introduction of sexually mature animals was practised.

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Birth of an Indian rhinoceros *Rhinoceros unicornis* at the National Zoological Park, Washington

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A ♂ Indian rhinoceros *Rhinoceros unicornis* born at the National Zoo on 30 January 1974 represents the first live birth of the species in the Western Hemisphere (a stillbirth occurred at Milwaukee Zoo 30 January 1967). Thirteen have been born at Basle Zoo since the first ever captive birth on 14 September 1956 (*2*; *4*; pers. comm.), and at least eight more have been born in zoos elsewhere (*3*). The importance of achieving greater productivity in captivity is evident from the precariously low levels of wild populations: 600–700 in the Kazaringa Sanctuary in Assam and about 200 in the Chitawan Rhino Sanctuary and vicinity in Nepal, and 100–200 in other sanctuaries in India and Nepal. At some stage in the future it may be necessary to draw upon the captive reservoir for reintroduction into natural environments. The birth at the National Zoo is particularly interesting in that both ♂ and ♀ were immature at the time of their arrival at the zoo and required considerable copulatory orientation before successful breeding was accomplished.

The ♂ 'Tarun' arrived at the zoo on 25 May 1960 at an age of about 2½ years. He was barely weaned when captured by the Assam Forestry Service and was kept in a corral at Gauhati Zoo for nearly a year afterwards (*5*). Weaning of Basle Zoo's first-born occurred at *c.* 16 months (*3*), and it is likely that a similar length of time is required in the wild. The ♀ 'Rajkumari' or 'Raji' was born at Gauhati Zoo on 2 April 1963 (*1*) and arrived in Washington with her mother on 16 December 1963. About two weeks later the mother died of haemorrhagic gastroenteritis and the youngster was hand-fed for the next six months. As a consequence, she became very tractable, in contrast to Tarun's rather unpredictable and occasionally extremely aggressive temperament.

BREEDING HISTORY

The rhinos were first placed together on 1 July 1968, as a result of which the ♂ drove the ♀ intensively but without attempting to mate. After another week of separation they were reintroduced and

were kept together every day (0800–1500 hours) for the rest of the summer without exhibiting breeding behaviour, suggesting that the ♀, now five years old, had not yet achieved reproductive maturity. From October 1968 to 1 January 1969 the animals were continuously apart. Between that date and the following May they were put together for one day (daytime only) on seven occasions but no mating was observed. After May 1969 they were again put together almost every day, from 0800 to 1500 hours.

No breeding behaviour took place until 9 August 1970. The ♀ was 7·3 years old at the time. Oestrus began at about 1000 hours and watch was kept continuously until 2335 hours, when the pair was separated for the rest of the night. The ♂ mounted the ♀ at least seven times, usually only momentarily and never for longer than ten minutes. The ♀ squirted urine horizontally at least six times, backed into the ♂ four times, exhibited Flehmen (lip curling) (*7*) twice and had a strong discharge from the vagina – all positive manifestations of oestrous behaviour (*3*). She also emitted a two-toned whistle – subsequent whistling has always been one-toned. The ♂ was heard whistling at least four times, either when trying to mount or when chasing the ♀. Once for 30 seconds he 'danced', forefeet leaving the ground as he jumped into the air, tossing and circling his head and at the same time snorting loudly. He chased and drove the ♀, often in a tight circle. The next morning, during a 1½-hour observation period, the ♀ was twice heard whistling and the ♂ twice seen driving, once circling and twice chasing the ♀.

On 6 November, the ♀ was again clearly in oestrus, but she was with the ♂ only until midnight, apparently toward the end of the oestrous period and consequently no mating occurred.

The next breeding attempt took place almost a year later, on 26 August 1971, and lasted from 1452 to 2355 hours. One mount took 17 minutes and another ten; ten additional mounts occurred, but never for more than about four minutes. At times the ♂ achieved partial intromission, at others he ejaculated externally, and all of the mounts were characterized by difficulty in locating the vagina, usually because the ♂ was too far forward. He would drive the ♀ frequently, often in a tight counterclockwise circle, but only once did he chase her. The ♀ squirted urine horizontally some ten times, but did not whistle. As in the previous year, this effort to mate was unsuccessful.

From December 1971 until July 1972 (except for two weeks in May) the rhinos were purposely kept apart. They were put together again on 11 July and observed daily in order that we might establish a behaviour pattern. Two days later a wild chase around the enclosure seemed to herald oestrus but it did not materialize. The pair was brought together every day from 0700 to 2100 hours, and had constant access to one another except for two hours at feeding time mid-afternoon. At night they were separated, except on the nights of 24 and 26 July when they remained together for preliminary observations of their nocturnal behaviour. On 11 August, volunteers of the Friends of the National Zoo (FONZ) began to keep a nightly watch between 2100 and 0600.

On 12 August, starting at 1850, the ♂ mounted the ♀ for the first time. In the next 15 hours, 23 mounts took place, for 12 of which the ♀ stood well. Partial intromission occurred at least three times and external ejaculation on five occasions, but the ♂ failed to achieve full intromission and no mount lasted longer than ten minutes. In addition, five attempted mounts took place after the last mount, and 14 other attempts during the 15 hours of the ♀'s receptivity. By feeding time on 13 August both animals were exhausted, and slept almost continuously for the remaining daylight hours and through the night. The ♀ whistled occasionally during the onset of oestrus, but

not during oestrus itself. No horizontal urination or flashing of the vulva occurred until she was fully receptive.

The procedure of keeping the rhinos together day and night – except for two hours at feeding time mid-afternoon – was continued until the next oestrus 48 days later, on 30 September. This happened with almost no preliminary signals. The animals walked outside at daybreak during a moderately heavy rain, the ♂ mounted immediately, intromitted without apparent difficulty, and remained mounted for 70 minutes – slightly longer than the average mount for the species (*3*). There were periodic bouts of pelvic movement, presumably followed by ejaculation. Conception took place and parturition followed 487 days later on 30 January 1974.

After mating, the animals were separated at nights. In the first three weeks of November, daytime access was extended from 0700 to 2100 hours and, with the help of FONZ volunteers, observation was kept to ascertain whether oestrus would recur. It did not, and we assumed that Raji was pregnant. The matter, however, remained uncertain until the first foetal movements were detected on 19 November 1973.

REPRODUCTIVE BEHAVIOUR 1972

Behaviour of the ♂: During the onset of the first oestrus, which occurred 32 days after the animals were placed together Raji and Tarun exhibited a rich variety of interactions and individual behaviour routines. Despite their six months' separation, the ♂ seemed to restrain his aggression on their first day together, confining himself to roaring and attacking the wall of the cage rather than chasing the ♀. The first chase occurred two days later; the ♂ roared and whistled as he pursued the ♀ around the outside enclosure; and, as on six other occasions, he stopped the chase abruptly, ran into the inside cage, and (still roaring and whistling) began slamming the side of his face against the wall and vigorously scraping his chin downward from the highest point he could reach. At one time the ♀ suddenly stopped short and wheeled 180° to face him, whereupon he quickly turned 90° and galloped into the cage to ram the wall. At other times the termination of the chase was either not seen or was not recorded in sufficient detail to be certain of the ♂'s behaviour.

Tarun smelled the ♀'s urine and performed Flehmen almost daily, and with the approach of oestrus began to lap and ingest urine from the drainage trough prior to Flehmen; at this time he also ingested urine-soaked hay. Horizontal, posteriorly directed spray urination increased, and was combined simultaneously with Flehmen as the ♀ neared oestrus.

Erection (with penis appressed to the abdomen) was observed only three times prior to the first oestrus, and as far as we know did not occur during the two weeks before mounting first began. With the approach of the second oestrus, on the other hand, full erections took place daily. No attempts to mount were seen before the 15-hour period of copulatory activity on 12–13 August. An isolated period of intensive horn rubbing occurred between 21 July and 7 August and during the first half of this time the testes were usually descended; in the latter part they were mostly retracted. The ♂ was capable of retracting and descending them in a matter of seconds, and often they remained retracted for at least part of the day. Prolonged urination was seen only twice and only prior to defaecation. On 13 August, however, he was seen to urinate steadily for about two minutes with strong pulsations. Such long urinations, unrelated to defaecation, increased in frequency during the ♀'s pregnancy. A few days before oestrus the ♂ also began to drag his hindfeet along the ground.

The most consistent guide to the ♂'s readiness to mate was his 'dance', in which he lifted his forefeet off the ground, whirled around first in one

direction and then the other, and at the same time tossed his head vigorously up and down and in circles and urinated almost continuously in a rapid succession of spurts. This routine took place three times in one hour on 12 August and once on 27 September.

Behaviour of the ♀: During the onset of oestrus, Raji almost invariably initiated contacts between the two, often going to the ♂ as soon as he lay down. She rubbed her chin against his side, back or rump; licked his hindleg steadily for up to 15 minutes or licked his genitals for 5–10 minutes; or backed into him and rubbed her rump against him, the more so as oestrus drew near. Head-to-head encounters occurred several times daily, at which time the ♀ usually snorted or honked loudly and bit at the ♂'s forehead, sometimes inflicting minor wounds.

The ♀ did not exhibit positive oestrous signals, such as isolated horizontal squirting of urine (without the normal long preliminary urination), two-toned whistling and flashing the vulva, as described by Lang (*3*). She would back into the wall, fence or stump and rub her anogenital area, toss her head and run from the ♂, 'inviting' him to chase her, and as she approached oestrus she increased urine testing by Flehmen. Although she had a vaginal discharge, flashed her vulva and sprayed urine horizontally at least 20 times during the attempted mating on 12–13 August, neither before the first nor the second oestrus was there any clear indication prior to mounting of its imminence. The most reliable index of impending oestrus was the persistent pacing that began about 1930 hours on 23 September and lasted without interruption for nearly 17 hours; the following night she paced constantly for some 12 hours. Pacing also took place on 10 and 11 August, but only for a few hours, and its significance was not appreciated at the time. Strangely, horizontal urination was most abundant the night of 24 September, when she squirted 25 times over a brief period of 48 minutes; it occurred six times the following night and was not reported thereafter, even on the day of conception. The mating on 30 September was unexpected, and it was only in retrospect that the subtly altered precopulatory behaviour of both animals could be fully evaluated.

POSTCONCEPTION PERIOD

The rhinos were allowed daytime access to one another daily until 13 July 1973, when relocation of the Black rhinos *Diceros bicornis* and construction work disrupted the routine. Periods of observation conducted at least twice a week indicated that ♂–♀ interaction continued during pregnancy. Before conception and for about three months afterwards, the ♀ seemed to be subordinate to the ♂. As pregnancy progressed, however, she became increasingly aggressive, defending her cage vigorously and not permitting the ♂ to enter. Apparently intimidated, the ♂ transferred his aggression onto the walls of his cage. His behaviour over the years had been characterized by violent banging and scraping of his head against the walls, but this activity seemed to intensify during Raji's pregnancy and ameliorated again after the two were completely separated in mid-July.

Interactions similar to those during courtship occasionally happened. Usually the ♀ initiated the activity and the ♂ remained unresponsive. By tossing her head and running from him, Raji invited Tarun to chase her in 14 separate instances during the ten-month period. She would often approach him from behind and rub her chin over his back and rump; back into him; rub her anogenital area against him, or some object; vocalize with honks and snorts (without whistling); and stood for the ♂ when he attempted to mount (7 November 1972, 6 January and 13 July 1973). Twice the ♂ chased the ♀ and on four other occasions he attempted to drive her from behind.

During the first part of her pregnancy, Raji developed the habit of eating faeces, mainly those of the ♂. Ignoring his attacks, she would often enter his cage to feed on them. This behaviour began about two weeks after conception, reached a peak in the next two months and died out completely by the seventh month.

Six weeks before parturition the udder was first seen to enlarge, and at the same time Raji became increasingly restless and aggressive. She ran to the bars of the cage and snorted at crowds of visitors and at keepers and research workers who approached. Eventually she was given access to two adjacent cages, one of which was covered with a canvas tarpaulin for privacy. Between the short-lived spasms of irritability and agonistic behaviour, Raji was usually calm. Her appetite increased and she slept for long spells. FONZ observers kept watch from 1600 to 2400 and from 0400 to 0700 hours between 4 and 30 January. During these periods, the ♀ divided her time between the sheltered and open cages, lay down for an hour or two at a time, fed often and became restive whenever the ♂ persistently banged the steel door and wall. As parturition approached, she became increasingly intolerant of anyone coming near the cage at any time of day.

PARTURITION

Raji's aggressiveness toward keepers appeared to reach a peak on the afternoon of 29 January 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 but only briefly. She vocalized almost continuously and from midnight to 0700 also began to whistle a great deal, mostly a brief attenuation of her full one-toned whistle. At daybreak the pattern reversed and she spent the greater part of her time lying down, with frequent short spells when she would rise.

As the birth approached the ♀ became progressively calmer. Some loss of fluid occurred at 0700 and from 0840 on the flow increased steadily. It was mostly amber in colour but some of the liquid was clear and yellow and the colour within a given outflow changed. Initially there was some horizontal urination, accompanied by contractions and flashing of the vulva. At 1320 she rolled almost onto her back and, assisted by the momentum of the roll, rose to her feet.

Foetal membranes appeared for the first time at 1327 and were alternately exposed and retracted until 1340. During labour Raji lay down most of the time; she rose to her feet a few moments before the foetus dropped at 1355. Instantly she whirled around and touched the calf with her nose, emitted several soft, abbreviated whistles, licked it and exhibited Flehmen and nibbled at its hindfoot. By 1400 the infant 'Patrick' began struggling to its feet, succeeding 105 minutes later. After much searching around the mother's hindlegs and neck, it finally nursed for the first time at 1730. Throughout the whole birth process the ♀ had remained remarkably placid. All the restlessness and aggression that had characterized the approach of parturition ceased abruptly with the onset of labour.

DISCUSSION

Before the successful mating of September 1972, the ♂ had exhibited great difficulty in orienting himself correctly for full intromission. He was often too far forward, and during the preceding attempt in August, even when he moved back to a more favourable position, his penis had had to search widely for the vulva. It is possible that the attempts to copulate in 1970 and 1971, and especially the prolonged effort in August 1972, were necessary prerequisites to breeding in these two virgin animals. In retrospect, it would probably have been best to leave the pair together throughout the night during each oestrus, so as to

acquire as much copulatory experience as possible. The intense nocturnal, as well as daytime, courtship behaviour in 1972 seems to have been a decisive factor.

Reluctance to permit such prolonged around-the-clock interaction stemmed from our fear that the ♀ might sustain injury during the wild chases that took place when the ♂ was in a high state of excitement. In view of his demonstrable self-restraint, there was in fact little danger, although the possibility of an accident in the rather cramped outside enclosure always existed. At Basle Zoo the initial breeding was accomplished by keeping ♂ and ♀ together throughout the night whenever oestrus occurred (*3*). When this procedure first started, the ♂ was five years old and the ♀ had already fully matured in the wild. Breeding took place two years later, suggesting that here too the ♂ needed a long time to learn the proper orientation. The ♀ underwent 19 observed periods of oestrus before conception.

From observations at both Washington and Basle zoos, it seems likely that protracted periods of courtship and copulatory orientation are essential before a ♂ Indian rhinoceros is able to mate correctly; and that successful copulation demands that the animals are kept together on a 24-hour basis, at least for their first breeding experience. The fact that at the National Zoo the pair were isolated from one another for some six months before being brought together for breeding may also have been significant. According to the birth dates given by Lang (*4*) and the oestrous behaviour exhibited by Raji, Indian rhinos in the North Temperate Zone are most likely to conceive between early spring and early autumn.

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