18 The Great Indian Rhinoceros (*Rhinoceros unicornis*)

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18.1 The Wild Population

The three Asian rhino species in the wild today number less than 1.800 individuals. Numerically, *Rhinoceros unicornis* is superior with a population lying between 1,100–1,500 [5]. Even so, the dangers which beset this species are manifold and it requires careful management both in its natural habitat and in zoological gardens.

Five hundred years ago the Indian rhino covered a wide range in northern India and Nepal. Two main pressures – habitat encroachment and hunting – contributed to the decline of the population which is now restricted to the Kaziranga National Park in India, the Royal Chitawan National Park in Nepal and a few smaller reserves [5].

Laurie [10, 11], who has studied the Chitawan population, mentions that bulls are not territorial in the strict sense though they do assert certain rights in their home range; a bull will tolerate the courtship of a cow by another resident bull, suggesting that there is a time difference between the male and female sexual cycles; the most permanent relationships are between a cow and calf, but subadults often roam in twos or threes, and up to nine individuals of different ages and sex occasionally gather at wallows. It clearly emerges from Laurie's study that each animal living in the home range knows the other.

18.2 The Indian Rhino and Man

The Indian rhino is represented on several seals which were discovered in the Indus Valley; these date back to the third century B.C. and are the oldest known records of man's association with unicornis [2]. Reynolds [13] in his survey of Asian rhinos in captivity traces the Indian rhino back to the time of the Roman Empire. At a later period armored rhinoceroses, which might well have been unicornis, seemingly passed as gifts into the hands of ancient Chinese emperors. After this no new record emerges until the sixteenth century. Then, in 1,515, an Indian rhino was presented to the king of Portugal. The arrival of this animal at Lisbon made a considerable impact on European culture, its memory having been immortalized by Albrecht Dürer. During the next three centuries there was increased collecting of unicornis. One of these specimens claims our interest in particular. Shown at Peale's Museum, New York, in 1926, it was the first Indian rhino known to have reached America.

One Medicine: a tribute to Kurt Benirschke
ed. Oliver A. Ryder & Mary L. Byrd
Berlin etc., Springer Verlag 1984 pp 1-373

18.3 The Captive Population

Historically interesting is a calf conceived in captivity and born as early as 1824 in a menagerie at Kathmandu [14]. In 1925 a cow at Calcutta gave birth to a calf which lived for a few hours. In 1948 a fetus was aborted on the high seas [1], and an entry in the studbook records a stillbirth during transport to Brookfield in 1948.

Births did not begin to occur frequently until the latter part of the 1950's. By that time the idea of breeding threatened species had firmly taken root, and as an ever increasing number of zoos intensified their breeding efforts the necessity of coordinated records for wild animals in captivity became evident. In 1967, when the IUCN's Zoo Liason Committee was assigned the task of organizing studbooks, it was decided that one for *Rhinoceros unicornis* should be compiled and kept at Basle.

The first entries in the studbook [9] reflect a change of attitude that was taking place in zoos toward the mid twentieth century. Whereas Indian rhinoceroses had hitherto been exhibited virtually as singletons in zoological collections, their import in the 1940's began to occur pairwise. We can reasonably infer that zoos were becoming seriously concerned with the captive reproduction of this species which was apparently verging upon extinction.

18.4 Status in Captivity

The first edition of the studbook included, as of 31 December 1972, 55 (31.24) [31 (56%) wild-caught, 24 (44%) captive-born] individuals then known to be alive in 30 zoos. The third and latest edition [16] shows that as of 31 December 1981 there were 70 (38.32) [33 (47%) wild-caught, 37 (53%) captive-born] individuals living in 33 zoos. Thus the captive population increased during the period 1973–1981 by 15 (27%) (Fig. 1). Contributing to this increase were one-third (9) wild-caught and two-thirds (18) captive-born animals.

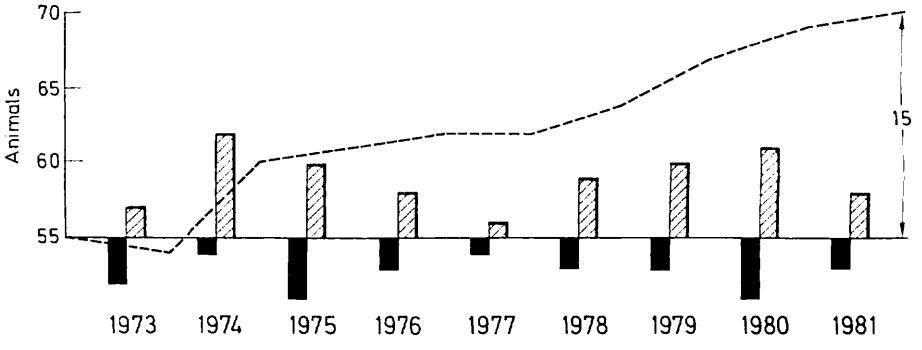


Fig. 1. Population trend 1973–1981

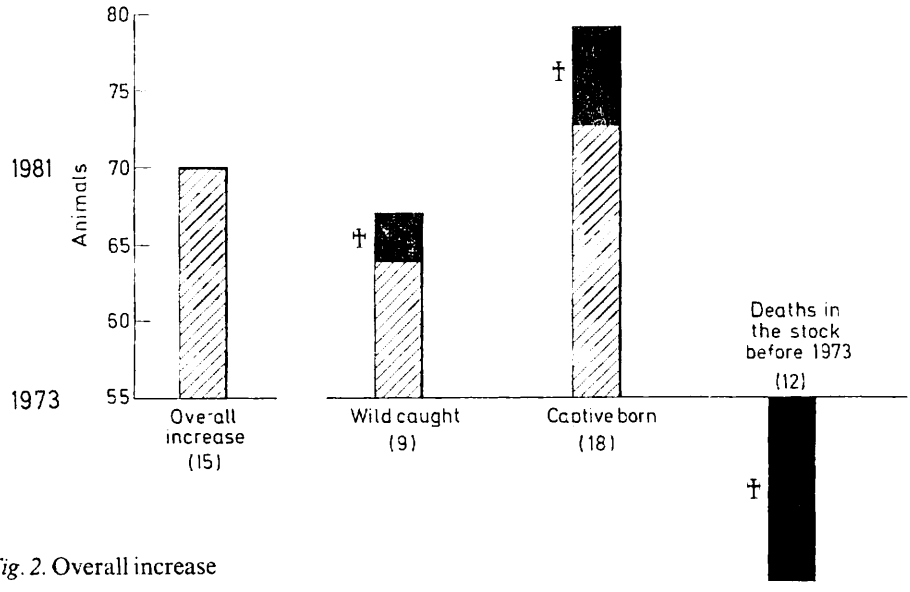


Fig. 2. Overall increase

A comparison of stock ratios in 1972 and 1981 shows that the percentage represented by captive-born animals has become predominant (Fig. 2). This shift can be ascribed to a proportionally higher, respectively lower, recruitment and death rate in the captive-born stock. The number of zoos has remained virtually constant, although it should be mentioned that altogether 39 zoos have held rhinos since the studbook was compiled.

18.5 Age/Sex Structure and Longevity

The change in age distribution between 1972 and 1981 (Table 1) clearly reflects difficulties in reproduction, on the one hand, and success in longevity, on the other. In the lowest age group, namely, the number of individuals has become relatively lower with a decrease of 7.95%. Conversely, the oldest group has increased by 6.4%.

By 1981 a more even balance of the sexes in the 10+ age group has been achieved but, on the whole, the sex ratio still inclines heavily to the male side.

Table 1. Age sex structure

Years	Specimens alive on 31.12.1972	Specimens alive on 31.12.1981
0–9	14.13	13.13
10+	10.6	14.12
20+	6.4	7.4
30+	1.1	4.3

Table 2

Zoo (births)	1966	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	198
Stuttgart (4)		† 1st born			o.k.			o.k.		o.k.			
San Diego (4)						† 1st born	†		o.k.	o.k.			
Tokyo (2)	† 1st born			o.k.									
Antwerp (2)											† 1st born		o.k.

The oldest living animal registered in the studbook is No. 6, Assam 2, born in 1944. No. 1, Assam 1, born in 1941, died in 1979 at ca. 38 years of age. These longevities approach the records given by Flower [3].

18.6 Mortality

Mortality in calves is seen to occur mainly in the first days of life. Three stillbirths were reported; one calf was inviable, one was killed by the cow, and another starved due to shortage of mother's milk; two further calves died of anemia, respectively colitis/enteritis/peritonitis.

Significantly, in five of these cases primiparous mothers were certainly involved, while in four of them (anticipating Antwerp 2, born in 1982) the second, respectively, third and later calves survived (Table 2). Mortality in early infancy is thus susceptible of a positive interpretation.

Mean age at death in 18 known-age animals was 16.9 years. Looking through the post-mortem results for these and three further animals which survived this initial period we find a high incidence of diseases involving the digestive system. These must, to some extent, be associated with husbandry deficiencies. Less frequently recorded were injuries/accident, respiratory diseases, liver, and kidney failure, carcinoma/myoma, stress, pyometra, and ascites. Three animals died of old age.

18.7 Reproduction

Reproduction to date has occurred in only 16 zoos. From 1956–1981 52 calves were born. Taking 1955 (the year when successful mating took place) as the starting-point, the reproduction period conveniently falls into three 9-year phases (Fig. 3).

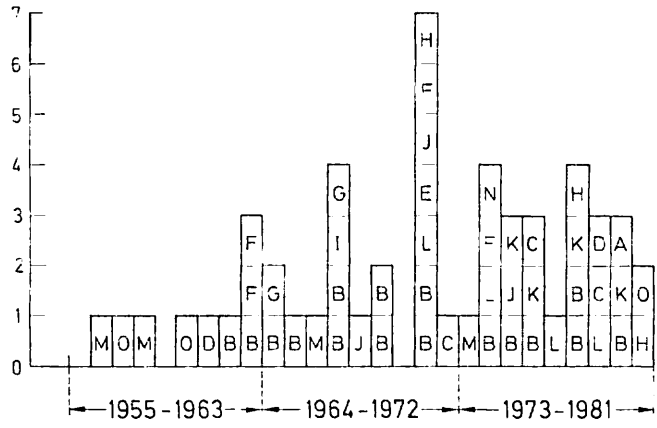


Fig. 3. Distribution of births 1956–1981. *A* Antwerp, *B* Basel, *C* Berlin West, *D* Calcutta, *E* Delhi, *F* Gauhati, *G* Hamburg, *H* Hyderabat, *I* Milwaukee, *J* Mysore, *K* San Diego, *L* Stuttgart, *M* Tokyo, *N* Washington, *O* Whipsnade

Table 3. Distribution of births among zoos

	Basle	Other zoos
1955–1963	4	5
1964–1972	6	11
1973–1981	8	16

The early years 1956–1963 saw the first eagerly awaited births. Offspring from Basle, Whipsnade, and Gauhati would later disperse to form new groups in North America and Europe.

The next 9 years brought forth a mushroom growth of new centers which were, in part, the results of cooperative arrangements between European zoos: Hamburg, Stuttgart, and West Berlin came into being, and the continuation of the Basle group was ensured. In Milwaukee the first captive-bred pair reproduced, while new founders in Tokyo, Mysore, Delhi, and Hyderabad swelled the breeding output. Accordingly, the birth rate increased, rising to a conspicuous peak in 1971.

The predominance of Basle young has been reduced since 1973 due to an increase in regular breeding of other zoos. One-third of the total births is nonetheless accounted for by Basle. The proportion of births in other zoos is apparently increasing (Table 3), although as yet only six of these institutions have had sequences of three births or more.

Further encouraging features of the period 1973–1981 are that Whipsnade and Calcutta have rejoined the breeding force with newly established pairs and Antwerp has experienced its firstborn. Meanwhile, calves born in the second zoo generation have survived in West Berlin, San Diego Wild Animal Park and Stuttgart. The dispersal of young from the different breeding centers is shown in Fig. 4.

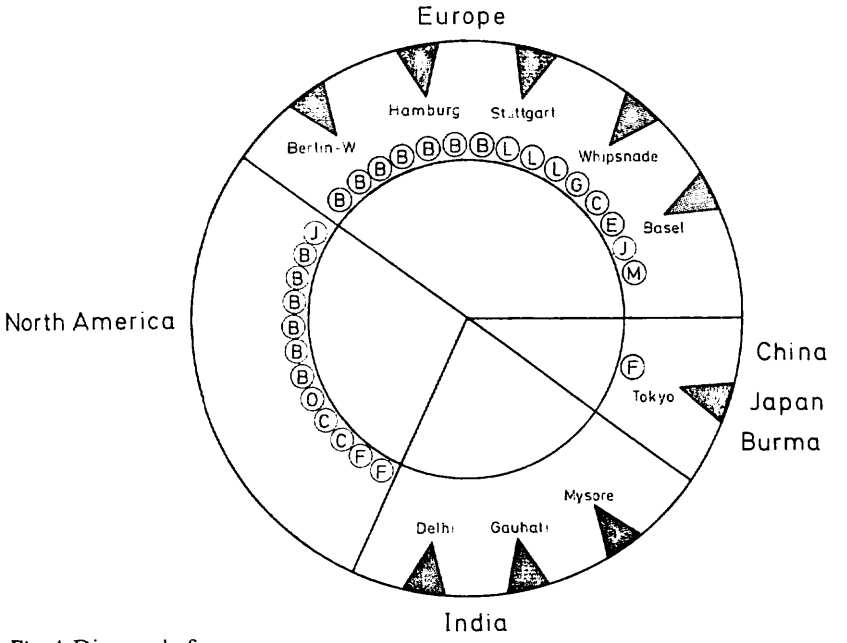


Fig. 4. Dispersal of young

Involuntarily, the question springs to mind as to why the majority of zoos have never bred or, more specifically, why several zoos have discontinued breeding.

Failure to reproduce may be due to immaturity, lack of sexual experience, maintenance of single or isolated animals, incompatibility, time difference between the male and female sexual cycles, inadequate enclosure, economic considerations, and difficulties with the disposal of surplus stock from which stem inexpediences such as the formation of related pairs. All of these causes are self-explanatory and, with the exception of the first, can be remedied by husbandry improvements and coordinated management [see 4]. Discontinuation of breeding, on the other hand, may be explained by the loss of a mate through aging, illness or accident, and for which no suitable replacement has been available. Since the Indian rhino is held mainly in single pairs, it would be wise to hold surplus animals in readiness to fill possibly occurring vacancies. With properly designed enclosures these potential replacements might live integrated in existing groups, thereby being prepared for their reproductive role.

Summarizing the studbook data, it may be said that an improvement in the reproduction rate is indicated by the increasing number of zoos undertaking regular propagation, the establishment of potential breeding units (three, moreover, in the first zoo generation) and the better performance of cows as they gain experience. Disregarding imports, a mean increase of 0.66 specimen annually from 1972–1981 can be calculated, suggesting, at least, that the captive population is self-sustaining.

18.8 The Indian Rhino at Basle

18.8.1 Husbandry (Fig. 5)

Factors which have contributed to establishing a successful rhino group are:

1. A balanced diet [17]. The animals receive a concentrate twice daily to ensure an adequate supply of the essential nutrients. Additionally, fresh fruit, vegetables and dried beet are offered, while freshly cut branches provide a welcome source of occupation. Straw is available ad libitum and is also used as bedding.

Recognizing the susceptibility of Indian rhinos to respiratory diseases which arise from allergies to hay [15], we began some years ago to replace hay by high-quality straw, mechanically shaken to remove the dust and afterward moistened and, in summer, mixed with grass.

2. An appropriate environment [7]. Special features of the rhino house are individual stalls and a bathing pool. The spacious outdoor enclosure has been designed to incorporate foraging, resting, and wallowing areas. This arrangement of the terrain, combined with its hilly nature, permits evasive tactics at full gallop. Made of marl, the substrate is easy to clean and has a certain resilience. Intensively used areas where the soil becomes eroded, exposing stones, are re-covered at frequent intervals.

Rhinos often have callosities on the soles of the feet. Also, the skin of the sole tends to crack, the cause of which is not clear. Sharp-edged stones may be a contributory factor, insufficient exercise another, but we rather suspect that the humidity level is generally too low. To prevent infection, an antiseptic ointment is applied.

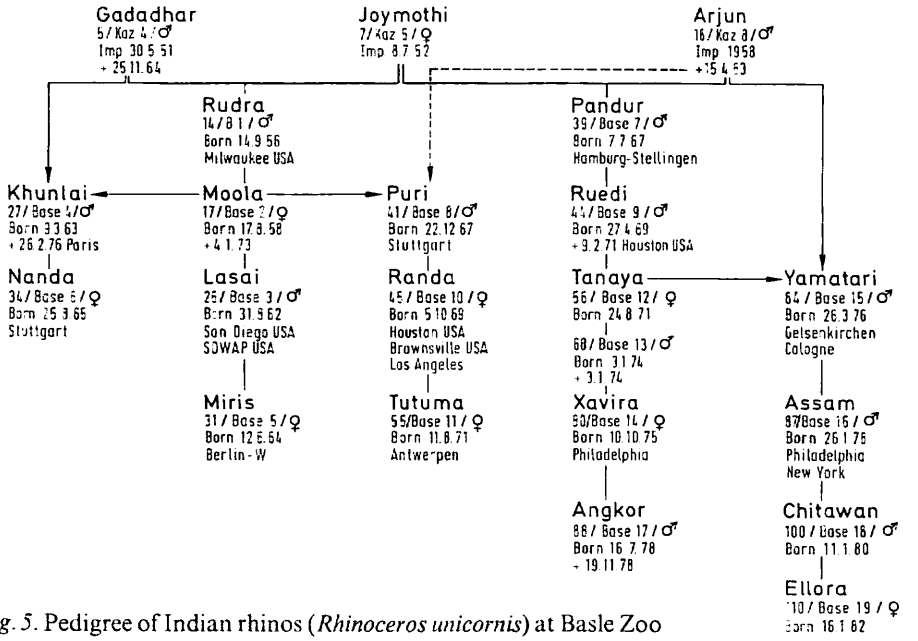


Fig. 5. Pedigree of Indian rhinos (*Rhinoceros unicornis*) at Basle Zoo

3. A keeper who is sensitive to the animals' needs. Crucial to the compatibility of the rhinos among themselves and invaluable for routine and medical care is a good relationship between the animals and keeper. Furthermore, critical situations in the courtship display and during calving can be favorably influenced by a trusted human presence.

4. Social stability. As in the wild, it is vitally important for captive rhinos to know each other and to be able to keep themselves informed of each other's movements. Although adult bulls join the cows only during oestrus, visual, and acoustic interactions between the sexes are possible.

18.8.2 Breeding (Fig. 6)

Data on reproductive physiology have been published by Lang [8]. The minimum age at which males and females reach sexual maturity is given as approx. 7 and 3 years, respectively. However, zoo-born males may, in the absence of a senior bull, mature earlier. Since Arjun's decline in health, Chitwan (born 1980) has experienced oestrus cows and shown great interest in the younger one. He is foreseen as Arjun's successor.

Based on the data at disposal, the length of the breeding life in females is some 28 years. Joymothi last gave birth in 1978, at 31 years of age. Despite sexual activity she has not conceived since, probably due to a leiomyoma.

Fig. 6

Females cycle every 36–58 days and, with the exception of a very few instances their condition has evoked "Flehmen" from the bull. A time difference in the male and female sexual cycles, as suspected by Laurie, could thus not be confirmed at Basle. During the mating act a continuous watch is kept for obvious safety reasons. No one, however, who has been privileged to witness this happening, could remain unmoved by its turbulent fury.

18.8.3 Births

There is no seasonality of births, a finding which agrees with field observations. Parturition takes place after a gestation period of 463–489 days, most calves (12 of 19) being born at night (Fig. 7a–c). A mean interbirth interval of 25.8 months has been determined. Birth weights range from 55.5–90 kg. Diffusa in type, the placenta is comparable to that in equines. Placental weights range from 5.5–7.8 kg.

There appears to be considerable variation in the time of delivery. Births have mostly been uneventful, but when uterine insufficiency was encountered, Oxytocin (10 ml = 100 I.U.) parturition could be induced in 15–20 min.

The cow and calf join the other females and juveniles after a few days.

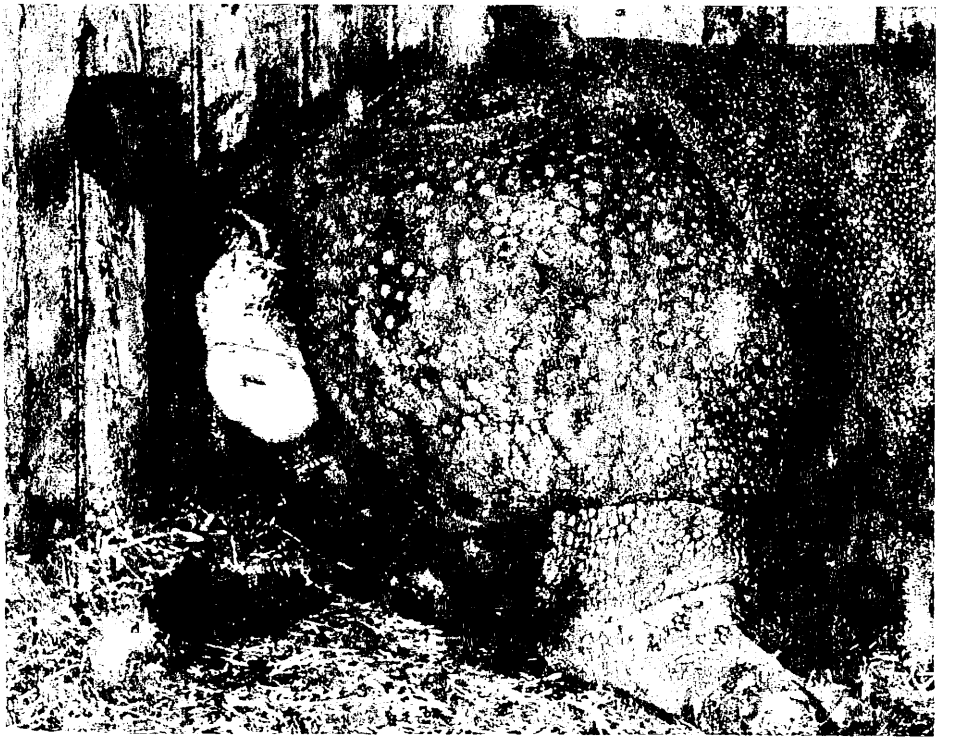


Fig. 7a

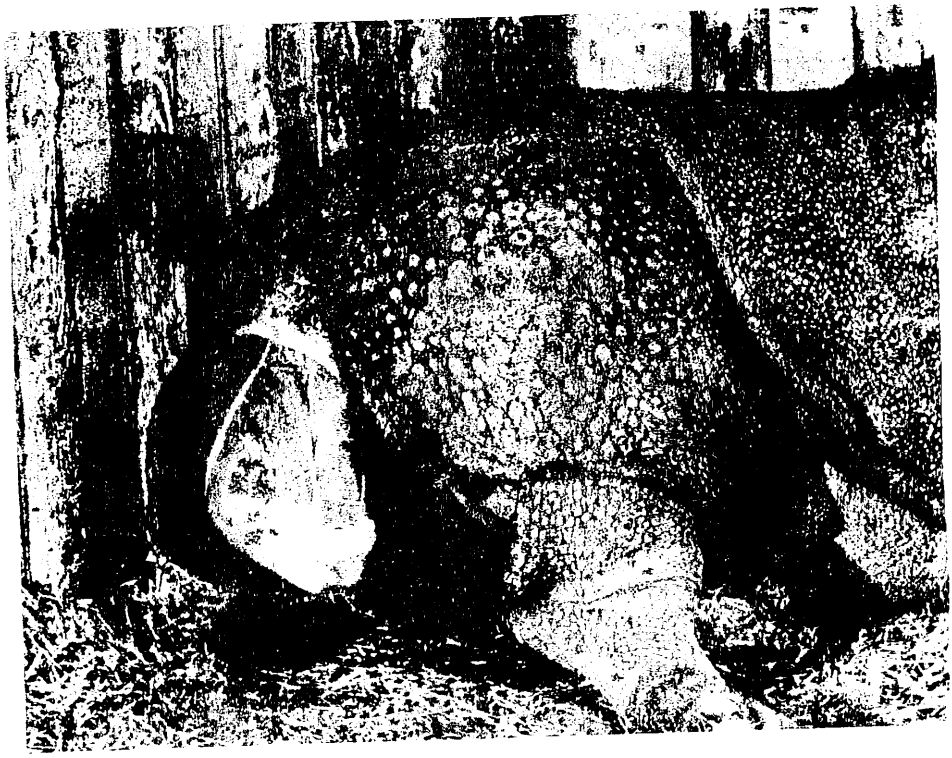


Fig. 7b

Fig. 7c

18.9 Clinical Medicine

18.9.1 Immobilization

Immobilon has proved to be an effective narcotic. It is used in concentrations of 0.4–0.8 cc per young animal (4 months – 2 years) and 1.3–1.8 cc per adult animal for procedures such as vaginal investigations, blood collections, ECG examinations, toe corrections, and horn and abscess treatments.

The sedative valium (0.5–1 mg/kg body weight = 50–100 tablets) is administered prior to crating, concealed in pieces of banana. It is also used to calm young animals after separation from the mother.

18.9.2 Hematological and Biochemical Analyses

A comparison of blood values reveals similarities between *Rhinoceros unicornis* and wild equids.

18.9.3 Milk Analyses

A sample taken 1 month after the second birth comprised: Fat 1%, Lactose 6.3%, Protein 1.4%. The time of collection is important for comparative purposes.

18.9.4 Semen Collection

When Arjun was euthanased (1983) we took the opportunity to collect semen from him. An initial attempt by electrical stimulation with the rectal probe for elephants failed to obtain erection. Platz et al. [6], using this technique on a black rhino, encountered a similar absence of response (Figs. 8 and 9). Stimulus applied via two copper collars on the penis achieved erection, however, and was repeated in periods of 10–15 min up to the point of death somewhat more than an hour later. Approximately 40 cc of ejaculate collected from the testes were subsequently frozen. A sample taken for thawing showed 30% progressive motility (Fig. 10 a, b).

A valuable insight into the female reproductive cycle has meanwhile been given by Loskutoff et al. [12].

Certainly, artificial insemination can be advantageous in exceptional cases and, obviously, does constitute a further safeguard to the species. Nonetheless, our main concern must be to promote natural patterns.

18.9.5 Parasitology

Fecal examinations have occasionally revealed proglotids of the tapeworm *Anoplocephala gigantea*. The life history of this genus is poorly understood. It is likely that the specific intermediate host (presumably the moss mite) does not occur in our latitudes. This might explain why only wild-caught Indian rhinos have been found to harbor the parasite. Treatment neither with Mansonil (100 mg/kg body weight) nor Droncit (20 tablets à 50 mg) has yielded unequivocal results.

Fig. 8

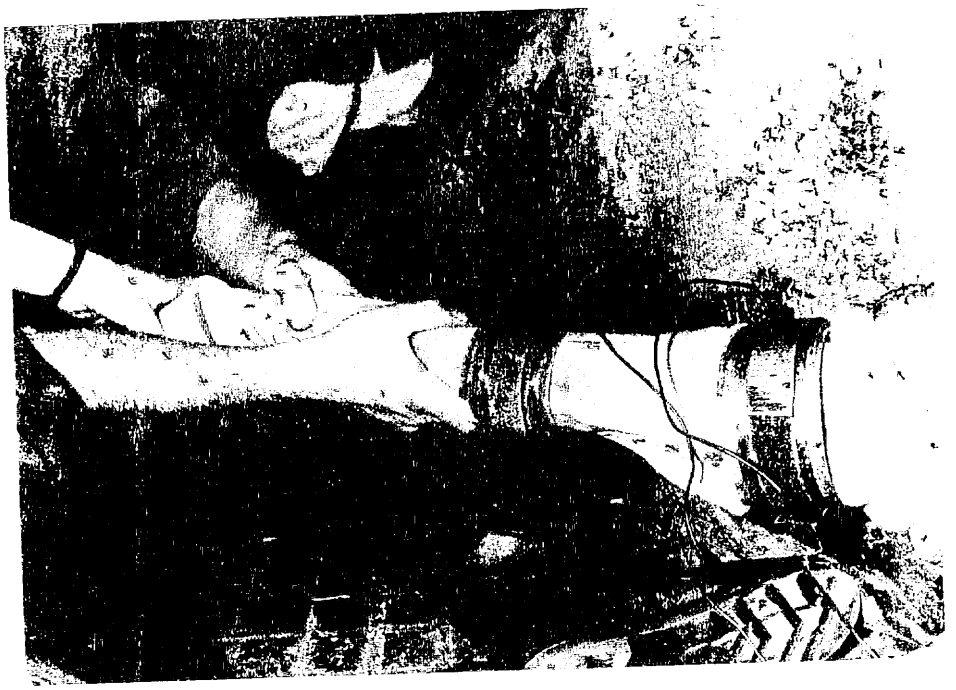
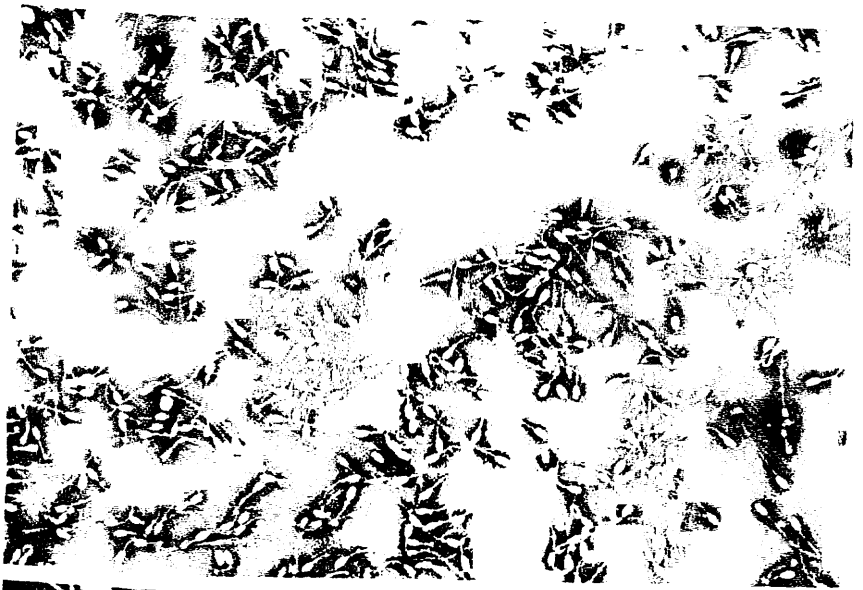


Fig. 9



10a

10b

At the post-mortem examination of Arjun the tapeworms *Anoplocephala gi-*
ea (Fig. 11) and *Anoplocephala latissima* (Fig. 12) were found to have entered
liver, immediately prior to death via the bile duct.

Pathology

1951 4,1 rhinoceros have been necropsied at the Basle Zoo. The three adults
showed comparable pathological features which are summarized in Table 4.

Fig. 11

Fig. 12

18.12 Serology

Serum samples were positive for *Micropolyspora faeni* antibodies (Ouchterlony test).

18.13 Anatomy

Above the foot, on the backside of the leg, lies a gland of 5 × 2½ × 2½ cm in the subcutaneous tissue. Sweat-gland-like areas drain their product into a thick-walled cistern which is lined with a stratified squamous epithelium. The excretory duct ends medial, 5–10 cm above the ground.

18.14 The Horn

Primarily because of the magical properties attached to its horn has the rhino been so ruthlessly hunted. Still highly prized, this trophy continues to fetch fabulous prices in eastern countries.

Understandably, much speculation has arisen on the composition of the horn. It has been variously reported to consist of horny material, hair or skin. The horn is, in fact, a product of the epidermis. It is united with the bony base by dense connective tissue (Fig. 23d). The dermal and epidermal papillae form a broad layer, visible in the cross-sectional profile as a white line (Figs. 23b and 24–27). The dermal papillae are highly vascularized and form the base of the tubular horn. The horny tubules are split up in a central zone of loose, partly degenerated elements and a peripheral area of keratinized cells. The intertubular horn consists of ghostlike cells which fill the spaces between the tubules (Figs. 27–30) path.). Histologically, the rhinoceros horn seems to be similar to the stratum medium of the equine hoof.

Captive conditions clearly bring a different set of factors to bear on the horn than those operating in the wild. For instance, the animals tend to rub their horn excessively due to lack of occupation. Once broken off at the base, a horn will take several years to grow again to its full size.

18.15 Conclusions

When zoos took upon themselves the task of breeding *Rhinoceros unicornis*, little was known about the way of life of this threatened species. Since those early days our understanding of the rhino has been improved by information obtained from intensive ecological and behavior studies. It lies with us, the present custodians of the captive population, to incorporate this knowledge into our husbandry procedures. There will then be reason for us to hope that the Indian rhino will survive to fascinate and delight the generations of man to come.

Acknowledgments. Grateful thanks for the kind cooperation is expressed to the studbook-keeper, Mrs. Kathleen Tobler, Basle Zoo, who also kindly translated this paper into English.

I greatly thank Dr. A. Heldstab, Institute of Animal Pathology, Berne, for text and the valuable histo-pathological pictures under "Pathology".

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