REPRODUCTION IN BLACK AND WHITE RHINOS: A REVIEW

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Abstract - This paper is a review of the more important literature on the reproduction of black and white rhinos which has been published over the past 20 or so years. It also includes valuable reproductive data collected at the Zoological Gardens of Zürich, where black rhino have been bred very successfully in recent years. Finally, a few suggestions regarding captive breeding *vs* breeding in the wild are put forward.

INTRODUCTION

The first rhinoceros ever to be born in captivity was a Sumatran rhino which was born in the Calcutta Zoo in 189[4]. Although the great Indian rhinoceros was brought to Europe in the Middle Ages, the first breeding was recorded in 1956 at Basel Zoo. This zoo has the best record for breeding the great Indian rhino, and as a result, is probably the most reliable source of reproductive data relating to this species[4].

The first black rhinoceros to be bred in captivity was in 1941 in the Chicago Brookfield Zoo[4]. The second one was born in Rio de Janeiro. Although the first black rhino to be introduced to German zoos was already in 1870 (Berlin)[1], the first European breeding success was only achieved at Frankfurt Zoo in 1950[4].

Very little is known about reproduction in the white rhinoceros as very few observations have been made in the wild. In captivity the first birth was recorded at Pretoria National Zoological Gardens[4]. However, the cow was pregnant at capture, and calved down later in the zoo. During the years 1987-1990 there were 709 white rhinos in captivity and 45 calves were produced[11].

Black and white rhinos were abundant in Africa before the arrival of Europeans in the 17th century. The white hunters decimated both species systematically. Some of the proud hunters claimed to have shot in excess of a thousand rhino each[4]. In 1892 the southern white was thought to be extinct but fortunately approximately 50-100 animals survived the cull in the Umfolozi Valleys[7]. It is interesting to note that, although the current white and black rhino populations of South Africa originate from a handful of surviving animals, the gene pool is fairly diverse (E Harley, University of Cape Town, personal communication).

This paper is a review of the literature with additional information from the Zoological Gardens of Zürich. The information will be dealt with on a species basis.

METHODS EMPLOYED BY RESEARCHERS TO MONITOR REPRODUCTION

Much of the data collected and reported in books like *Grzimeks Animal Life Encyclopedia*[4] and *Mammals of the Southern African Subregion*[18], as well as some journal publications[7], are the results of observations in the wild. As can be expected, some of these observations are inaccurate, and have resulted in the wide ranges reported for some reproductive parameters. Since the captive breeding of rhinos has become more successful in some zoos and captive breeding stations, observations on reproduction have become a more reliable source of information.

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The most exciting development with regard to the monitoring of wildlife reproduction has been the introduction of faecal and urine steroid hormone assays[12 14 16 17]. This non-invasive approach allows accurate monitoring of the reproductive status of animals, as long as the correct oestrogen and progestagen metabolites are selected for monitoring a particular species[6]. By collecting samples from individual animals at regular intervals, steroid hormone profiles (oestrogens and progestagens), can be obtained, which are then used to monitor the oestrous cycle, pregnancy (including pregnancy diagnosis), parturition and *post partum* cycling.

The use of urinary steroid hormones was first described in black[13] and Indian[10 12] rhinos. Distinct differences are seen in urinary steroids of these two species. For instance, pregnanediol-3-glucoronide (PDG) was not found in the urine of cycling black rhino but was extremely useful for the purpose of pregnancy diagnosis, and the concentrations climbed steadily throughout gestation[13]. In the Indian rhino, however, PDG was useful for monitoring the oestrous cycle as well as for of pregnancy diagnosis from 3 months of gestation onwards, where levels were significantly higher than during the luteal phase of the cycle[10]. Subsequently Hindle and Hodges[5] have studied the metabolism of oestradiol-17ß and progesterone in the white rhino and have identified the main metabolites in urine and faeces.

REPRODUCTION IN BLACK RHINOS

Observations in the wild and in captive breeding stations

Sexual maturity

Most researchers agree that sexual maturity in black rhino cows is reached at approximately 7 years of age[4 7], however, one cow was reported to have produced a calf at 5 years and 10 months and another at 6 years and 5 months of age, respectively. Data on bulls is limited to two observations, where a seven-year old bull showed no spermatogenic activity whereas an eight-year old did[7]. The same authors gauge sexual maturity in black rhino bulls at 8 years but also mention that bulls do not hold their territory until 9 years of age.

Oestrous cycle

Black rhinos in Africa appear to cycle the year round[4 7]. However, there is a bimodal distribution which is reflected in the calving pattern. The majority conceptions occur in October-November and a second peak is seen in April-July. These correspond with parturition peaks in January-February and June-August, respectively[7].

During puberty cows appear to cycle erratically and only once they have calved once or twice do they cycle at regular intervals[7]. Hitchins and Anderson[7] recorded 10 oestrous cycles in mature cows in the wild. The cycles varied from 26 to 46 days with a mean of 35 days. The bull was attracted to the cow for 6-7 days but the cow apparently only allowed mating on the last day. This probably means that the first 5-6 days should be regarded as pro-oestrus and that oestrus (standing heat) is only one day long. The signs of pro-oestrus are obvious and similar to those of the mare. Cows show frequent tail erecting, void small amounts of urine with simultaneous winking of the vulva[4 8]. The vulva is distinctly swollen. In zoos overt behavioural changes are also noted. Animals are restless, appear to seek out a male (when separated) and make squealing noises[8]. The cow allows mating for one day only. In Zürich Zoo the duration of heat varied from 1-2 and the oestrous cycle from 21-25 days[8].

Mating

The bull approaches the cow during pro-oestrus carefully and with a typical stiff-legged gait[4 18]. They stand head-to-head sniffing each other, frequently make gargling noises and spar with their horns[18]. The bull horns the cow between the hindlegs and in the flank from time to time[18]. This is often followed by the cow butting the bull vigorously in the flank but without causing serious damage[4]. Bulls also show flehmen, especially after sniffing the cow's urine[18].

Information regarding copulation *per se* is confusing. Hitchins and Anderson[7] observed copulation in black rhino 47 times. Pairs were observed to copulate 2-7 times in a day. The duration of copulation varied from 12 to 43 min with the number of ejaculations per copulation varying from 2 to 9. Perhaps the authors were referring to repeated intromission rather than ejaculation. Grzimek *et al.*[4] report one copulation observed in Frankfurt Zoo and one in the wild (Tsavo Park), which lasted 35 and 22 minutes, respectively. In Zürich Zoo the bull is allowed into the cow's pen under supervision and stays with her as long as she is on heat (1-2 days)[9].

Pregnancy, parturition and intercalving period

Gestation length recorded in the wild is, for obvious reasons, quite variable. The Natal Parks report a gestation period of 450 days with mean intercalving periods of 44 and 30 months in Hluhluwe and Umfolozi Parks, respectively[7]. Intercalving periods can, however, be as short as 20 and as long as 89 months in the same parks. In other parts of Africa mean calving intervals are similar to those reported above (26-48 months)[2,7].

In Zürich Zoological Gardens[9], where 6 births have taken place in recent years, gestation periods of 457 to 470 days were recorded. Drops of milk on the teats (waxing?) are seen as long as 3 weeks before partus. The onset of udder development is sudden and massive and is seen 2-3 days before parturition. Parturition lasts 0,5-1 h and no complications have been recorded to date. One cow currently pregnant, has developed a vaginal prolapse. Cows come on heat *ca* 1,5 years after calving when she allows service.

Birth mass of black rhinos is as little as 20 kg in zoos, with one calf recorded at 38 kg[4]. A birth mass of 40 kg is given for black rhino in the Natal Parks[18]. The newborn rise to their feet soon after birth (10 minutes in one case) and are walking soon after that. They suckle for the first time within 3-4 h[4,18]. Cows continue to suckle their young well into the following pregnancy in the wild[4]. Natal Parks report cows lactating for up to 15 months[7].

Monitoring by means of urine and faecal steroids

Oestrus cycle

The first paper dealing with this subject in black rhinos was published by Ramsey *et al.*[13]. They determined oestrogen and PDG concentrations in the urine of cycling and pregnant animals. In order to standardise results, concentrations were expressed relative to creatinine urine concentrations. All subsequent papers dealing with urinary steroids, use the same method of standardisation. Oestradiol and oestrone concentrations did not vary during the oestrous cycle or pregnancy and were found to be of no use for monitoring these events. The same was true for PDG during the oestrous cycle.

Hindle *et al.*[6] published the next paper on urinary steroids in cycling black rhinos. They identified oestrone and 20α-DHP as the major urinary steroids in 4 cycling cows. A total of nine cycles were monitored and the results showed a follicular phase lasting 3-4 days, a luteal phase of 18 days, giving a total cycle length of 21-22 days, which is within the range established by means of observation at Zürich Zoo[9].

A third paper by Schwarzenberger *et al.*[16] reported on the faecal progestagen metabolites of cycling and pregnant black rhinos. Two cows monitored for 5 and 6 consecutive cycles had average cycle lengths of 24 and 26,5 days, respectively.

Pregnancy

Ramsey *et al.*[13] showed that urinary PDG levels could be used to diagnose and monitor pregnancy in black rhinos. In the 8 cows monitored, urinary concentrations were detectable 9-12 months prior to parturition. An interesting finding during one of the pregnancies monitored was the breeding dates of the cow. She was mated on Days 493, 467, 460 and 389 before parturition. If one takes the mean gestation period of 464 days observed in Zürich Zoo[9], it indicates that this cow allowed

service during pregnancy (Day 389). The mean length of gestation in this paper[13] is given as 462 days.

Schwarzenberger *et al.*[16], who monitored pregnancy in 3 black rhino cows by means of faecal progestagens, found a gestation lengths of 440-454, 459 and 470 days, respectively. Mating in the case of the first cow was not observed and, if one takes other reliable sources in the literature into account, it seems likely that this figure cannot be regarded as correct. All 3 cows gave birth to live female calves. From 10 days after mating and until 2 months of pregnancy faecal progestagens remained at cyclic luteal-phase levels. They then rose further to reach a second plateaux at 4 to 5 months of pregnancy, where they remained until about 2 weeks prior to partus, when they declined. The secondary rise in progestagens during pregnancy was thought to be due to the onset of placental progestagen production. Figure 1 shows the typical profile of 20α-DHP during pregnancy in a black rhino cow[3].

An interesting additional finding in the work of Schwarzenberger *et al.*[16], was the fact that all 3 cows showed luteal-phase faecal progestagen concentrations within a month of calving, indicating that the cows had ovulated soon after parturition. Mating, however, was not allowed until the normal time *post partum* reported for black rhino.

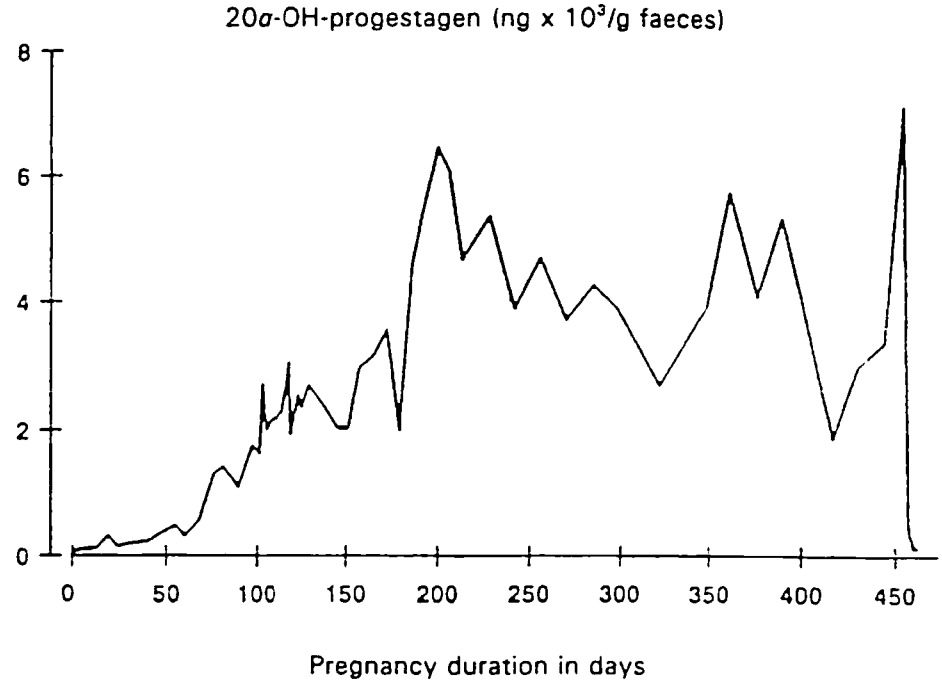

Fig 1: 20α-OH-progestagen profile of the black rhino cow "Theluyi" during pregnancy (458 days' Adapted from Francke & Schwarzenberger[3].

REPRODUCTION IN WHITE RHINOS

Observations in the wild and in captive breeding stations

Information in the literature is scant but maybe this is due to the covert nature of oestrus in som white rhino cows. On the other hand, according to the 4th Report of the International Studboc of African Rhinoceroses[8,11], which covers the period 1987 to 1990, there were 709 white rhinc in captivity, indicating that more information on the reproduction of these animals should t available. There may also be differences in the reproductive parameters between the southern ar northern white rhinos[6].

Sexual maturity

Little information is available here and some people use the same figures given for black rhinos (♀♀ 7 or 8 years; ♂♂ 8 years)[2,18]. However, white rhino bulls only start to hold their territory at 12,5 years of age[18].

Oestrous cycle

Based on 5 observations in the wild the length of the oestrous cycle is given as *ca* 28 days[18].

Cows in the Natal Parks cycle the year round but a bimodal calving pattern is observed with peaks in March and July corresponding to conceptions peaks in November and February[7].

Mating

No specific information is available on this subject. Hence some associated information is provided that could be useful to captive breeding of white rhino. In the wild adult white rhino bulls are territorial and trespassing of territories can result in serious fighting[18]. Subordinate bulls are tolerated by territorial bulls provided they remain submissive. The home ranges of cows may overlap each other and may cross the home ranges of a number of territorial bulls.

White rhinos are gregarious and are encountered in smaller groups of up to 18 animals. Sometimes an adult bull occurs in such a group. They do not tolerate calves close to themselves and calves are continuously in danger of being killed in such cases[4]. Apparently white rhinos need a certain minimal group size in order to reproduce efficiently[1]. The group size is not clearly defined, but breeding pairs do not reproduce in captivity.

Pregnancy, parturition and intercalving period

Figures in the literature are sparse and are quoted as 547[4], 484[2] and 480 days[18]. Birth mass is approximately 40 kg. The calf is weaned at about 12 months of age but stays with the mother for the first 2-3 years of its life[18]. Intercalving periods quoted in years are as follows: Umfolozi 2,63; Kruger National Park 2,70; Matopos 2,85 and Kyle 3,45[2].

Monitoring by means of urine steroids

Oestrus cycle

The only paper related to this subject, which does not include pregnancy, is that of Hindle *et al*[6]. One northern and one southern rhino cow were used in the study. The main urinary steroids in white rhino cows were found to be oestradiol-17ß and 20*a*-DHP. Cyclic patterns for both steroids were observed in each animal. The northern cow showed an interoestrus interval of 24 days while that of the southern cow was 32 days, as judged by the oestradiol-17ß peaks. The northern white rhino showed overt oestrus during two consecutive cycles, was mated on each occasion, but did not fall pregnant.

DISCUSSION AND CONCLUSIONS

The populations of all species of rhinos in the wild are decreasing rapidly all over the world. With the exception of populations in the reserves of South Africa, efforts to save rhinos from extinction in the wild have not been particularly successful . Strategies to save the rhino by means of captive breeding programmes have also not been successful. If one looks at the 1987-1990 statistics of rhinos in captive breeding programmes, 204 black rhinos were to be found in 72 locations all over the world. During this period 30 births were registered and 26 animals died, giving a net gain of 4 black rhino. The statistics for white rhinos are hardly better. During the same period 709 white rhinos were held in 245 locations, there were 45 births and 31 deaths, thus giving a net gain of 14 animals. If one compares these statistics to the phenomenal population growth registered for black

and white rhinos in South Africa game reserves over the past 80-90 years, one must really question the validity of some of the captive breeding programmes. There are some very successful stations like Zürich Zoo but, on the other hand, many of the rhinos that die in captivity are young animals. If the individual rhino species are to be saved from extinction, we need to learn from the captive breeding stations that are successful. What factors in the management and nutrition of the rhino make zoos like Zürich so successful? On the other hand, white rhinos appear to need a certain minimal critical number before they will breed. What is this number and should zoos that have only one or two animals be allowed to continue their breeding programmes? What is crystal clear is the good reproductive rate of rhino in their natural habitat. In this context game ranching, particularly in South Africa, where animals are relatively safe from poaching, offers a good adjunct to the breeding of rhino outside of our game parks.

Although rhinos were introduced as zoo animals to Europe during the last century, relatively little is known about their reproductive patterns. Reliable observations in zoos and other captive breeding establishments in recent years have contributed a great deal to overcoming this deficit in knowledge. Probably the most valuable contribution in this respect has been due to the development of urinary and faecal steroid assays, both of which offer non-invasive methods of monitoring oestrous-cycles and pregnancies. These methods should be further exploited to study reproductive patterns of rhinos, especially during the postpartal period. Schwarzenberger *et al.*[16] have already shown that black rhinos probably have a *post partum* oestrus. Mating, however, is not allowed until about 15 months or more later[13]. Manipulation of the *post partum* period by means of management can perhaps reduce the intercalving period and so increase the reproductive rate of rhinos.

In future, I believe, sound management techniques, optimal nutrition and anti-poaching strategies will make the greatest contributions to saving rhinos from extinction. As part of this a sound understanding of their reproduction is required. Reproductive biotechnology, although useful in isolated cases, I believe, will not contribute substantially to saving these species.

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