

## Behavioural Characteristics used to Determine the Reproductive Status of Captive Black Rhinoceroses (*Diceros bicornis michaeli*)

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With 2 Figures and 2 Tables

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### Introduction

The questions and problems of breeding endangered species for conservation have mainly been addressed from the viewpoint of genetics and demography (SMITH & READ 1992, SOULE 1986, 1987). However, behavioural considerations also have to be kept in mind, as these recommendations often conflict with those of genetics (SCHREIBER et al. 1995, GANSLOSSER 1995). In order to increase the captive black rhino population at the maximum growth rate attainable, husbandry and breeding recommendations suggest to breed the animals early and to separate mother and offspring at a young age (SMITH & READ 1992). It is possible that this could conflict with aspects of natural social behaviour.

For successful management it is important to keep the breeding situation as natural as possible. Behaviour studies are very important for monitoring behaviour patterns, courtship, mating procedures, and comparing these to observations in the wild. This information can be used to ensure that there are no important factors absent which may reduce the success of reproduction in captivity. The reliable detection of the onset of regular cyclic activity is also important in deciding when to "pair" young adult animals.

Currently the only reliable methods of determining oestrus and cyclicity involve regular urine/faecal hormone analysis (FLINT 1991, HODGES & HINDLE 1988, SCHWARZENBERGER 1993), however, there are problems associated with these methods, including difficulty in obtaining regular, uncontaminated samples and the lack of equipment/financial backing at many institutions. Hence, in captivity, it is often difficult to determine when the female is in oestrus, without the presence of a male, this results in many pairs being housed together on a permanent basis. A management technique which can result in the problem of aggression between the pair (J. WILLIS pers. comm.).

Chester Zoo has a young pair of black rhinos (*Diceros bicornis michaeli*) housed together on a permanent basis. The male is five years old and the female six and a half. Females exhibit varying degrees of overt oestrus by frequent urination, rhythmic contractions of the vulva and the vulva may also appear swollen with some milky white discharge (HITCHENS & ANDERSON 1983). The female at Chester shows no physical signs and only a slight increase in urination on the peak day of oestrus, making it very difficult to determine oestrus.

By analysing their behaviour the aims of the project were to determine:

- If the female is cycling regularly and if this regularity is comparable to that of females in other zoos and in the wild.
- The frequency and duration of oestrus by analysis of possible behaviour patterns.
- Whether it would be possible to determine the female's reproductive status by observing her behaviour without the male present.

## Materials and Methods

Preliminary Observations involved continuous all occurrence recording to formulate hypotheses, familiarise with the subjects, and build up a manageable catalogue of behaviours. Instantaneous focal sampling with sample intervals of sixty seconds, in a thirty minute sample period, were chosen as the shortest possible interval that allows the observer to record reliably (MARTIN & BATESON 1993, COLGAN 1978). A check sheet was used for recording behaviour and notes were also made on temperature, weather, urination frequencies, and duration of penile erections. The span of the study period was 129 days and the total number of observation days within this period was 90. Of those 90 days, 70 included morning sessions; 8 am–10 am, 43 included midday sessions; 11 am–1 pm, and 34 included afternoon sessions; 3 pm–5 pm, a total of 73.5 hours observing.

## Behavioural Categories

Rhinos are documented as displaying a relatively predictable sequence of pre-copulatory behaviour patterns. Observations of behaviour cited in: ESTES 1991, GODDARD 1966, HALL-MARTIN & PENZHORN 1977, HITCHENS & ANDERSON 1983, JOUBERT & ELOFF 1991, KOCK et al. 1991, KINGDON 1979; KIWIA 1986, MERZ 1991, MOSS 1982, OWEN-SMITH 1988, PENNY 1987, SCHENKEL & SCHENKEL 1969, SMITH & READ 1992 indicate that: Male and female black rhinos usually only associate during oestrus, when the male follows the female closely, testing her reproductive status by tasting her urine and exhibiting the flehmen response. After some time the female stands in front of the male, he rubs his chin along her back and flanks and then levers himself up onto her back. Eventually the male develops an erection and attempts to copulate. Copulation can occur several times during peak oestrus and can last between five and forty-five minutes, until the female dislodges the male by walking away.

The Following definitions are some of the behaviours exhibited by the pair at Chester Zoo.

Pacing-PA	Walking up and down restlessly. Often exhibited by the female when the male is following her.
Following-FO	Male shows an interest in the female and follows her closely.
Chin Resting-CH	The male rests his head on her rump, sometimes rubbing.
Female Stance-FS	At the peak of sexual activity the female stands before the male with her tail raised to one side, in readiness to copulate.
Mounting-MN	When the female adopts the stance the male levers himself onto her back, without an erection.
Attempted Copulation-AC	A full penile erection usually begins to develop shortly after mounting and the male attempts penetration.

## Results

Initially data from a questionnaire, circulated in 1986 by the American Association of Zoological Parks and Aquariums (AAZPA-SSP), were analysed as a guide to expected results (Table 1).

Table 1. Analysis of questionnaire data indicating data for oestrous cycles in captivity

Section of questionnaire	Number of institutes	Number of animals	ME AN	S. D. +/-
Mating peak (hours)	11	12	41.5	10.06
Duration male attendance (days)	9	9	5.8	2.86
Frequency of oestrus (days)	14	18	31	7.62
Age at sexual maturity – (years)				
female	24	25	5.7	1.85
male	23	25	6.4	2.65

N.B. Duration of male attendance is suggested to be indicative of the duration of oestrus, and the mating peak indicative of peak oestrus.

## Analysis of behaviour

The check sheets were split into separate days and all the occurrences of each behaviour on each day were accumulated. The number of observation periods for each day varied according to time available, so to make the occurrences of behaviours representative and comparable they are expressed as a proportion of all sample points. Every behaviour, for male and female, was then plotted as the percentage time observed in that behaviour, against consecutive days. These were expressed as vertical bar charts (see fig. 1 and 2).

Adoption of female stance coincided with mounting and attempted copulation,

Table 2. Analysis of behaviour patterns to indicate the duration and frequency of oestrus

Behaviour category	Median length of peaks in behaviour	No. Peaks
Female stance – duration (hours)	36	6
Female stance – Frequency (days)	22	5
Following/attendance by male (days)	6	5
Pacing/restlessness in female (days)	7	6

N. B. No. peaks indicates how many times a particular behaviour peaked in occurrence over the observation period.

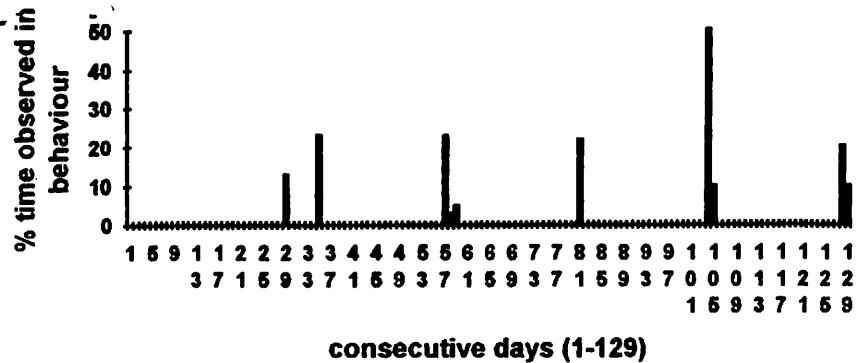


Fig. 1. Observations over the study period from day 1–129 indicating percentage time the female was observed adopting the female stance position (receptive to the male's advances) in readiness to copulate.

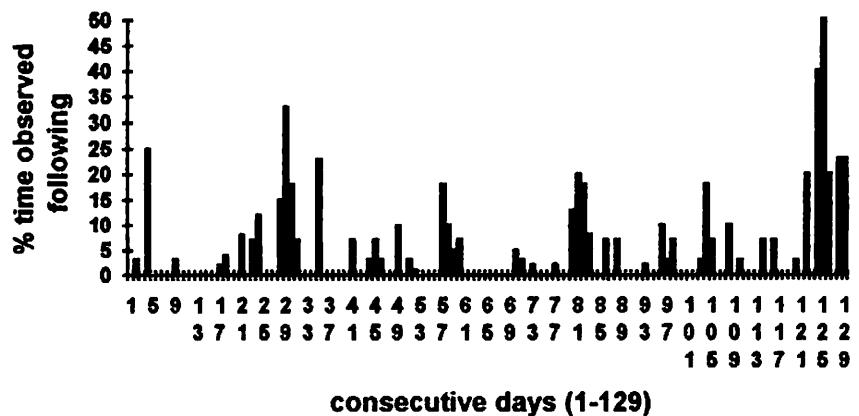


Fig. 2. Percentage time the male was observed following the female on each day of the study period from day 1 to 129.

indicative of peak oestrus. Following by the male (length of male attendance) and pacing by the female also showed a similar pattern, indicative of the total duration of oestrus. The frequency of peaks in these behaviours were used to calculate the frequency of oestrus. The frequency and duration of periods of heightened sexual activity, calculated from the above, are shown in table 2.

## Discussion

The behaviour charts for female receptivity (fig. 1), mounting, and attempted copulation all showed a very similar pattern. They indicate that oestrus activity (receptivity) usually peaks for one day, extending to a maximum of three days on one occasion. The survey results from other zoos (AAZPA-SSP 1986) show similar values (24–54 hours peak receptivity).

## Other observations include:

Duration of receptivity – 24 hours (HITCHENS & ANDERSON 1983), 24 hours (OWEN-SMITH 1988), 24–48 hours (GÖLTENBOTH & OCHS 1995), determined from similar observations of female behaviour in the wild and captivity, such as the female's stance or rejection of the male's advances.

The frequency of oestrus is the time between two consecutive oestruses (time between peaks in sexual activity). On the female's receptivity chart (fig. 1) the initial peak was very unusual, there seemed to be two separate peaks only a few days apart, this may be explained by the fact that at this time the pair were moved from the old house to a new enclosure, which may have disrupted the cycle and caused a secondary peak. Apart from this discrepancy the peaks in receptivity occurred at: 35 days, 57–59 days, 81 days, 104–105 days, and 128–129 days. Ignoring the initial peak, these gave a median duration of 22 days.

These data compare well to the data from other zoos (AAZPA-SSP 1986) which give a range of 17.5–48 days and a mean of 31 days (S. D. 7.62). Other observations give durations of: 26–46 days (HITCHENS & ANDERSON 1983), 21–28 days (GÖLTENBOTH & OCHS; 1995), 21–25 days (PENNY 1987), and 28–46 days (OWEN-SMITH 1988). Determined by the length of attendance of the male to the female (observations of the male following the female and the amount of time the pair spend in close proximity).

The charts of pacing in the female, following in the male (fig. 2), and head/chin rubbing by the male, infer that the male is in attendance to the female for a few days, up to and following attempted copulation (peak oestrus). The female is increasingly restless and active for up to one week (6 days) surrounding peak receptivity. The male shows an interest in the female for approximately six days surrounding attempted copulation. References from other zoos (AAZPA-SSP 1986) gives a duration of attendance by the male as 4–12 days. Observations from the wild suggest duration of interest in the female as 6–7 days (HITCHENS & ANDERSON 1983), 1–3 days (GÖLTENBOTH & OCHS 1995), and 6–7 days (OWEN-SMITH 1988).

The results have shown that the female is definitely cycling regularly, but she exhibits no overt signs of oestrus, that would be recognisable in time to introduce the male. Urination frequency only shows a marked increase on the peak day of receptivity, during peak oestrus there is a constant dribble of milky urine and frequent contractions of the vulva. This change in urination occurs too late to be used as a marker for oestrus. The pair need to be introduced 5–6 days before peak oestrus, to enable the natural sequence of behaviours (courtship) to take place.

Pacing, by the female, showed the most obvious pattern of behaviour in relation to oestrus, time spent pacing increased steadily up to peak receptivity, then gradually falling off again. Overall, the female gets increasingly restless approaching oestrus, she spends less time eating and lying down, and more time pacing and standing (data not included in this report, available from author). It is possible that this may be more obvious when the male is not present, as the female may get increasingly impatient and restless with no sign of a mate. This could be investigated by observing the female for a complete cycle without the male.

### Conclusions and Further Directions

The female is mature with a normal and regular oestrous cycle. The median length of five oestrus cycles is 22 days, oestrus duration about 4 days (interest from male) and peak oestrus 40.1 hours (peak receptivity). The male is probably mature but lacking experience. He shows all the behaviours of courtship and territory marking attributed to a mature male, and has shown a decrease in the occurrence of playful characteristics (e.g. prancing, chasing, throwing sticks etc.). Two years after this study the pair produced a healthy calf.

There are several hypotheses as to why it is difficult to determine if young females are cycling regularly. The oestrus cycle may only become regular after the female reaches a certain age, or females may appear irregular because at a young age overt oestrus is discrete. The male is young and not proven as a territory holder and may be dismissed by the female, or over familiarity may result in a lack of interest between a pair housed together permanently, hence oestrus would be less apparent. Stress factors may disrupt the oestrus cycle so that it appears irregular – prior to moving to a larger enclosure the female may have been irregular due to the stress, caused by a small enclosure and lack of privacy, they may also be affected by changes in routine.

The project needs more time for observations and more individuals to observe, to be able to come to any definite conclusions, but it makes a good preliminary study for further investigations.

Similar behaviour studies could be used at many institutions to determine the reproductive status of females, regularity of cycles, whether the female is mature, suitability of a particular pairing, as well as for investigation into the effects of stress and enclosure design on behaviour.

### Zusammenfassung

Spitzmaulnashörner, *Diceros bicornis michaeli*, werden in vielen Zoos paarweise von früher Jugend an gehalten. Um eine dem natürlichen Fortpflanzungsverhalten mehr zu entsprechende Situation zu schaffen, sollte das männliche Tier nur während des Östrus zum weiblichen Tier gelassen werden.

In der vorliegenden Untersuchung wurde an einem Paar dauerhaft zusammenlebender jungerwachsener Spitzmaulnashörner (5 bzw. 6 Jahre) durch Verhaltensbeobachtungen

- die Regelmäßigkeit des Zyklus
- Dauer und Auftreten östrustypischen Verhaltens

- die Möglichkeit der Östruserkennung an Verhaltensmerkmalen der Kuh überprüft und mit Daten aus anderen Haltungen verglichen.

Die Verhaltenselemente der Vor-Kopulationssequenz wurden beschrieben und über die Dauer von 129 Tagen durch Fokusprotokolle erfaßt. Die Arbeit umfaßt 73,5 Beobachtungsstunden aus Vormittag-, Mittag- und Abendbeobachtungen. Verhaltensmerkmale von Interesse sind weibliche Paarungsbereitschaft, Aufreiten und Aufreitversuche. Die Angaben werden mit Daten aus Freilandliteratur und dem AAZPA-SSP-Fragebogen von 1986 verglichen. Es ergab sich hier eine Östrusdauer von 24–60 h (andere Zoos gaben 24–5 h, Freilandbeobachtungen 24–48 h an). Die Aufmerksamkeit des Bullen dauerte ca. 6 Tage vor und bis zum Hochoestrus, Vergleichsdaten aus Zoos 4–12 Tage, Freiland 1–7 Tage. Östrusaufreten war alle 22–23 Tage (andere Zoos 17–48 Tage, Freiland 21–46 Tage). Es konnte anhand der Verhaltensbeobachtungen ein regelmäßiger anderen Veröffentlichungen vergleichbarer Östruszyklus festgestellt werden. Anzeichen für Östrus im Verhalten ohne Anwesenheit des Bullen konnten nicht gefunden werden. Um normales Werbeverhalten zu ermöglichen sollten ca. 5–6 Tage vor dem Hochöstrus zugestanden werden. Mit Herannahen des Hochöstrus steigt die Bewegungsunruhe der Kuh. Sollte sich dies in Abwesenheit von Bullen verstärken, könnte es bei sorgfältiger Beobachtung eventuell als Verhaltensindikator genutzt werden.

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## Movement order in a Captive Giraffe (*Giraffa camelopardalis*) Herd

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With 2 Tables

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### 1. Introduction

The examination of the ordinal positions of individual animals during movement between areas has been studied frequently in domestic ungulates such as sheep (HAFFEY & SCOTT 1962, SYME & SYME 1975, LYNCH et al. 1992) and cattle (HAFEY & SCHEIN 1962). However, this behavior has not been well documented in their non-domestic counterparts.

For example, no systematic studies of movement (or progression) order exist for either captive or wild giraffes (*Giraffa camelopardalis*) and the available relevant accounts are somewhat conflicting. DAGG & FOSTER (1982) and ESTES (1991) state that giraffe herds have no leaders while PRATT & ANDERSON (1985) observed that while at times a herd may have no leader, at other times a middle aged or old female appeared to take that role.

In order to provide some preliminary information on this behavior in captive giraffes, the progression orders of the giraffe herd at the Brookfield Zoo near Chicago, Illinois were observed as they moved between two areas as part of their daily routine.

### 2. Methods

The study herd consisted of seven individuals of varying ages and lengths of time in the herd (Table 1). Observations were made from 5 January-23 March 1995, at which point one of the study animals was shipped to another zoo. During this period the animals were housed indoors as the weather was too cold for them to be exhibited in outside yards. An adult male was also present, but due to management considerations he could not be housed with the group indoors so he was not included in the study.

The group had access to two off-exhibit stalls with a combined area of 70 sq m and an exhibit stall with an area of 150 sq m. These were connected by a corridor