

FUTURE DEVELOPMENTS

The Arabian oryx is a highly social animal and this is taken into consideration before distribution is made to other institutions. If we are to carry out the original intention of holding the Arabian oryx in captivity only until such time as their protection and survival in the wilds is assured, we must make sure that we release individuals bearing temperaments and behaviour patterns identical to those exhibited by the animals which we removed.

In a socially orientated animal such as the oryx, patterns of behaviour are often acquired by young through contacts with adults. The greater the number in a group, the more varied the contact will be and the less the likelihood of development of an abnormal behaviour pattern. Institutions responsible for such animals should maintain as large a herd as their facilities and finances allow. When limits are reached and further distribution is to be made, the same considerations must apply. Although there are many worthy and proven institutions today, rather than release a pair to each it would be far better to release breeding groups to only one of them.

Today's captive Arabian oryx population numbers more than 75 animals located in six collections situated on two continents. In Arabia, there are collections at Qatar, Riyadh and Abu Dhabi, whilst in America there are herds at Phoenix Zoo, Los Angeles Zoo and San Diego Zoo. The potential of such a large number of individuals should sufficiently establish this species in captivity. The primary point of vulnerability is the limited number of collections. However, we at Phoenix Zoo are rapidly approaching our maximum facility capabilities and will shortly be contacting our fellow members of the world herd with a proposal to help relieve this situation.

The Indian Rhino in Captivity

E. M. Lang

HISTORY

From earliest times, the Indian rhino (*Rhinoceros unicornis*) has been treated as a celebrity by man (see Fig. 1). The oldest record of such interest in this large mammal is a seal (Lang, 1961), depicting an Indian rhino, which dates back to the 3rd century B.C.; it was discovered in the Indus Valley near Mohenjodaro (West Pakistan). A mosaic in a Roman villa in Sicily, preserved from the 3rd century A.D., features, among other animals, an Indian rhino. I personally own a Chinese bronze dating from the Ming period (1386–1644); it obviously represents an Asiatic rhino, probably the Javan species. Of wide repute are the pen-and-ink drawing and woodcut by Albrecht Durer, both modelled in 1515 on contemporary descriptions and sketches.

In the year 1748 an Indian rhino was to be seen on tour in Europe. A coin was struck in its honour and, in Venice, it was painted by Pietro Longhi. As early as 1834, the London Zoo possessed an Indian rhino. Two specimens (a male and a female) were kept in Berlin about 1872. Further specimens lived at about that time in the zoos of Cologne, Frankfurt, Hamburg, Vienna, Amsterdam and also in various zoos in America.

In 1971 Wolfgang Ulrich (see Ulrich, 1971, p. 15) estimated the world population of the Indian rhino at only 250 specimens, distributed in national parks in Assam and Nepal. It is therefore high time for zoological gardens to recognize the task confronting them: that of preserving these rare large mammals in captivity with a view to restoring their progeny to regions where wild populations have been exterminated. I consider that it should be feasible to re-establish the Indian rhino, even after generations of captive breeding, in well guarded national parks in the natural areas of origin. The first captive-bred Indian rhino was born in Basle Zoo on 14 September 1956. Since then, 11 more calves have been produced in Basle and eight in other gardens. Our experience of breeding in captivity is thus confined to 20 cases, a modest number indeed. However, according to the 1971 edition of the *International Zoo Yearbook*, in 1970 only 24 male and 20 female Indian rhinos were kept in 25 zoos, and the limited breeding successes to date must be viewed in this light.



FIGURE 1. Indian rhino (*Rhinoceros unicornis*) mother and offspring in Basle Zoo. Note the difference in the shape of the head between adult and infant.

CAPTIVE ENVIRONMENT

1. Accommodation

Establishing the minimum accommodation requirements and defining the optimum conditions: In Basle, the Indian rhinos are kept in three stalls, each 4.5×5.7 m. The floors are fitted with "Stallit" stall tiles which possess a heat conducting coefficient closely corresponding to that of wood. The walls are made of concrete, but, as the rhinos frequently lean against them, they have been lined with vertical wooden boards to reduce loss of heat. Moreover, the boards reduce the tendency of the animals to rub their horns against the wall, though this habit disappears altogether when a cow has a calf. Next to the row of stalls is a

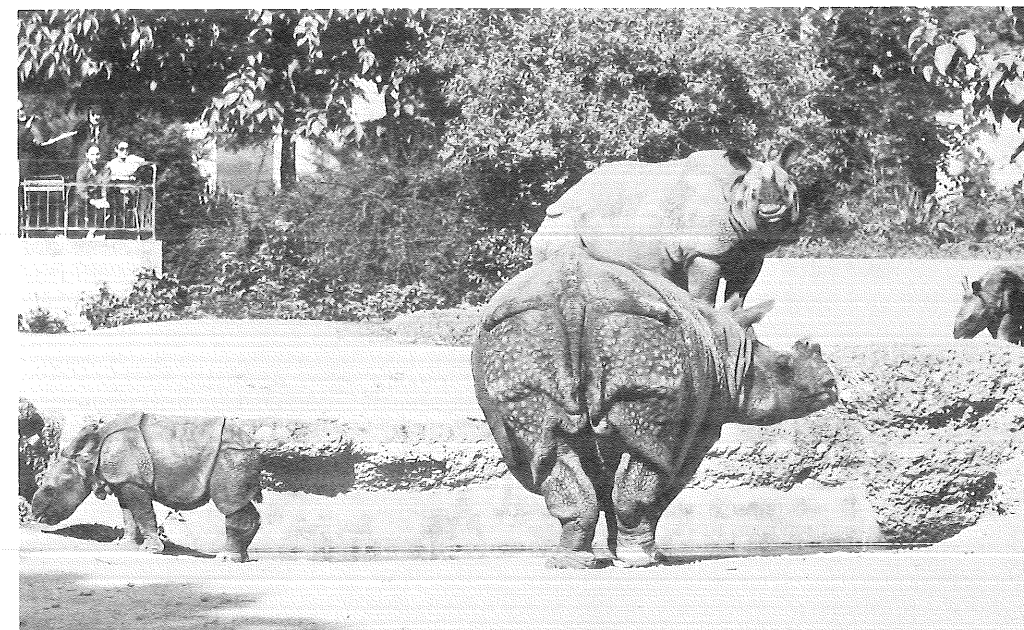


FIGURE 2. This spacious outdoor enclosure for the rhinos at Basle Zoo is regarded as the minimum area which will permit freedom of movement of the animals.

heated pool; a daily bath keeps the animals' skin supple and healthy. A reserve stall serves to accommodate a female from another zoo for mating purposes from time to time. The Hamburg female "Nepali" has already been here twice and the Stuttgart and Berlin females once each. Successful breeding results have been achieved in all four cases. A service corridor, 2–2.20 m wide, which can be divided into sections by lateral doors, runs behind the stalls. The dry moat, separating the stalls from the public area, is 1.5 m deep; it contains gravel distributed to leave a shelf on the animals' side (Lang, 1960).

The house opens out to an enclosure of some 1000 sq. m, surrounded by a ditch of only 170–180 cm wide and 170–190 cm deep. A pool, occupying the middle section, can be heated during the cooler seasons; with the onset of winter, it is drained dry and padded with straw to break the fall of any animal

which should happen to charge into it. The terrain has been sharply profiled; its hilly character, as compared to a flat surface, considerably increases the scope for chasing activities (see Fig. 2). We have the impression that, with respect to overall size, the enclosure verges on the minimum to permit freedom of movement. During oestrus, various aggressive bouts occur which necessitate evasive tactics. If there is not enough space, the animals can seriously damage one another.

A small area of the enclosure has been partitioned off with wooden planks to permit separation of the animals if necessary. For instance, a cow in oestrus is confined there during the preliminary aggressive mating phases, while the bull gives full "vent to his passion" in the main enclosure. The Brookfield Zoo, Chicago, has owned a pair of Indian rhinos for many years, but has never been able to leave the two animals together because of lack of space. I am afraid that several other enclosures, constructed recently, will also prove to be too small. A short while ago Charles Schroeder, San Diego, related the following story: In San Diego Zoo a pair of white rhinos lived peacefully together in a relatively small enclosure. The time went by with no signs of oestrus or of any kind of sexual activity. In 1971, 20 white rhinos were imported to the USA from South Africa. A new pair was acquired for the San Diego Zoo and the old pair was transferred to join the new arrivals in the spacious new enclosure in San Pasqual. The old bull immediately became interested in the cows and by autumn 1971, had already mated with seven of them. Probably, sexual activity was induced by availability of adequate space.

2. Dietary requirements

Our Indian rhino diet is based on the system adopted by H. L. Ratcliffe, Philadelphia, and has been adapted to meet our special requirements by H. Wackernagel, the scientific assistant at Basle Zoo (see Wackernagel, 1966). Ratcliffe holds that all wild animals need a balanced diet, comprising protein, fat and carbohydrates in the right proportions, as well as vitamins and mineral salts. We feed good hay *ad libitum* and a concentrate in the form of pellets. In addition, the animals receive large quantities of fresh branches, bearing buds in winter and leaves in the period of green vegetation. The branches are offered more to provide occupation than extra nourishment. Fresh carrots and other vegetables are also strewn on the hay.

3. General husbandry

We keep our rhinos according to the farming system. Each animal has a stall where it feeds and rests. Otherwise, the animal's time is spent in the indoor pool and in the enclosure. The cows with their young usually pass the morning and afternoon in the main enclosure, while the bull is either in the indoor pool or in the fenced-off area. Over midday, the cows and calves rest in the stalls, whilst the bull enjoys the run of the main enclosure. All of the animals pass the night in their stalls.

The bull is only allowed to join a cow when she is in oestrus and, even then, special precautions are taken. Oestrus in the cow is heralded by expiratory, two-phased whistling; she simultaneously lifts her tail and urinates intermittently, soon impregnating her entire surroundings. The bull shows interest in the cow and reacts with "Flehmen" (lip-curl) and increased urination (Lang, 1961; Schenkel and Lang, 1969). We visit the rhinos every morning. If a cow is seen to be in oestrus she is let out into the fenced-off area. The bull enters the main enclosure. Contact is established and the bull can subsequently "let off steam" by galloping round the enclosure. If necessary, the cow is turned out into the main enclosure for a while and the bull takes her place in the smaller area. After some 5 h, the aggressive phase has usually subsided and the animals are allowed to meet each other. They stand together, or the bull lies down for a time while the cow stands near him, whistling and squirting urine. Finally, they stand side by side (see Fig. 3) and, sooner or later, copulation takes place (see Fig. 4). The intromission of the penis often involves difficulties. Erect, the penis is approximately 1 m long and curves sharply at the tip. Thus, after mounting, the bull is obliged to draw back until the actual copulatory position is achieved. Copulation lasts for roughly an hour, ejaculations occurring at the rate of almost one per minute. After separating, the animals are very tired. In rare cases we have noticed ulceration on the cow's back, resulting from friction caused by the bull's fore-feet. The following day, the animals want nothing more to do with each other. It is then necessary to wait 35–45 days to see whether oestrus sets in again or not; if oestrus does not appear the cow is probably pregnant.

PREVENTIVE MEDICINE

So far we have suffered the loss of only one animal, the adult bull "Gadadhar". The bull was attempting to mount a cow over a fence. She evaded him and he became wedged, sustaining a rib injury. His condition deteriorated after the accident, as a piece of broken rib irritated the pericardium, causing chronic inflammation. To ease the situation, a permanent straw mattress was put in the bull's stall for the whole winter. The straw contained moss mites (Oribatidae) which were carriers of cysts of a tapeworm (*Anoplocephala gigantea*). A hyperinfection with this parasite ultimately resulted in the rhino's death. This example shows us the importance of eliminating potential causes of accident on the one hand and, on the other, of preventing the ingestion of tapeworm cysts, via moss mites, by maintaining a high standard of hygiene. Permanent mattresses should not be used and the enclosure should be closely supervised to keep down moss and grass.

Following parturition, one of our Indian rhino cows suffered from slight endometritis which manifested itself through a chronic yellow discharge from the vulva. She came into oestrus again and mated, and, as no further oestrus occurred, we assumed she was pregnant. The discharge continued, however, and treatment was given. Evidently conception had not taken place for, after a

series of injections of metritis vaccine, the cow again came into oestrus. She then mated and conceived normally.

We feel that Indian rhinos adapt easily to zoo life. However, the importance

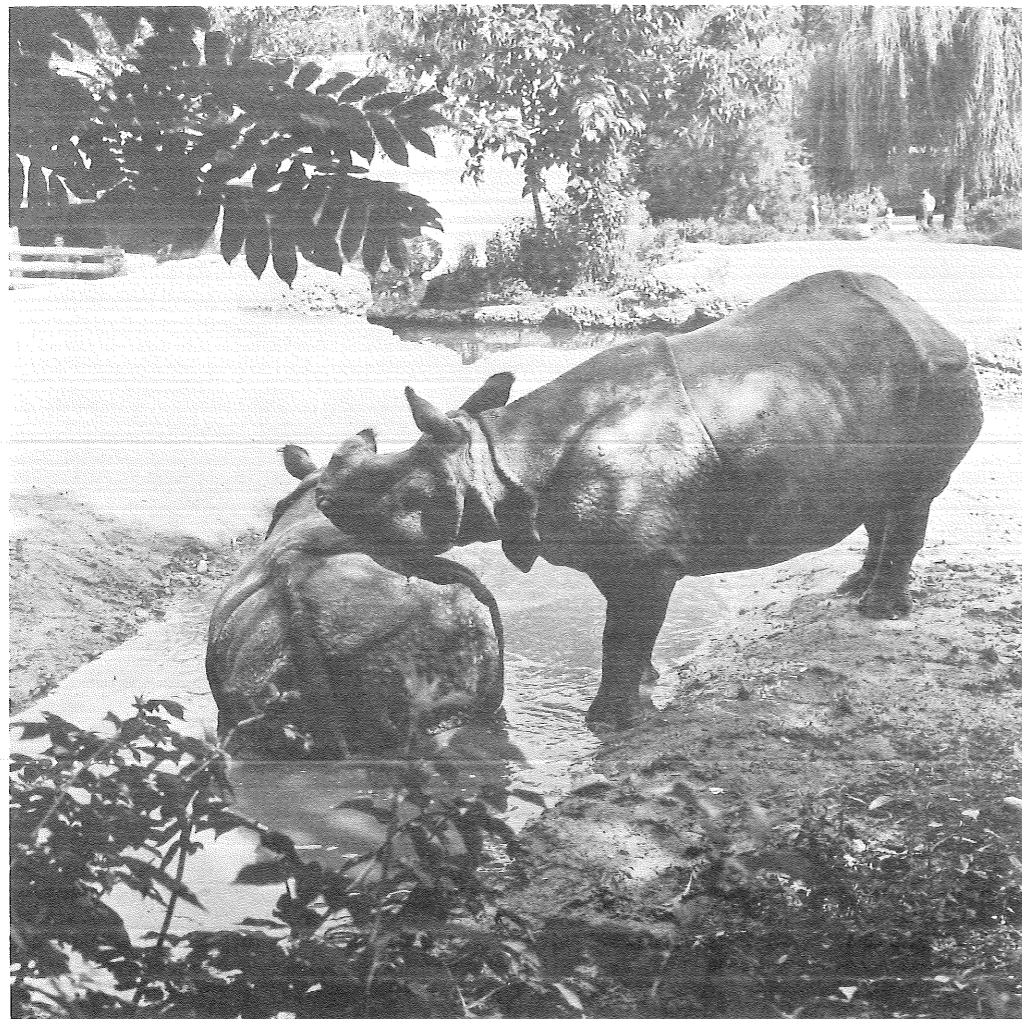


FIGURE 3. In the prelude to copulation, the cow and the bull are seen to remain close to one another without aggressive interactions.

of the right nourishment, on the one hand, and of sufficient space, on the other, can hardly be emphasized enough. If the animals receive an unsuitable diet (i.e. excessive quantities of carbohydrates), they will become fat and sluggish. If the enclosure is too small, the preliminary mating ceremonies cannot take their course, or the crowding-effect blocks the mating urge from the very beginning. Sterility in captivity may be attributed to either of these deficiencies.

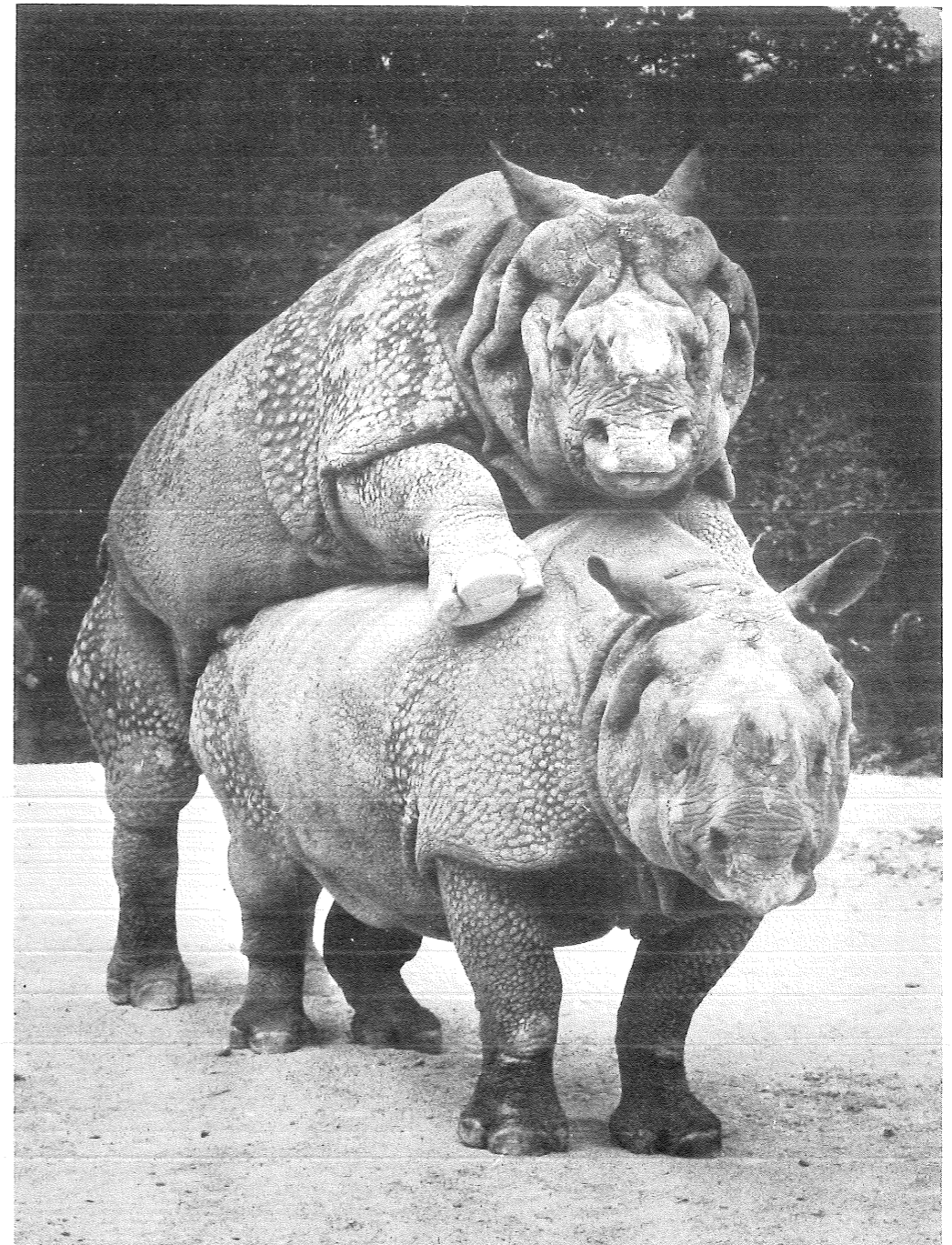


FIGURE 4. When copulation takes place, following the mating prelude, it usually lasts for about an hour.

TABLE 1. International Studbook for the Great Indian Rhinoceros.

Studbook-number	Sex	Studbook-name	House-name	Born	Died	Father	Mother	Location since
1	♂	Assam 1	Kasi	1941	—	—	—	Mysore 1941
2	♀	Kaziranga 1	Kamala-Rani	?	6.5.68	—	—	Brookfield 24.6.48
3	♂	Kaziranga 2	Kashi-Ram	?	13.11.70	—	—	Brookfield 24.6.48
4	♀	Kaziranga 3	—	16.5.48	16.5.48	—	Kaziranga 1	Brookfield 24.6.48
5	♂	Kaziranga 4	Gadadhar	1948	25.11.64	—	—	Basle 30.5.48
6	♀	Assam 2	Tomy	1944	—	—	—	Rome 5.9.51
7	♂	Kaziranga 5	Joymothi	1947	—	—	—	Basle 8.7.52
8	♀	Assam 3	Mohini	?	—	—	—	Whipsnade 16.7.52
9	♂	Assam 4	Kanaklota	?	—	—	—	Philadelphia 17.6.53
10	♀	Assam 5	Kanakbala	?	—	—	—	Philadelphia 14.9.55
11	♂	Assam 6	Ranni	1948	—	—	—	Mysore 1956
12	♀	Kaziranga 6	Many	?	—	—	—	Trivandrum 25.5.56
13	♂	India A	Manik	?	1962	—	—	Whipsnade ?
14	♀	Basle 1	Rudra	14.9.56	—	Kaziranga 4	Kaziranga 5	Milwaukee 20.7.59
15	♂	Whipsnade 1	Mohinjia	18.7.57	—	India A	Assam 3	Milwaukee 20.7.59
16	♀	Kaziranga 7	Nepali II	1956	—	—	—	Hamburg 11.8.57
17	♂	Basle 2	Moola	17.8.57	4.1.73	Kaziranga 4	Kaziranga 5	Basle
18	♀	Kaziranga 8	Arjun	1958	—	—	—	W.-Berlin 22.9.59 Basle 8.7.65
19	♂	India B	Tarun	1.59	—	—	—	Washington 26.5.60
20	♀	Whipsnade 2	Manik	18.8.60	—	India A	Assam 3	Whipsnade
21	♂	India C	Laue	?	—	—	—	Tokyo 1961
22	♀	India D	Tamao/Lupsin	?	—	—	—	Tokyo 1961
23	♂	India E	Sneha	12.3.61	—	—	India C ?	Alipore
24	♀	India F	Siraji	?	—	—	—	Gauhati ?
25	♂	India G	Padmini	?	—	—	—	Gauhati ?
26	♀	Basle 3	Lasai	31.8.62	—	Kaziranga 4	Kaziranga 5	San Diego 12.10.63
27	♂	Basle 4	Khunlai	9.3.63	—	Kaziranga 4	Basle 2	Paris 29.4.64
28	♀	Gauhati 1	Rajkumari	10.4.63	—	India F	India G	Washington 16.12.63
29	♂	Gauhati 2	Jaypuri	10.7.63	—	?	?	San Diego 28.2.65
30	♀	India H	Deepali	1948	28.12.63	—	—	Washington 16.12.63
31	♂	Basle 5	Miris	12.6.64	—	Kaziranga 4	Kaziranga 5	W.-Berlin 6.7.65
32	♀	Hamburg 1	Gauhati	11.8.64	—	Kaziranga 4	Kaziranga 7	W.-Berlin 6.8.65
33	♂	Kaziranga 9	Mehan	?12.1.65	—	—	—	Delhi ?
34	♀	Basle 6	Nanda	28.8.65	—	Kaziranga 4	Basle 2	Stuttgart 29.5.68
35	♂	Assam 7	Herman	?	—	—	—	Los Angeles 8.3.66
36	♀	Tokyo 1	—	20.6.66	20.6.66	India D	India C	Tokyo
37	♂	Nepal 1	Kanchi	?	9.1.67	—	—	E.-Berlin 6.8.66
38	♀	Hamburg 2	Shita	9.4.67	—	Kaziranga 8	Kaziranga 7	Hamburg
39	♂	Basle 7	Pandur	7.7.67	—	Kaziranga 8	Kaziranga 5	Hamburg 3.9.68
40	♀	Nepal 2	Kumari	5.67	—	—	—	E.-Berlin 1.8.67
41	♂	Basle 8	Puri	22.12.67	—	Kaziranga 8	Basle 2	Stuttgart 3.6.69
42	♀	Mysore 1	Mysore	13.2.68	—	Assam 1	Assam 6	E.-Berlin 24.4.71
43	♂	Kaziranga 10	Rengi	?28.3.68	—	—	—	Delhi ?
44	♀	Basle 9	Ruedi	27.4.69	9.2.71	Kaziranga 8	Kaziranga 5	Houston 6. 10.70
45	♂	Basle 10	Randa	5.10.69	—	Kaziranga 8	Basle 2	Houston 6.10.70 Brownsville 6.4.72
46	♀	Assam 8	Rhadha	?	—	—	—	Los Angeles 29.11.69
47	♂	Kaziranga 11	?	4.67	—	—	—	Los Angeles 30.11.69
48	♀	Assam 9	?	6.68	31.1.70	—	—	Omaha 1.70
49	♂	Nepal 3	Mohan	6.69	—	—	—	Crandon 23.4.70
50	♀	Nepal 4	Shanti	?	—	—	—	Florida/Crandon 12.6.70
51	♂	Dehli 1	Roopa	27.1.71	—	?	?	Whipsnade 6.2.73
52	♀	Milwaukee 1	?	30.1.71	—	Basle 1 ?	Whipsnade 1 ?	Milwaukee
53	♂	Mysore 2	?	16.4.71	—	Assam 1	Assam 6	Mysore
54	♀	Stuttgart 1	?	16.7.71	16.7.71	Kaziranga 8	Basle 6	Stuttgart
55	♂	Basle 11	Tutuma	11.8.71	—	Kaziranga 8	Basle 2	Antwerp 5.9.72
56	♀	Basle 12	Tanaya	24.8.71	—	Kaziranga 8	Kaziranga 5	Basle
57	♂	Gauhati 3	Krishna	12.9.71	—	India F	India G	Gauhati
58	♀	Hyderabad 1	?	25.11.71	—	?	?	Hyderabad
59	♂	Kaziranga 12	Rukmini	?28.1.71	—	—	—	Delhi 28.1.72 ?
60	♀	W.-Berlin 1	Kumar	4.4.72	—	Kaziranga 8	Basle 5	Amsterdam autumn 1973
61	♂	Kaziranga 13	Sonto	?	—	—	—	Gauhati 28.6.72

Key: (1) Kaziranga = animals born in Kaziranga Reservation; Assam = animals born in Assam, including the Kaziranga Reservation; Nepal = animals born in Nepal; India = animals born on the Indian subcontinent, including Nepal.

(2) The studbook-number indicates the sequence of arrival in captivity, whilst the studbook-name shows the name of the town where any animal was born in captivity. The number following the name of the town in the studbook-name indicates the sequence of birth or capture at that place.

For example: 8 ♀ Assam 3 is the eighth animal to be taken into captivity and the third to be caught in Assam.

CAPTIVE BREEDING POPULATIONS

Given one Indian rhino pair composed of animals of about the same age, and good luck, a breeding unit can be established. This has been proved in Basle. The ideal unit is a trio of one male and two females. Zoological gardens with enough room to keep larger breeding groups comfortably form the exceptions. Much could be achieved, however, if neighbouring gardens were prepared to work together. In this connection, I would like to recall the praiseworthy example of Berlin. When we lost our bull "Gadadhar" in 1964 there were only two specimens in Europe suitable to replace him, the roughly 7-year-old "Arjun" in the Berlin Zoo and a somewhat older bull in Rome. When the matter was put to him, Heinz Klos, the director of the Berlin Zoo, immediately recognized the necessity of continuing the Basle breeding group and convinced his Board that the bull "Arjun" should be placed at Basle's disposal. In return, we presented the young female to Berlin and made arrangements for a young male, which had been sired by our first bull and, in the meantime, delivered to Hamburg, to be transferred to Berlin. Thus another potential breeding unit was established.

We have made a point of selling Indian rhinos to zoos where they are kept in pairs. The first-born male "Rudra" went to Milwaukee with a female, born in Whipsnade. A calf produced by this pair was unfortunately stillborn (30 January 1967). As yet no further birth has been recorded. We have delivered young pairs to Houston, USA and Stuttgart, as well as partners for single animals in Hamburg-Stellingen, Berlin and Paris-Vincennes.

Zoological gardens should be aware of the responsibility they assume in keeping Indian rhinos. If we had room, we would install a second bull or even a second breeding pair. With only one bull available, the breeder always has the disconcerting feeling of standing on one leg! But the cooperative example set by Berlin Zoo is indeed very encouraging.

Within a span of 15 years, 12 Indian rhinos—with one male and one female during the first 5 years, then with one male and two females—have been born in Basle. In captivity, the Indian rhino has a life-expectancy of 40 years (Crandall, 1964). The gestation period lasts 478 days, which allows for one calf about every 2 years. With careful management, the present captive population (24, 20 in 25 zoos) could produce sufficient offspring to cover zoo requirements and for subsequent release in the wild. The preservation of this species would then be ensured for generations to come. An international studbook has now been established for the Indian rhinoceros, and this should be of great value in coordinating any long-term programme (see Table 1).

Breeding the Indian Rhinoceros at Delhi Zoological Park

C. L. Bhatia and J. H. Desai

The great Indian one-horned rhinoceros (*Rhinoceros unicornis*), the largest of all Asian animal species (see Prater, 1971), is commonly exhibited in the Zoological Gardens and Parks of the world. But like all rhinoceroses, the great Indian rhinoceros does not breed readily in captivity (see Crandall, 1964). Until recently, births of Indian rhinoceroses in captivity were very rare. Up to 1960, only five calves had been born in captivity. One reason for the rarity of rhino births in captivity might be the violent battles that take place between male and female, which discourage zoo authorities from keeping them together. Over the last 10 years, however, more Indian rhinos have been bred in captivity. According to the *International Zoo Yearbook* (Volume 10, 1970) there have been 12 births of Indian rhinoceroses in captivity during that time (see also Tong, 1960).

The Delhi Zoological Park obtained Mohan, a male great Indian rhinoceros, in December 1965. It was 3½ years old when it came to the zoo. Later, in March 1968, a female rhinoceros Rongi of about 6 years of age was brought to the zoo from Gauhati, Assam.

The rhino enclosure at Delhi Zoological Park is an open-air enclosure of about one acre in area (Fig. 1). The enclosure has luxuriant growth of naturally growing trees and undergrowth of mesquite (*Prosopis juliflora*). In the centre of the enclosure, a muddy depression has been provided where the animals can wallow. The enclosure has a few cells and a large enclosed paddock where the animals may be kept separately if the need arises. Details of the diet are provided in Table 1.

Rongi, the female rhinoceros, arrived at the zoo in the evening of 28 March 1968, and was kept in the paddock. Mohan was at that time kept in the outer enclosure. It was observed that Mohan was very much interested in meeting Rongi, but she was not very keen and remained restless for the first few days. Later on, both animals began to sniff and to look at each other regularly. It was then decided to introduce the female to Mohan. However, this decision was not taken without apprehension, as it was known that rhinoceros do not readily live