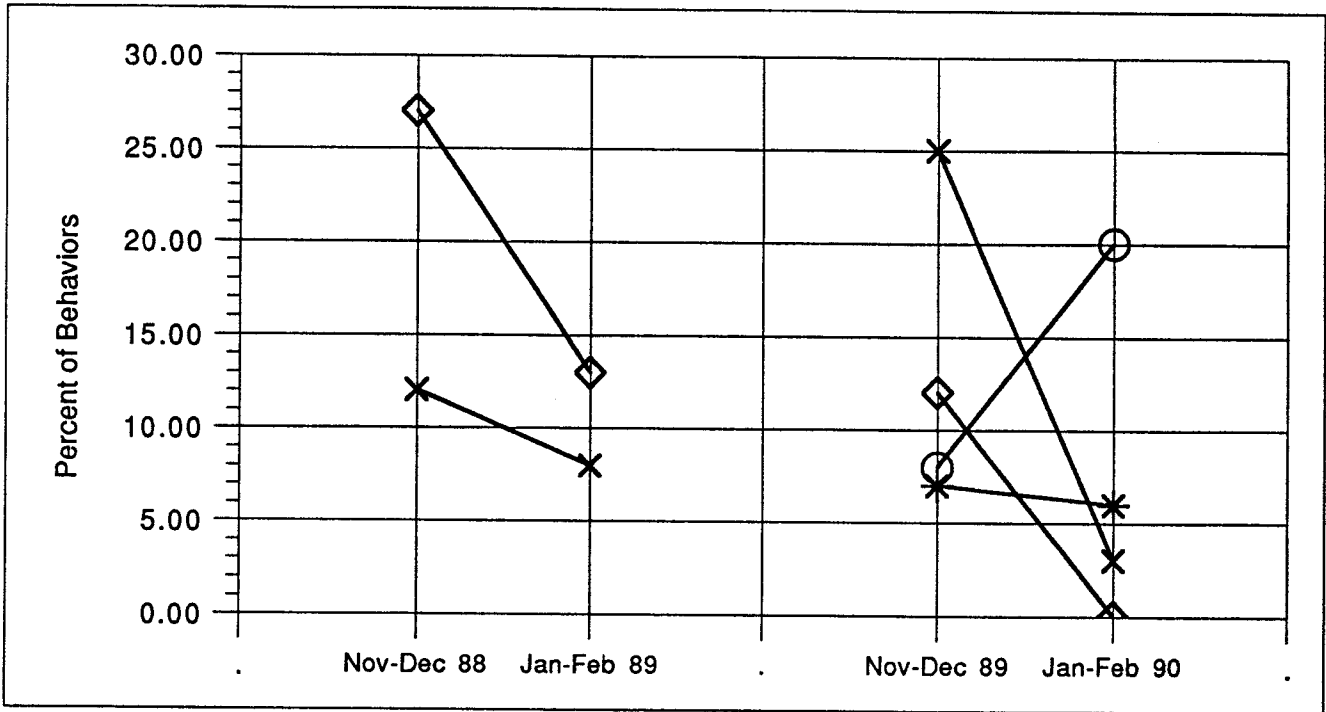
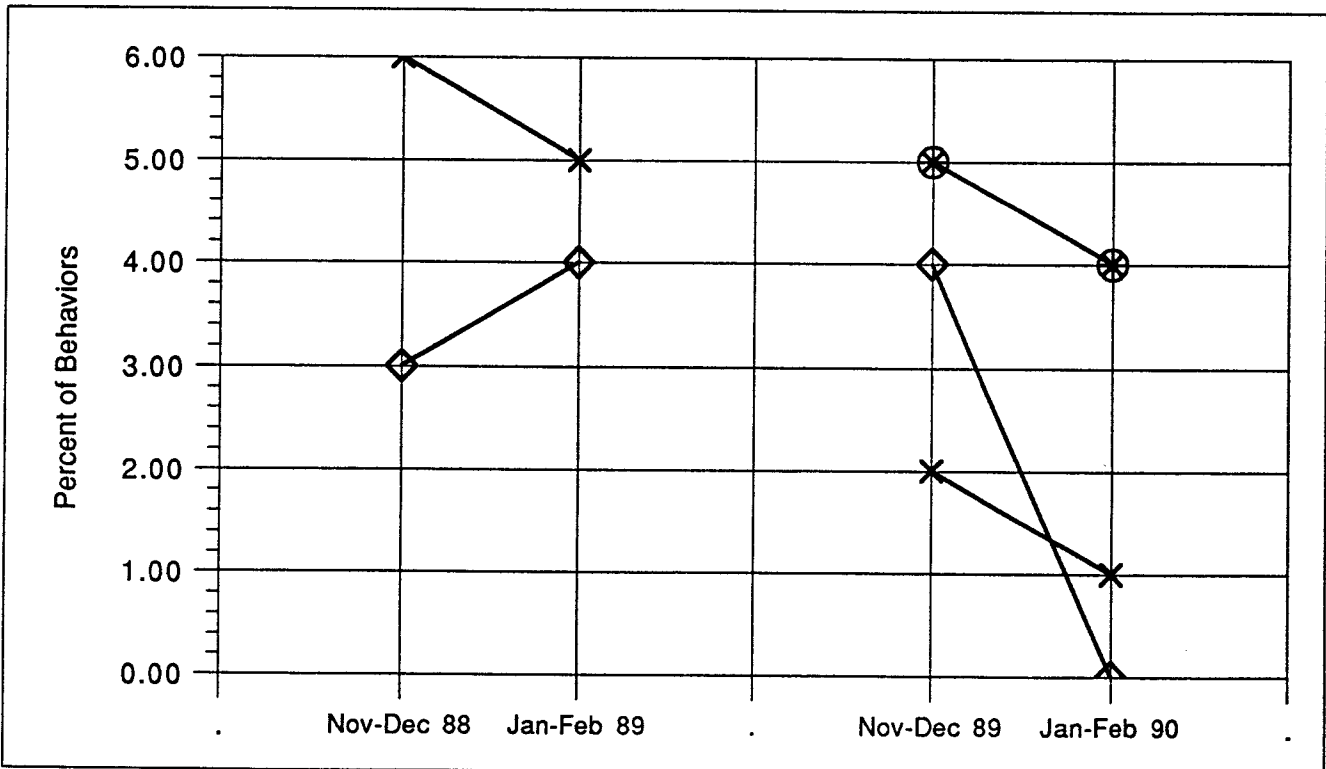


Figure 9. The percent of the total number of behaviors for each category and each two month grouping for both am and pm for each stag - #84, #85, #89, #91, #94, #95, and #99.

Stag-Hind Behavior



Stag-Stag Behavior



◇ #84

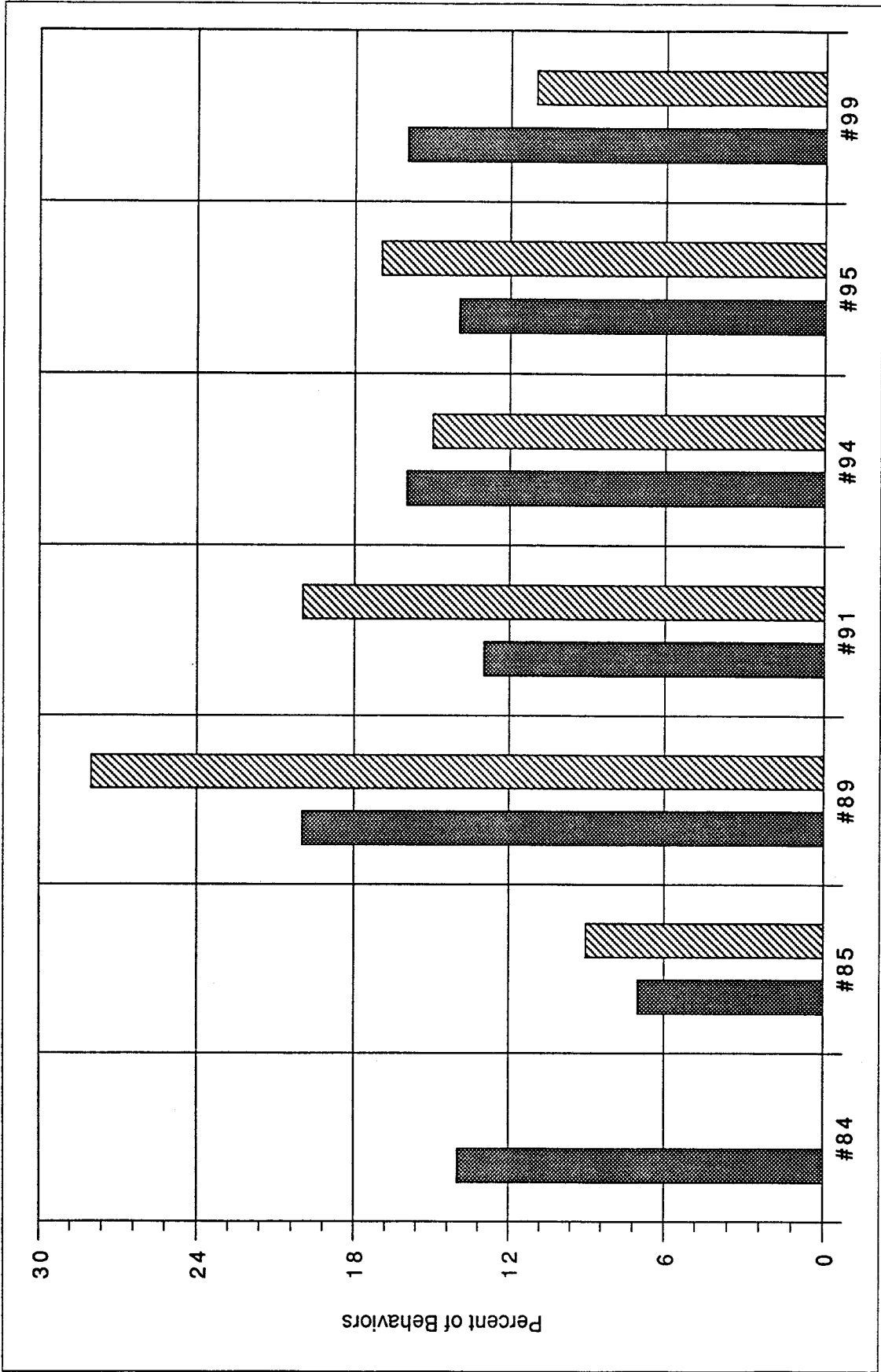
* #85

⊖ #89

* Others

Figure 10. The percent of the total number of behaviors for Stag-Hind and for Stag-Stag Categories for each of three stags and for the other four averaged together.

Sparring Bouts



■ Nov-Dec ▨ Jan-Feb

Figure 11. The percent of the total number of sparring matches that each stag participated for each two month period during the 1989-1990 Rut.

MALE _____ DATE/TIME ____/____/____ 2 : ____ Weather _____ Observer _____

MINUTE -->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Totals
Provided Food																
Grazes																
Lies Down																
Ruminates																
Eliminates																
Locomotes																
Stands																
Bugles																
Wallows																
Tongue Flicks																
Thrashes																
MALE/MALE #-->																
Kicks																
Head-Up																
Lowers Antlers																
Spars																
Chases																
Moves Away																
MALE/FEMALE #->																
Head-Up																
Low Stretch																
Naso-Anogenital																
Flehmen																
Drives																
Chases																
Mounts																
Copulates																
Allogrooms																
Butts																
Naso-Nasal																
Vocal																
Other																
Intersp Agresn																
Species ----->																

COMMENTS:

MINUTE -->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Totals
Nurses	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Provided Food	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Grazes	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Eliminates	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Stands	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Lies Down w/Dam	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Lies Down w/othr	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Lies Down w/herd	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Lies Down alone	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Locomotes w/Dam	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Locomotes w/othr	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Locomotes w/herd	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Locomotes alone	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Fawn Vocalizes	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Dam Responds	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Dam Vocalizes	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Fawn Responds	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Tactile Interact	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Naso-Nasal	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Naso-Anal	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Naso-Genital	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Allogroom/Anogen	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Allogroom/Other	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Play Behavior	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Other Interacts	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
With Dam	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
With Adult	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
With Fawn	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
w/Other Species	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Solitary Play	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Investigates	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::
Other	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	::

COMMENTS: