

BREEDING BEHAVIOR IN THE INDIAN RHINOCEROS

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INTRODUCTION

The historical background, initial breeding, and first birth of a pair of Indian rhinoceroses, Rhinoceros unicornis, at the National Zoological Park have been reported elsewhere (Buechner, et al., 1974). More detailed descriptions of the reproductive behavior are given in the present paper. The events leading to successful copulation are of interest in that both animals were sexually inexperienced and required considerable orientation as a prerequisite to mating.

On arrival at the zoo, the male (Tarun) was about 2.5 years old and the female (Rajkumari) was 6 months old. The first attempt to mate occurred on 9 August 1970, when the male and female were 12.8 and 7.3 years of age, respectively; the second and third attempts occurred on 26 August 1971 and on 12-13 August 1972. The first two attempts were curtailed around midnight after 9-14 hours of sexual activity; in August 1972 the animals were allowed complete freedom of access to one another throughout the female's period of receptivity (20 hours). None of the mounts exceeded 15 minutes in any of these three initial attempts to breed. The male achieved partial intromission only occasionally. The penis (ca. 1 m long) usually passed beneath the female or laterally, mostly because the male positioned himself too far forward on the female's back. When the male was in the proper position for insertion, the penis was ineffective in reaching the vagina.

On 30 September 1972, the male mounted the female quickly intromitted without difficulty and remained mounted for 70 minutes, with frequent bouts of pelvic thrusting. Conception occurred on this date, and a male calf was born on 30 January 1974.

The experiences at other zoos also indicate that a long period of orientation is required for immature Indian rhinoceroses prior to successful copulation. At the Basel Zoo, the female went through 19 periods of observed estrus before conception occurred, and the initial breeding was accomplished by keeping the male and female together throughout the night whenever the female was in estrus (Lang, 1961).

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\* Deceased

Patterns of placing the male and female together seem to be important in achieving synchrony of sexual motivation and opportunity for initial copulatory orientation. Complete separation for prolonged periods (ca. 6 mos) may be as essential as around-the-clock access of the animals to one another during seasons of the year favorable for conception in the North Temperate Zone.

#### BREEDING BEHAVIOR IN 1972

Observations of the male and female during Rajkumari's proestrus, throughout one estrous period without copulatory success, and through the subsequent onset of estrus leading to successful mating 48 days later show the manifestations of disposition to mate and contact-promoting interactions in relationship to the female's estrus (Figures 1 and 2). Although the daily observations varied somewhat in duration and time of day, the behavioral patterns of these two Indian rhinoceroses, neither of which had bred previously, are clearly depicted.

#### BEHAVIOR OF THE FEMALE

Apart from her interactions with the male, Rajkumari exhibited several behavioral and physiological signs of the onset of estrus. However, none of these indications alone, or even in combination, could be used to predict precisely the time of full overt estrus and readiness to accept mounting by the male. Only when the male mounted the female could we be certain that the female was in estrus.

The first positive sign of the mid-August estrus was a milky vaginal secretion observed at 1455 hours, about 2 hours, prior to the first mount. Flashing the vulva, rhythmic contractions in which the partly everted and swollen labia minor are visible momentarily, was first observed when the female was halfway through the 15-hour period over which she accepted 23 mounts by the male. Isolated spontaneous horizontal squirting of urine, supposedly a good indicator of the onset of estrus, was seen only on 21 July (1 squirt) and 7 August (4 squirts) before the first estrus occurred on 12 August 1972. When she was in full estrus, Rajkumari emitted at least 20 horizontal urine squirts, often coupled with vulval flashing. On four separate days after the August estrus, a few single horizontal squirts were observed; then unexpectedly on 24 September a series of 25 squirts occurred over a 48-minute period (0139-0227) -- a week prior to the complete copulation. The following night 6 squirts were observed, again over a brief period between midnight and 0300; no horizontal urine squirts were seen thereafter, even on the day of copulation.

Whistling was heard occasionally before and during the first estrus, and infrequently thereafter. Immediately after copulation the female

emitted a series of frequent, high-pitched, subdued whistles, which suggests that whistling is an expression of a high state of excitement.

These symptoms of estrous behavior have been reported by Schenkel and Lang (1969) for the Indian rhinoceroes, but without detailed reference to the total time-period over which they occur or to the exact time of mounting. Mucous secretions, vulval flashing, and urination, as described briefly by Anderson (1969) and Nishikawa and Hafez (1968), are also indicators of estrus in the mare; and they reveal the evolutionary link between these two perissodactyls.

Backing into objects, such as a stump, wall, or the bars of a cage, provided a good index to the female's interest in breeding. Similarly, Flehmen [upcurling of the upper lip with head held high--see Schneider (1930) for initial description of term, and Estes (1973) for probable olfactory function] provided some indication of impending estrus, as did tail muscle contractions, tail swishing, head tossing, and the intermittent passing of brown (sometimes gelatinous) material in the urine (Figure 1). Flehmen was observed on 27 different days over the 80-day period from introduction to conception, and on 8 out of 14 occurrences in which the source of the odor could be discerned, Rajkumari tested her own urine. She also did Flehmen on two out of ten occasions when she was observed to smell the male's genitalia. However, as already stated, neither Flehmen or any of the other behavioral activities mentioned here could be relied upon to pinpoint estrus.

An exceptionally prolonged period of intense, continuous pacing began at dusk on 23 September (one week before the conception) and lasted 16.8 hours. Rajkumari walked back and forth along the bars of the cage or along a wall, she frequently went outside and walked around the enclosure, and she curtailed her contacts with the male. The temperature of the surface of her body rose perceptibly; her skin was very warm to the touch. After lying down for 5.6 hours during the afternoon of 24 September, pacing was resumed at dusk and continued until 0832 hours the next day. Her skin temperature remained abnormally high. Another long spell of lying down followed, and only three 5-10 minute periods of pacing occurred the evening of 25 September. The female entered the water tank at 2015 for a stay of 4.5 hours. No observations were made from 0100 to 0600 on 26 September, but the surface of the female's body was still warm at 0600, suggesting that Rajkumari could have been pacing between 0100 and 0600. Pacing was steady for 30 minutes between 0713 and 0743, but shortly thereafter the animals lay down for a long rest until 1355; by the evening of 26 September, the female's skin temperature was essentially normal. In summary, pacing was intense on 23 and 24 September, a week prior to conception, and continued intermittently and only for short periods (<1 hr) up to the day of conception.

Pacing was also observed for periods of less than an hour in the early morning on five separate days as the female approached her first estrus, including the first day of estrus (August 12, 1972) and the two preceding days (Figure 1). Although the pacing was not protracted and continuous as in the pacing associated with the onset of the second estrus, it appeared to be a significant sign of restiveness related to impending estrus. This suggestion is supported by the absence of pacing for 41 days after the first estrus. Experienced local field observers informed S. Dillon Ripley (pers. comm., Ripley, 1952; Hutchinson and Ripley, 1954) that female Indian rhinoceroses wander over great distances (presumably for days) when estrus is imminent.

#### BEHAVIOR OF THE MALE

The most remarkable behavior of the male was a "dance," which was observed three times within a half hour (0830-0900), 10 hours prior to the first mount during the female's mid-August estrus, and once again on 27 September, 3 days before completed copulation took place (Figure 2). With rapid, vigorous movements the male ran around the center of his cage in a tight circle. Despite his weight (ca. 2,300 kg) and bulk, the male was surprisingly nimble. Several times he gracefully reversed his direction, lifted his forefeet 10-30 cm off the floor and whirled first in one direction and then in the opposite; at the same time he repeatedly tossed his head high into the air and urinated in strong, posteriorly directed sprays. The action was fast, impressive to the viewer, and reminiscent of a stallion performing in a circus ring. Each dance began suddenly and ended abruptly with the male standing quietly for a minute or two in his urine-soaked cage. The male's readiness to mate and the imminence of the female's estrus seem to have been heralded by the male's dances.

The intense urination during the dances was all by powerful posterior spraying in bouts of 3-5 squirts. According to keepers, such spraying was Tarun's normal mode of urination. The penis was almost constantly extruded (ca. 20 cm) from the sheath. When excited, as during the dance or when estrus was impending, urine spraying increased in frequency and forcefulness, at times reaching over a distance of 2-3 meters. Almost invariably, passing through a doorway, an open gate in the outside enclosure or the entrance to the water tank triggered spurts of urine. This was the male's most stereotyped behavior.

Long, steady urinations were seen only occasionally, and then mainly preceding defecation. On the morning of 13 August, after attempting to mate all night, the male had a prolonged urination, punctuated by many strong pulsations, as he stood facing the female. Two other observed long urinations in July were without pulsations and were followed by defecation; four observed after the incomplete mating were all characterized by pulsations and were not followed by defecation.

Flehmen as a process in testing the female's urine, presumably in relationship to her receptibility to mate, was observed almost daily (Figure 2). As Rajkumari's estrus approached, Tarun did Flehmen more frequently and intensely; increasingly he licked urine on the floor (ingesting the brown gelatinous substance when available), lapped urine from the drainage trough, and ate hay soaked by the female's urine. Ingestion of the urine seemed to have a stimulatory effect on the male's libido. Flehmen was observed immediately prior to the first mount on 12 August and five times the following day between 0900 and 1500, as the interest in mating waned. Over the next 2 weeks Flehmen was greatly reduced, and with the onset of the second estrus, the process again increased in frequency. Flehmen simultaneously with strong squirts of urine characterized the male as the female approached estrus.

The male's libido appeared to be reflected in the frequency of full erections (penis directed forward and tightly appressed to the ventrum) when standing alone, often on rising at daybreak. With the onset of the second estrus, erections were more frequent than before the first estrus (Figure 2). On 23 September the male was filmed masturbating which included pelvic movements, erected tail, and one ejaculation.

During most of the full erections observed, the male's testes were descended into the scrotum. Descent and retraction of the testes could occur within a few seconds and seemed to be under the male's control; testes ascent and descent did not correlate clearly with the male's libido, interactions with the female, or the ambient temperature.

Two other aspects of the male's behavior deserve note. The male was seen to drag his hind feet on the morning of 23 September, the same day he masturbated, and the same day the female began pacing. Foot-dragging was observed also on 24, 25, and 29 September before the copulation. Its meaning is unclear.

In the 5 years prior to Tarun's first successful copulation, he had often reacted strongly to the estrus periods of a neighboring black rhinoceros, Diceros bicornis L., by banging the walls of the cage, running up and down the fence, and even trying to climb the divider fence. Rajkumari was ignored during such periods of excitement.

#### CONTACT - PROMOTING INTERACTIONS

The interactions between Rajkumari and Tarun over the 80 days of almost continuous access to one another before conception were surprisingly rich and varied. Extremely gentle contact was made at times during mutual horn-rubbing, when nuzzling one another's prehensile upper

lips, when the female licked the male's hind leg or genitalia, and when simply lying side by side in a muddy wallow or bathing together in the water tank. On the other hand, violent contact was made during strong head-to-head encounters and when the male initiated wild chases around the outside enclosure by thrusting his horn under the female's flank and attempting to lift her. Usually the male initiated the aggressive interactions; but he also terminated the activity, often exhibiting remarkable restraint. The female promoted most of the gentle interactions by approaching the male while he was lying down or in the pool and engaging in nuzzling, licking, chin-rubbing, backing into the male, rump-rubbing or lying down beside him.

Lying together, usually in a muddy wallow, was initiated by the female--she approached the male and lay down beside him, often in close body contact. Usually the male continued lying in the same spot; sometimes he got up and moved off, leaving the female in the wallow.

The female preferred to approach the male while he was lying down or in the pool. Each contact in the water involved the female presenting her rump to the male's face, but once she rubbed her rump against the male's hindquarters. In no case did the male show any perceptible response. Rajkumari approached Tarun 28 times while he was lying down, sometimes going to him shortly after an aggressive encounter, whereas she approached him only seven times while he was standing up. While standing next to the reclining male, the female often nuzzled his nose, horn, lips, or the side of his face; backed into him and stood or rubbed her buttocks and genitalia against the male's hindquarters; rubbed her chin across the male's back; smelled his genitalia; and licked his hind leg and genitalia. Not all of the activities were performed each time.

Licking the hind leg was seen seven times before the first estrus (Figure 1), averaging 5.71 minutes in duration (range = 2-12,  $sd=3.77$ ); it was noted on 5 and 8 September for 15 and 13 minutes, respectively, and for < 1 minute on two occasions thereafter. During the evening of 29 July, the female was observed licking the male's genitalia over a 7-minute period, sometimes shifting to the male's side and licking there. On three other occasions (< 1 min) the proestrus genital licking was extremely brief and seemed inconsequential. The male pulled back and/or lifted his hind leg when the female licked his leg or genitalia. Both the male and female would exhibit a reflexive lifting of the hind leg when the lower leg, inguinal region, or genitalia were stroked or rubbed by a human. The male also would develop a partial erection at such times.

Although the male continued lying down when approached by the female, he usually responded to the female's active contact (licking, rubbing, backing into him) by standing up within half an hour and often

engaged the female in a head-to-head encounter varying from mutual horn-rubbing (Figure 3) with little or no vocalization to vigorous horn-fighting with vocalizations by the female, and open-mouth biting directed toward the male's forehead. Occasionally the female inflicted minor wounds on the male's face with her lower incisor tusks. The male kept his head low, seldom opened his mouth or vocalized, and seemed to restrain himself from becoming overly aggressive.

Mutual horn-rubbing was most intense before the first estrus and often lasted 5 to 10 minutes. The rhinos rubbed their horns together gently or with moderate pressure, and often they merely held their horns in contact. Vigorous pushing, knocking, and hard rubbing of the horns occurred before, between, or after bouts of gentle stroking. Before 26 July, and never thereafter, the female was observed approaching the male on six occasions to engage in horn-rubbing; the male approached the female nine times during the same period of time and 28 times thereafter, often more than once a day, to engage in horn-rubbing (Figures 1 and 2). During the second proestrus the rubbing was both brief and infrequent.

Instead of horn rubbing, head-to-head encounters appeared to become more intense and more frequent with the onset of the second estrus, and the female defended her position with greater "confidence" and vigor, threatening the male with open mouth, loud snorting, and slashing at his forehead with her tusks. Despite the more intense "fighting", however, there were many moments and spells of gentle contact during which the female stroked the male's face with her lip. As with the first estrus, the male approached the female more often with the onset of estrus in late September (Figure 2).

The most elaborate and interesting courtship activity was observed at night on 24-25 and 25-26 July, the first time the animals were kept together around-the-clock. Tarun and Rajkumari approached one another repeatedly and "played" spryly around one of the trees by engaging and breaking horn contact. Nearly always it was the male who broke contact. The female tossed her head, vocalized, and, using the tree as "escape cover," ran from and back to the male. When the male lay down, the female went to him immediately and stood over him, rubbed her chin on his rump and back, and backed into him. These initial nocturnal observations suggested the importance of keeping the animals in constant contact.

What appeared to be an "invitation" by the female to the male to chase her was observed 18 times (Figure 1). On 12 of these occasions, the male and female were in a head-to-head encounter when she broke away, turned, and ran. On five occasions, the female tossed her head high into the air before turning and running. Strangely, the male responded to the

invitation only twice, and then merely walked slowly toward the female. None of the invitations to chase occurred during the week preceding either the first or second period of estrus. The most noteworthy invitation was observed on 23 July at 2009: the female backed up after about 5 minutes of head-to-head encounter with horn-rubbing and pushing, lunged at the male, snorted and tossed her head, lunged at the male again, raised her head and twirled her body in a circle and returned to horn contact with the male, tossed her head with a circular motion, and galloped away from the male. For about 4 minutes she ran around the bathing pool alternately with running up and down the center of the enclosure from the building to the moat; she passed the male repeatedly, snorting at him as she went by. Other than standing and watching, the male did not respond to the female's extraordinary behavior.

During the 80 - day observation period, the male chased the female vigorously around the outside enclosure on eight separate occasions, usually for 4-5 laps. All but one of these chases were both initiated and terminated by the male; the exception was on 23 September when the female broke and ran after the male who had rubbed her buttocks with his chin for about 5 minutes and then made an intention movement to mount. The male roared, bellowed loudly, and whistled several times as he chased the female. The female never chased the male.

Except for two occasions at the start of a chase when the male attempted to lift the female with his horn in the inguinal region while she was in a corner of the inside cage, and she slipped in struggling to extricate herself, there was no danger of serious injury to the female before or during the chases. Independently of chases, Tarun occasionally exhibited violent aggressive behavior by roaring, whistling, bellowing, banging the wall, and scraping his face against the wall or steel door-- and at the same time urinating profusely (Figure 2).

In summary, Rajkumari and Tarun interacted in a wide variety of behavioral activities at various times through the day. The female made most of the advances during each of the proestrous periods and the male began to take the initiative more often as Rajkumari approached estrus. Seemingly, the female played an active role in arousal of the male's libido. Tarun chased the female when first reintroduced to her, and again on several occasions about one week before each estrus. A lull in the interactions occurred over the 5-6 days preceding each period of mating activity.

#### COPULATORY BEHAVIOR

Attempted Copulation--An hour and a half before the first mount on 12 August, the male began following the female as she walked rapidly from



him; when she stopped he forced her to turn by walking around her, and when she walked rapidly again the male stayed directly behind her. This was the first "driving" behavior to be observed. At the entrance of the pool, the female hesitated and then galloped into the building. An hour later Tarun approached the female indoors, met her with horn-horn contact, forced her outside, and pressed her with his horn until she broke contact and turned. As the female stood quietly, the male placed his foreleg against her thigh and at the same time rested his chin on her rump. Then he raised his leg, pressed his carpal joint against the vulva, and rubbed his cheek on her rump. He raised his right leg and placed his foot on Rajkumari's back; then he placed his left foot on her back and gradually worked both feet forward. Full erection occurred as the male mounted. However, Tarun was too far forward, and he did not achieve intromission, his penis passing under Rajkumari's abdomen. The mount lasted about 5 minutes and he ejaculated externally.

The pattern of behavior over a 20-hour period of attempted mating on 12-13 August is shown in Figure 4. Nocturnal observations were made with the night-vision image-intensifier scope aided by the light from a single floodlight mounted on the eaves of the building and directed upward. Because of the limited visibility nocturnal vulval flashing and horizontal urine-squirting may be missed, and the pattern of these signals in Figure 4 may not be an accurate reflection of the female's total estrous behavior. Other details recorded in the graph clearly depict the course of events.

During the first two mounts, the female stood firmly; on the next four, she walked out from the male each time after tolerating mounting for less than 5 minutes. Between mounts the male followed the female around the outside enclosure and through the cages without pursuing her aggressively. When the female began resisting the mounting, the male began driving her aggressively. Often she chose to circle tightly around a stump, which made it difficult for the male to mount or stay mounted. At times the male ran on his hind legs in an effort to keep his forefeet on the female as she circled the stump. Not until 3 1/2 hours after the first mount did the male become somewhat rough with the female, putting his horn under her flank and trying to lift as he drove her. The first strong head-to-head encounter occurred at 2310, with the female biting at the male's forehead; but a mount followed immediately, and 5 minutes later both lay together in a muddy wallow for 10 minutes. At 0015 the male searched in vain for the vagina as the female stood cooperatively for 5 minutes; finally he dismounted while the female stood firm.

On the next mount the male achieved partial intromission for the first time. The female continued to stand quietly on all but two of the subsequent mounts. When the female stood well, the male often scraped his chin down-







ward forcefully on her rump, much as he did against the wall of the cage when "enraged", and rubbed his chin from side to side across the female's back, much as she did at times while standing over the reclining male. From 0236 to 0740, no mounts occurred although the male made 5 attempts. Neither animal spent much time lying down during this period (Figure 4).

When the female lay down, the male nudged her strongly in the shoulder, bit her ear, and rubbed her back with his prehensile lip. The female walked, often rapidly during most of the 5-hour period when she did not allow the male to mount; she appeared uninterested in standing. At 0540 the pool was refilled and both animals immediately began bathing frequently, but only for short periods ( 15 min). The male followed the female in and out of the tank, around the enclosure, into and out of the cages; the female began whistling again with attenuated, high-pitched notes, and frequently urinated in horizontal squirts, occasionally flashing her vulva. At 0800, the male began to drive the female persistently and an hour later the pair began an intensive effort to mate. With excellent cooperation from the female, six mounts occurred over a 2-hour period (Figure 4), but the male never achieved full intromission. Attempted mounts occurred over the next 4 hours, until the animals were separated for feeding at 1500 hours.

The male continued to be highly animated and aggressive for about 2 hours after the animals were separated; he finally calmed down, fed, and then slept near the female through the night. The animals had free access to one another beginning at about 1800 hours.

#### COPULATION

Beginning at 0330 on 30 September, the female approached and backed into the male several times. From 0400 onward, the male, now motivated, pursued the female persistently. The animals stayed outside in the rain from 0520 to 0540, and thereafter walked continuously from cage to cage. The male attempted to mount the female inside the cage at 0620, and at 0630 they walked outside where they were not visible for about 5 minutes. Shortly thereafter the male mounted the female. The mount was observed from 0640 to 0750. The male presumably ejaculated during bouts of pelvic movements which occurred at intervals of 2-5 minutes. The female moved about slowly within an area of about 50 m<sup>2</sup>, the male remaining mounted without difficulty. He occasionally relaxed with his head on the female's back, but lifted his head when thrusting.

After the copulation Rajkumari came directly into her cage, walked around restively, and emitted frequent grunts and soft, high-pitched whistling sounds. Tarun lay down in a muddy area of the outside enclosure and water vapor rose from his back. When he stood up 45 minutes later, the female approached him, rubbed her side against his hindquarters, and walked back into the building followed by the male. Both animals

moved in and out of the cages often during the remainder of the day, usually in close contact.

At 0736 on 1 October, Rajkumari walked slowly to the reclining male, rubbed her nose against his foreleg, nuzzled and smelled his inguinal region and penis, held her chin over the male's back, rubbed her chin on the male's hind leg, and placed her head deep into the inguinal region. The male stretched out his leg to expose his genitalia. Licking by the female was not discernable. The male dragged his hind feet the morning of 1 October, had partial erections to ground level, and engaged in gentle head-to-head contacts with the female.

#### BEHAVIOR DURING PREGNANCY

Rajkumari and Tarun were allowed daytime access to one another daily until 13 July 1973, when construction work required their separation. The animals continued to interact during the period of pregnancy. Before conception and for about 3 months thereafter, the female seemed to be subordinate to the male. However, as pregnancy progressed, she became increasingly aggressive and defended her cage vigorously, not allowing the male to enter. The male took his aggression out on the walls of his cage by banging them violently, a habit which gradually decreased in frequency.

Interactions similar to those during courtship occurred during pregnancy and were almost invariably initiated by the female. She attempted to engage the male in active contact by tossing her head and running from him (inviting him to chase her), by approaching him from the rear and sometimes rubbing her chin over his rump, and by vocalizing with snorts and honks. During her pregnancy, Rajkumari exhibited these behaviors fairly consistently during three separate periods: October-November 1972, January-February 1973, and June-July 1973. Although the male's response to the female's frequent demonstrations of interest was only occasional, he did respond during each of the periods. The female exhibited signs of interest in the male from mid-October to mid-November, 1972, and was able to elicit a response on only three occasions. He chased her on 13 October, pushed her from behind on 15 October and 17 November, and attempted to mount on 17 November. Rajkumari stood during attempted mounting which was little more than an intention movement. The male also responded to the female's sporadic attempts to initiate contact in January and February by attempting to mount on 16 January 1973, and by driving her on 2 February. From mid-June to mid-July, the female approached the male from the rear often, rubbed her chin over his buttocks on six occasions; and invited him to chase once. On 13 July 1973 the male responded to an invitation to chase by driving, chasing, and attempting to mount.

During the first part of her pregnancy, Rajkumari developed a habit of eating feces, mainly those of the male; this habit peaked within the first 2 months, and had completely tapered off by the seventh month.

Foetal movements were first noted on 19 November 1973, 10 weeks before parturition, and a definite enlargement of the udder was observed on 14 December at which time the female became increasingly restive and aggressive. She ran to the bars of the cage and snorted when seemingly annoyed by large crowds of visitors and when approached at the bars by keepers and researchers. In late December she was given access to two adjacent cages, one covered with canvas to provide privacy. Between the short-lived spasms of irritability and agonistic behavior, Rajkumari was usually calm; her appetite increased and she slept for long periods. FONZ observers kept watch from 1600 to 2400 and from 0400 to 0700 between 4 and 30 January. During these observations Rajkumari divided her time between the sheltered and open cages, lay down for an hour or two at a time, fed often, and became restless whenever the male persistently banged the steel door and wall. As parturition approached, she became more and more intolerant of anyone coming near the cage at any time of day.

#### PARTURITION

Rajkumari's aggressiveness toward keepers appeared to reach a peak on the afternoon of 29 January 1974 and a continuous watch was begun at 1630. Throughout the night she paced back and forth along the walls and bars of her cages, lying down often for less than 10 minutes. While pacing she vocalized almost continuously; and starting at midnight she whistled often (53 times) until 0700, mostly a brief attenuation of her full one-toned whistle. Her pattern reversed itself at daybreak of 30 January and she spent most of the time lying down, rising frequently and walking for brief periods of less than 10 minutes. Her udder and vulva were enlarged and red. The following sequence of events occurred:

0700 - First slight drainage of urine.

0840 - Several long periods of fluid elimination began; fluid amber in color, some clear and yellow; color changed within a given outflow.

1307 - Fluid passed in horizontal bursts and dribbles, often with contractions and vulval flashing.

1315 - Female began straining hard, lying on her side and pushing with her legs against the floor; respiring heavily.

- 1320 - Female rolled almost onto her back, and assisted by the momentum of the roll, she rose to her feet; contractions of vulva followed.
- 1327 - Foetal membranes exposed for first time, then alternately exposed and retracted.
- 1340 - Straining increased and membranes pushed through vulva.
- 1343 - Forefeet within foetal membranes protruded 2-3 cm from vulva. Female alternately lay down, strained, and got up and walked slowly during labor.
- 1355 - Female rose to her feet, strained, and dropped the foetus, leaving the membranes protruding from her vulva.

As soon as the foetus dropped, Rajkumari whirled around and touched the calf, "Patrick", with her nose, emitted several abbreviated soft whistles, licked the calf, exhibited Flehmen, and intermittently nibbled and licked his hind feet. Patrick's eyes opened immediately at birth; by 1400 he made sucking movements and struggled to stand. He succeeded in standing 105 minutes later, and when taking his first steps at 1550, immediately began searching for the female's udder (Figure 5). From a reclining position, Rajkumari lifted her hind leg and rolled onto her side to expose her udder to the calf. For 80 minutes the calf searched for the udder, alternately dozing, waking, struggling to his feet, and tossing his head. During this time the female tried to orient the calf to her udder by rolling farther onto her side and lifting her leg.

At 1705 the afterbirth was expelled; the female stood up and began eating it. Fifteen minutes later Patrick nibbled along the female's flank and thigh and finally nursed 3 hours and 35 minutes after being born. It seemed easier for him to nurse when the female stood. She lifted her leg to provide easier access to her udder. The calf followed his mother, vocalizing in a squeaky bleat, searching, finding and losing the nipple repeatedly. By 1818 he was fairly well oriented to the location of the udder and had little difficulty nursing thereafter. Throughout the process of parturition and afterwards, Rajkumari was remarkably calm; all the restiveness and aggression that had developed with the approach of the birth suddenly ceased with the onset of labor.

#### POSTPARTUM ESTRUS CYCLING

Rajkumari's periods of estrus occurred at irregular intervals after parturition (Table 1). Dates of estrus were established by the occurrence of vulval flashing, urine squirting and dribbling, and anogenital rubbing.



A general increase in alertness, restiveness, inclination to participate in play, and frequency of Flehmen by both the female and the calf seemed to be correlated with estrus.

Rajkumari exhibited two "strong" estrous periods and several "weak" estrous periods during the 8 months following parturition (Table 1). The first estrous period began 34 days postpartum. The wide variety and 5-day duration of estrous behaviors indicated a strong, clear-cut heat period. Urine-squirting occurred on 7 March, vulval flashing 6-9 March, and anogenital rubbing on 6-7 March. An increase in Flehmen was also observed. The strongest indications of estrus occurred from 24 May to 3 June when vulval flashing, urine squirting and dribbling, and Flehmen were observed nearly every day.

#### ATTEMPT TO REBREED

The female was separated from her calf in the evening and given access to the male for an hour on 1 June 1974 and for 30 minutes the evening of the next day. She was extremely aggressive and initiated vigorous encounters with the male, charging, butting, biting, and roaring at him. Tarun usually held his ground, but occasionally ran from the female, who chased him around the yard. Tarun had not been chased by the female previously. The female's strong concern for her "lost" calf, as indicated by pacing restlessly and vocalizing with rapid, successive, abbreviated whistles, alternated with bouts of agonistic behavior toward the male. The encounters were significant in demonstrating that Rajkumari would not accept the male at 4 months postpartum and that breeding at this stage was impossible.

During August the male was put in the outside enclosure adjacent to the female and calf for an hour in the afternoon. This arrangement afforded some visual and olfactory contact between the male and female without necessitating the separation of mother and calf. At first the male was highly excited, climbed on the fence, rubbed his horn vigorously, squirted urine profusely, and ran along the fence. Rajkumari seemed mildly interested and walked around the yard occasionally, but spent most of her time inside the cage. Patrick was curious and interested, although frightened at first. He came out only with his mother on the first three afternoons and stayed very close to her. Eventually, he ventured outside by himself and even snorted at Tarun. He tossed his head, ran along the fence, and snorted several times, exciting Tarun who increased urine-squirting and vigorously rubbed against the fence. Occasionally the three rhinos smelled each other by getting as close to their respective sides of the wall as possible.

Since Rajkumari had exhibited her strongest estrous behavior and accepted mounting in August of each year from 1970 through 1972, a period of well-defined signs of estrous behavior was expected in August 1974. Preparations were made to place the animals together at the beginning of the estrous symptoms, rather than late in the period as on 1-2 June, with the hope that Rajkumari would be more receptive to the male. No periods of overt estrus were evident in August or September 1974, and no endeavor was made to rebreed the animals.\*

## DISCUSSION

It appeared that considerable orientation was required to augment Tarun's innate reproductive behavior before successful copulation could be accomplished. He may have acquired effective positioning and intromission 2 years earlier than his first copulation had he been given an opportunity to engage in courtship around-the-clock, with free and continuous access to the female. Also apparent was an astonishing self-restraint during times of intense aggression. The small size (614 m<sup>2</sup>) and obstacles (fences, gates, ramps) of the outside enclosure provided an array of hazards that might have led to accidental injury.\*\* Yet Tarun did not seriously injure the female during wild chases, violent horn-to-horn encounters, or while driving the female persistently. Although additional evidence is needed, the observations in this study indicate that considerable manipulation of courtship activity can be accomplished safely to help increase reproductive success of the Indian rhinoceros in captivity.

Prior to his first copulation (at 14 years of age), Tarun urinated almost exclusively by squirting posteriorly in frequent bouts, and his penis was almost continuously extruded several centimeters from the sheath. After the copulation, horizontal spraying was much reduced, long urinations not coupled with defecation became frequent, and the penis remained inside the sheath most of the time. The frequency and intensity of so-called "tantrums" or fits of rage, during which Tarun pounded and scraped the walls and steel doors, also declined after the copulation, suggesting that Tarun underwent some important hormonal and behavioral transitions. How these changes will affect Tarun's next copulation will be particularly interesting and significant.

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\* Due to construction, it has not been possible to rebreed the pair to date.

\*\* The outside enclosure is now being enlarged to about 1,000 m<sup>2</sup> and redesigned to reduce hazards by eliminating fences and providing an "island" around which the animals can run during chases.

The importance of nocturnal activity was well established during the present study. Courtship behavior was especially intense at night when the animals were first placed in continuous contact. The continuous pacing of the female when estrus was imminent occurred almost exclusively at night. Copulatory behavior began at dusk in mid-August and continued throughout the night.

A lull in courtship activity occurred for about a week before each of the two estrous periods, comparable to a 4-5 day period of unresponsiveness of a male tiger prior to copulation noted by Kleiman (1974). The observations indicate the importance of maintaining an alert for the time of copulation irrespective of the signs of behavioral estrus.

Indications of estrus were weak during the onset of each of the two periods in the summer of 1972. According to Lang's (1961) observations at the Basel Zoo, horizontal urine squirting, vulval flashing, and whistling are particularly reliable indicators of estrus, but all of these signs were weak and erratic in Rajkumari's case, possibly because she had not yet experienced copulation. After parturition she exhibited two strong periods of estrus lasting for about 4 and 7 days. Our observations suggest that behavioral estrus may be more evident and clear-cut following the first birth.

Vaginal discharge was noted only on the day Rajkumari accepted mounting by the male and on only one day during the two strong post-partum heats. No discharge was observed in the predawn hours on the day of copulation. Seemingly, although the female Indian rhinoceros exhibits signs of estrus over a period of days, she accepts the male only at a peak of readiness, at which time she releases a vaginal discharge. This may indicate that estrus lasts for less than a day, rather than the several days over which signs of estrus may be apparent. Unlike the Equidae in which the zebra and horse accept several copulations over an estrous period of 2 to 9 days (Wakernagel, 1965; Nishikawa and Hafez, 1968), only one copulation occurs at a given estrus in the Rhinocerotidae (Lang, 1961; Schenkel and Lang, 1969).

One of the best indicators of copulatory activity was a "dance" by the male, performed on the morning of the day mounting began on 12 August 1972 and again 3 days prior to the copulation on 30 September 1972. Dragging the hind feet, which began about a week prior to the copulation, seemed to have been another of the male's behavior correlated with the approaching copulation.

It is noteworthy that, in 23 mounts over a 15-hour period in mid-August 1972. Tarun achieved intromission only three times and then only partially. All mounts were of less than 15 minutes duration, far short of the average

of about 60 minutes (Schenkel and Lang, 1969) required for complete copulation in the Indian rhinoceros. Resumption of an intense copulatory effort by both animals after a quiescence of about 5 hours (0236-0740) leaves little doubt that artificial termination of copulatory activity is unnecessary because of physical exhaustion. Also there is no evidence for exhaustion of spermatozoa and semen and it therefore seems dubious to terminate copulatory behavior on the basis of physiological exhaustion of the male's reproductive capability. The period of concentrated effort by the male and female on the morning of 13 August may have contributed importantly to the successful copulation on 30 September 1972.

From the present study the best procedure for achieving reproduction in pubertal captive Indian rhinoceroses is to allow complete freedom of access of the animals to one another at those seasons of the year that are most favorable for breeding.

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Table 1. Evidence of Estrus Subsequent to Parturition.

Dates (1974)	Vulval flashing	Horizontal urine squirting	Urine dribbling	Flehmen	Estrous interval (days) <sup>‡</sup>
5 March				+	34*
6 March	+			+	
7 March	+	+		+	
8 March	+			+	
9 March	+				
29 March				+	24
31 March	+	+	+		
25 May			+		57
26 May	+		+	+	
28 May	+	+		+	
1 June	+	+	+		
2 June	+	+	+	+	
3 June		+		+	
18 July	+	+			54
19 July	+	+			

<sup>‡</sup> Interval between first days of estrous periods.

\* Interval between parturition and first estrus.

## LEGENDS FOR FIGURES

Figure 1. Pattern of Rajkumari's behavioral activities during the onset of two periods of estrus (vertical shaded lines) in 1972. Vf = vulval flashing, Hu = horizontal urine squirting, Wh = whistling, Pa = pacing, Vd = vaginal discharge, Su = squirt at end of normal urination, Bm = backing into male, Bo = backing into objects, Ic = invitation to chase, Fl = Flehmen, Lg = licking male's genitalia, Ll = licking male's leg, Sg = smelling male's genitalia, Ht = head tossing, Am = approaching male, Bu = brown material in urine, Ts = tail swishing, Tc = tail muscle contraction, St = stroking male with chin, Nm = nuzzling male with prehensile lip, Th = threatening male, Sa = salivation during head-to-head encounters, Mh = mutual horn rubbing.

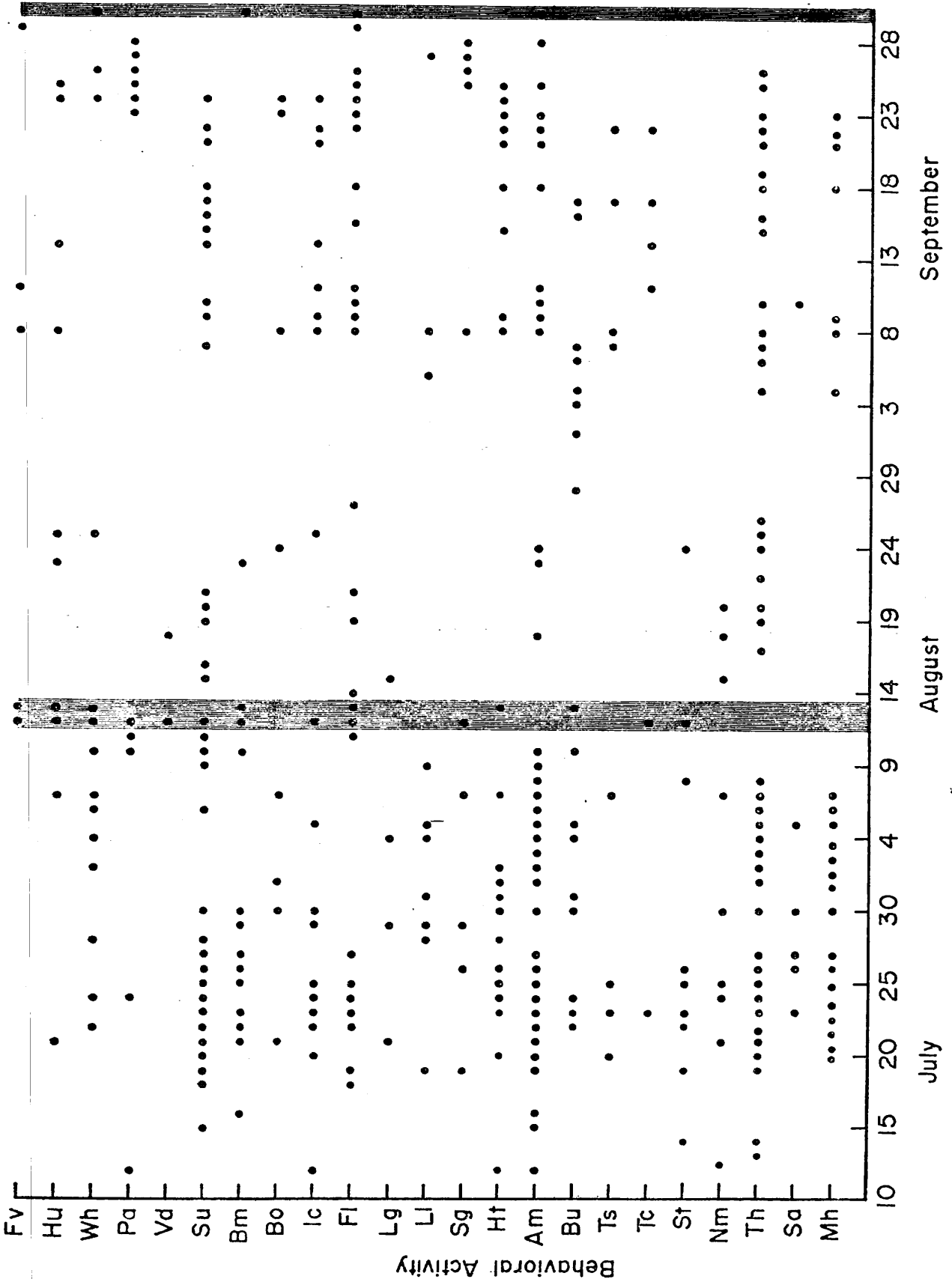


Figure 2. Pattern of Tarun's behavioral activity in relationship to the female's estrus (vertical shaded lines) during the summer of 1972. Mt = mounting, Sv = smelling vulva, Df = driving female, Da = dance, Cf = chasing female, Wh = whistling, Ro = roaring, Bw = banging wall, Fs = Flehmen with simultaneous urine squirting, Dh = dragging hind feet, Du = drinking female's urine, Eu = eating hay soaked in female's urine, Er = erection, Fl = Flehmen, Ht = head tossing, Af = approaching female, Lu = long urination, Tr = testes retracted, Td = testes descended, Sa = salivation during head-to-head encounters, Mh = mutual horn rubbing.

Figure 3. Mutual horn rubbing, which was usually associated with vigorous head-to-head encounters involving clashing of horns, pushing with horns, open-mouth biting by the female, female vocalizations, and other aspects of ritualized "fighting."

Figure 4. Behavioral activities of the male and female during 20 hours of mating behavior. Mt = mounting, Am = female approaching male, Dr = male driving female, Vp = male pressing carpel joint in vaginal area, Vs - male smelling vagina, Ly ♂ = male lying down, Fl = male Flehmen, Wh ♂ = male whistling, HH = head-to-head encounter, Bm = female backing into male, Hu ♀ = horizontal urine squirting by female, Vf = vulval flashing, Wh ♀ = female whistling, Ly ♀ = female lying down.

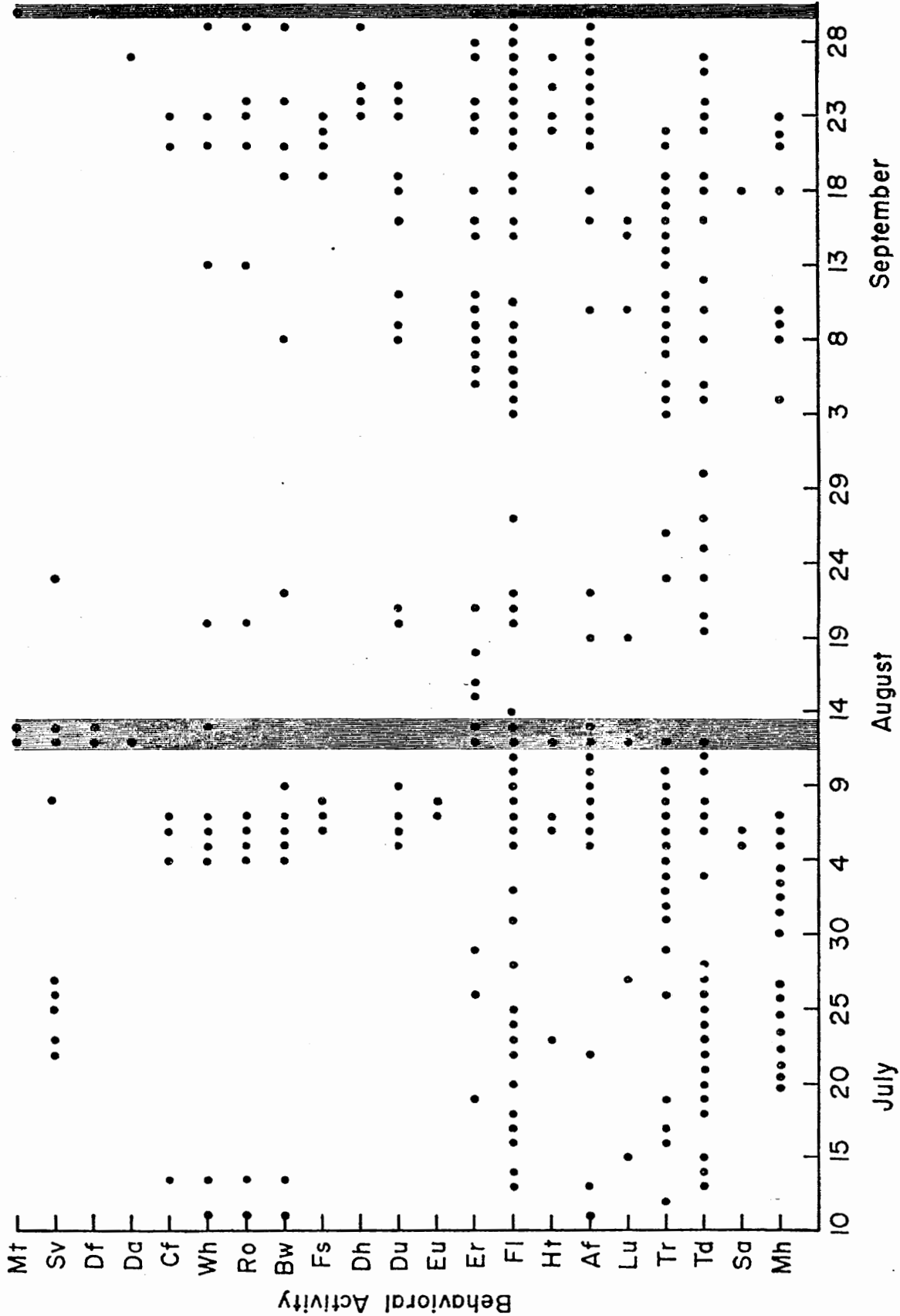
Figure 5. Rajkumari and Patrick a few hours after birth (while calf was orienting to the udder) Photograph by Wolfgang P. J. Dittus.



September

August

July



# AAZPA

50<sup>th</sup>  
YEAR

CONFERENCE SEPT. 29-OCT. 3, 1974



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PHILADELPHIA ZOO 100<sup>th</sup> YEAR