Conservation and captive management of Sumatran rhinos in Sabah, Malaysia

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Abstract:

Captive management of highly endangered species becomes more and more important. However, information on the requirements of successful reproduction is often limited. The Sumatran rhino is one of the most threatened mammals. Only 300 Sumatran rhinos are left in the wild. The captive breeding of the species is not a story of success. Sumatran rhinos are solitary animals. They can fight viciously if the female is not sexually receptive. It is therefore important for captive management to identify the right time of mating. The purpose of the study is to determine whether a correlation exists between the female oestrus cycle and the behaviour of the rhinos. Data was collected between March 2004 and October 2005 from two captive Sumatran rhinos (1.1) kept in the Sumatran Rhino Breeding Centre in Sepilok, Sabah, Malaysia. We conducted regular hormone analysis using faecal samples. The rhinos were introduction regularly to each other through a fence and the time spend in contact was measured. We conducted regular behaviour observation, and we did daily temperature measurements. Progesterone analysis indicated that the female is still cycling but cycling activity is irregular. Our findings also suggest that male activity, such as erection and masturbation correlate with the female's cycling activity.

keywords: Sumatran rhino, reproduction, oestrus, behaviour

Captive management of highly endangered species becomes more and more important since large areas of natural habitat are rapidly dwindling. The management of captive animals requires knowledge of the basic requirements of a species and knowledge about its reproduction. However, this

information is often lacking in highly endangered species (Wildt et al. 2003). The Sumatran rhino is one of the rarest and most threatened species in the world. It once occurred from the foothills of the Himalaya in Bhutan, through Burma, Thailand and Malaysia to Sumatra and Borneo (van Strien 1974). Today its distribution is limited to small numbers in Burma, Thailand, the Malaysian pensinsula and the islands of Sumatra and Borneo (Joubert 1996, van Strien 1974). Reasons for that are the age-long persecution for its horn and other remarkable parts and the disappearance of a large part of its habitat (Van Strien 1974).

The Sumatran rhino is the smallest of the five living species of rhinos. It was, and still is, one of the least studied and least known mammals in the world. Reasons for this are its elusive character, its rarity and the inhospitable nature of its habitat. Direct observation of the animal is almost impossible in the dense tropical forest and the study of indirect evidence is often the only feasible procedure (van Strien 1974). Due to the lack of information captive breeding of the species was not a story of success. Since 1984, a total of 27 Sumatran rhinos were caught in the wild and brought to facilities throughout the world. Over a six year period, 29.6 % of the Sumatran rhino died without contributing any genetic material towards the species' conservation (Abdullah et al. 1989). With time passing, people learned about the requirements of Sumatran rhinos in captivity and managed to keep the remaining animals alive. However, the next problem to be solved was how to breed the Sumatran rhino in captivity.

In captivity, male and female fight viciously if they are brought together while the female is not sexually receptive (Khan 1999). Due to this aggressive behaviour it is very important to identify the right time of mating. Hormone analyses have been used successfully to assist in the breeding of rhinos but there is disadvantage in their usage. The collection and processing of samples is costly and time consuming. For fast breeding decisions it is necessary to have other reproduction-associated characteristics which are easy to identify even for unskilled personal. Aim of our study was to establish whether rectal temperature and reproductive associated behaviour patterns correlate with faecal steroid hormones and can therefore be used to predict a forthcoming oestrus.

Material and methods:

Data was collected between March 2005 and October 2005 from two captive Sumatran rhinos (1.1) kept in the Sumatran Rhino Breeding Centre in Sabah, Malaysia. The male is approx. 17 years old and the female is approx. 27 years of age. Both rhinos originate from the Kinabatangan area, in Sabah Borneo.

Faecal collection and hormone metabolite concentration in the faeces:

A total of 102 faecal samples were collected from the 3rd of March until the 31st of October 2005, with one faecal sample every second day. Faecal samples were collected in the morning, either from the rectum of the animal, from the wallow in the enclosure, or from the ground of the night enclosure. The samples collected from the water and from the enclosure were from the night or the early morning and less than half a day old. The faeces were collected in a plastic bag, mixed and different parts of the dung were placed into a plastic tube. The tube was stored at – 12 °C until processing. The faecal hormone analyses were conducted in Vienna (see Kretzschmar et al., in prep.).

Behaviour observations:

The behaviour of the rhinos was monitored six days per week, from the first of March until the 31st of October 2005, resulting in 202 days of observation. The behaviour was monitored on an hourly basis, starting from 9:15 in the morning and finishing at five in the afternoon. Each animal was observed for 15 minutes per hour using focal animal sampling. The total time of observation was 287 hours and 15 minutes.

For 60 minutes each day, 30 minutes in the morning and 30 minutes in the afternoon, the animals were brought into a so called "contact area". In this enclosure the rhinos could get in direct contact to each other through a gate. The gate had vertical metal bars which allowed them to touch and lick each other. The animals were observed for 15 minutes each and were than returned to their normal enclosures. The total time of observation in the "contact area" was 199.69 minutes or 187 days.

Several behaviour categories were measured but only two categories were analysed in the study: the "proportional duration of erection" and the "proportional duration of contact". The proportional duration of erection was established by measuring the length of an erection during a 15 minutes observation period using a stop watch. The length of time of all erections occurring within one day were added up and divided by the total length of observation for this day.

The proportional duration of contact between the male and female was established by measuring the length of time the animal spend in direct contact with each other while they were in the contact area. Direct contact was defined as an event starting when the animals touched each other through the gate with their mouth, ears, tongue etc., and stopped when one of them turned its had away and interrupted the contact. The length of time of all contacts in the contact area within one day were added up and divided by the total length of observation in the contact area during this day.

Body temperature:

The temperature was measured early in the morning, three times per week from March until October 2005. It was measured in the rectum of the animal (until July 2005). In order to avoid variations in measurements in relation to the position of the thermometer the method was changed and a thermometer was placed in the faeces directly after collection. The difference between the two methods was 0.1 °C (median 1st method = 36.3°C, IQR = 0.4°C; median 2nd method= 36.2°C, IQR = 0.5°C).

Data analysis:

Data are presented as median ± interquartil range (IQR). To determine the time of oestrus, we used behavioural and endocrine criteria. The beginning of oestrus was identified by oestrogen values above the median oestrogen concentration plus IQR. The termination was determined by a decrease in concentrations below median concentrations plus IQR. Once the presence of a cycle was identified, we used behaviour patterns (see above) for verification.

Results:

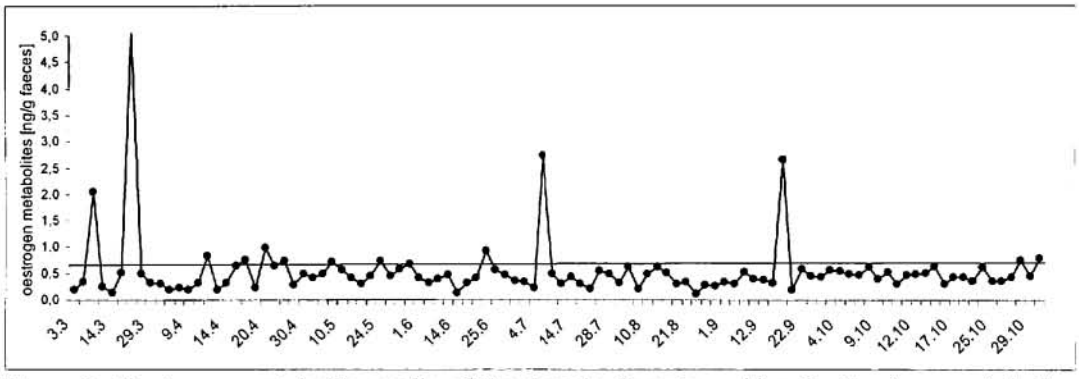

Figure 1: Oestrogen metabolite profile of the female Sumatran rhino for the time period: March to October 2005. The horizontal line indicates the range of concentration which are above the median concentration plus the interquartil range.

The female rhino did not cycle regularly (Figure 1). She had a few clear oestrogen metabolite peaks which reached oestrogen metabolite concentrations of 2 ng/g faeces and above (on the 7th of March, the 23rd of March, the 7th of July and on the 15th of September) and she had a few less pronounced peaks which reach concentrations above 0.69 ng/g faeces (= median concentration plus IQR, see Table 1). The median length of the ovarian cycle, defined as the interval between successive oestrogen peaks was 16 days (IQR = 10 days, n = 11).

Table 1: Oestrogen metabolite concentrations that reached concentrations above the median plus interquartil range.

date	Oestrogen metabolite concentration [ng/g faeces]
12. Apr. 05	0.83
16. Apr. 05	0.76
20. – 23. Apr. 05	0.75 – 0.99
7. May 05	0.73
24. May 05	0.74
21. June 05	0.93
28. Oct. 05	0.76
31. Oct. 05	0.79

Tanjung and Gelugob had frequent contact with each other while they were in the "contact area". They had 14.5 days (median) per month direct contact with each other through the gate. During these days of contact, they spend 4.6 % (median) of the time in the contact area in direct contact with each other. The number of erections per month was much lower compared to the number of direct contacts. The male Sumatran rhino had one erection per month (median = 1, IQR = 1.25). The median length of an erection was 2.8 minutes. Once it occurred, it took 3.9 % (median) of the daily observation time.

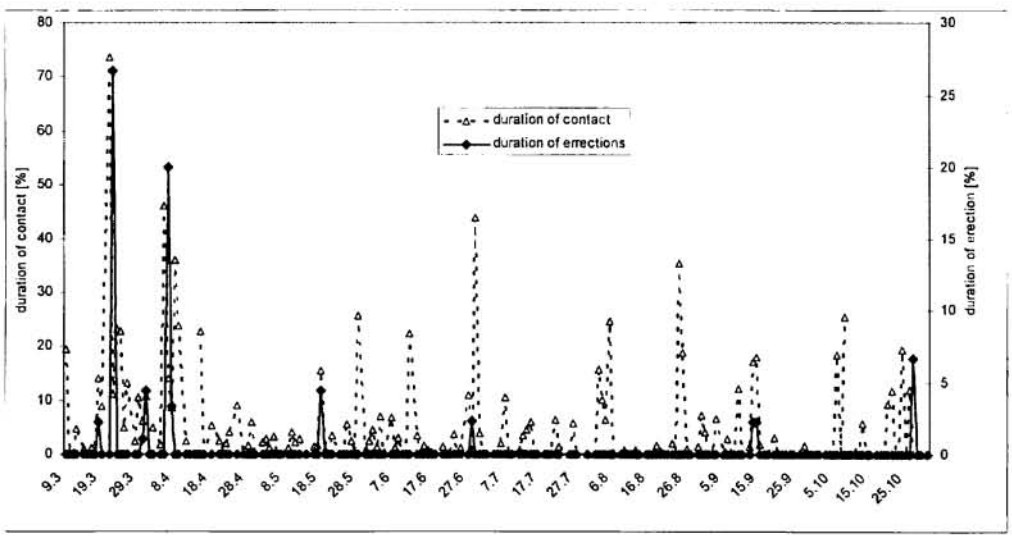

Figure 2: Proportional duration of contact between the male and female Sumatran rhino in the contact area and the proportional duration of erections of the male rhino during the daily observation period from March until October 2005.

There was a connection between the proportional duration of erections and the proportional duration of contacts: erections never occurred without direct contact between the animals and the longest proportional duration of erections occurred on days with the longest proportional duration of contact (Figure 2). However, there were quite a few number of contacts were there were no erections.

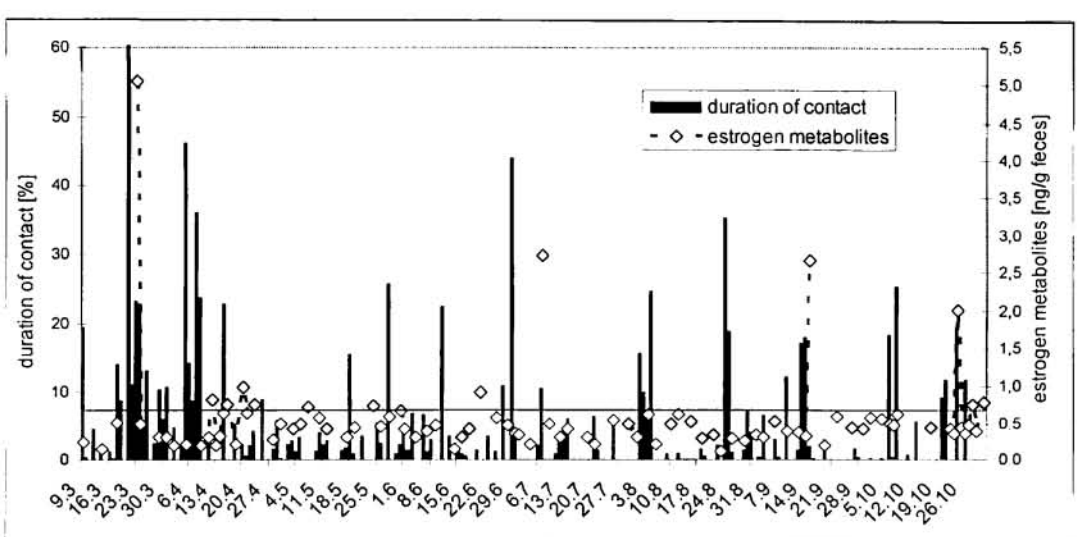

Figure 3: The proportional duration of contact between the male and female Sumatran rhino and the concentration of oestrogen metabolites in the faeces of the female for the time period March to October 2005. The horizontal line indicates the range of concentration which are above the median concentration plus the interquartil range.

Long lasting proportional contacts occurred on average two days (median, IQR = 2) before oestrogen metabolite peaks occurred (Figure 3) and the longest lasting proportional contact between the rhinos occurred two days before the highest concentration of oestrogen metabolites. This suggests a correlation between hormones and proportional duration of contact but there was often contact between the rhinos without any peak in oestrogen metabolite concentrations. In 69 % of the days during which the rhinos had long lasting proportional contact (defined by the median proportional duration of contact plus IQR) with each other but no oestrogen metabolite peak occurred within the next 4 days following the contact.

Erections occurred on average 5 days (median, IQR = 5) before an oestrogen metabolite peak occurred in the faeces and the longest lasting proportional erection per day occurred one day before the highest concentration of oestrogen metabolites was measured (Figure 4). Every oestrogen metabolite peak was preceded by an erection by 5 days, except in two cases, on the 7th of May and the 21st of June. However, in these two cases, erections occurred outside of the observation period which were not included in this analysis.

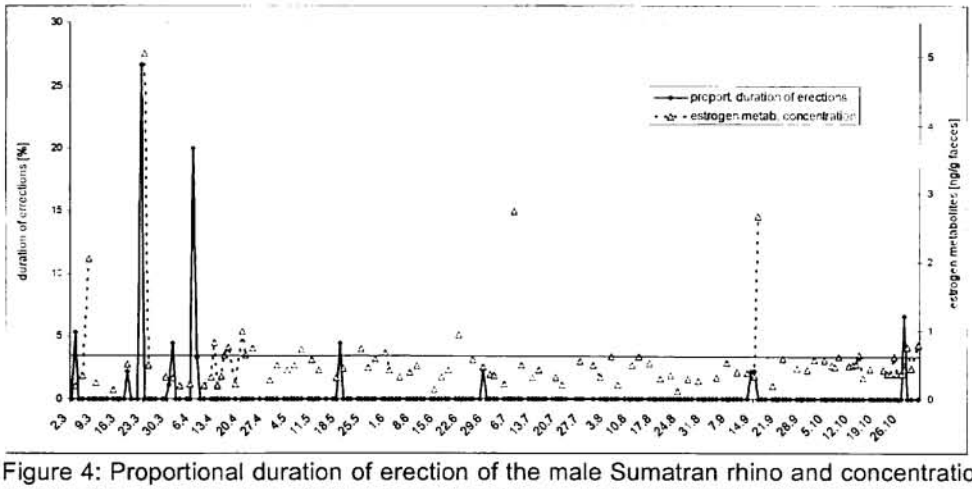

Figure 4: Proportional duration of erection of the male Sumatran rhino and concentration of oestrogen metabolites in the faeces of the female for the time period March to October 2005. The horizontal line indicates the range of concentration which are above the median concentration plus the interquartil range.

The median rectal temperature of Gelugob is 36.24 °C; IQR = 0.4 °C; n = 184). The temperature curve is characterized by a frequent rise and fall in temperature (Figure 5). Peak oestrogen concentrations occur during high and low temperatures measurements and are therefore not correlated with the rectal temperature.

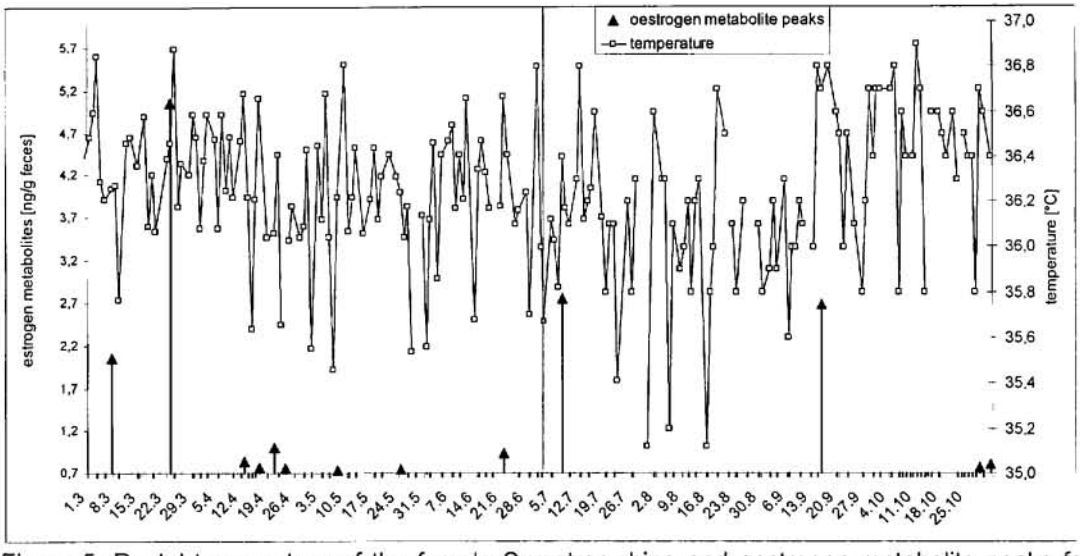

Figure 5: Rectal temperature of the female Sumatran rhino and oestrogen metabolite peaks for the time period March to October 2005. The arrows give the date and concentration of oestrogen metabolite concentrations that are above 0,7 ng/g faeces. The vertical line indicates the beginning of a new measurement method to measure the temperature.

Discussion:

The study is using oestrogen metabolites to characterize the cycle of the Sumatran rhino. Oestrogen metabolites are not common for characterization of oestrus cycles in rhino species. However, Berkeley et al. (1997) found elevated faecal estrogens concentrations during the follicular phase of black rhinoceros and Schwarzenberger et al. (2000) used oestrogen metabolites as an indicator of the follicular phase.

The objective of the study was to characterize long-term faecal oestrogen excretion in the Sumatran rhinoceros and to determine whether behaviour patterns and temperature can be used to predict oestrus. Faecal oestrogen analysis revealed that the female Sumatran rhino is cycling but cycling activity was irregular. The female had short oestrogen peaks of one or two days and she developed a median oestrous cycle length of 16 ± 10 days. The cycle length is short in comparison to other cycles reported for Sumatran rhinos. Heistermann et al. (1998) reported a 25 day reproductive cycle for the Sumatran rhino and Roth et al. (2001) found a 21 day reproductive cycle. However, the cycle length in the present study was not regular. The longest interval between successive cycles measured was 70 days (occurring between July and September). The irregular cycle length is similar to the variations in cycle length reported for white rhinos. White rhinos develop cycle length from 4 to 10 weeks (Patton et al. 1999, Schwarzenberger et al. 1998) and the length varies among and within animals.

The identification of an approaching oestrous is very important for mating of Sumatran rhinos, since aggressive interactions between male and non-oestrous female often result in serious physical injury (Kahn et al. 1999). The irregular cycling activity of the female Sumatran rhino makes it very difficult to predict the upcoming oestrus. The identification of other factors helping to determine the periovulatory

period is therefore very important. We measured the rectal temperature expecting that rectal temperatures would rise - in a similar way as in humans - just after ovulation when oestrogen concentrations decline. However, the study did not show any correlation between temperature measurements and oestrogen concentrations. A more promising alternative is the behaviour of the animals. Our findings show that there is a connection between the male and female behaviour, measured in frequency of contact and the frequency of erections and the oestrogen concentration of the female measured in her faeces. However, frequency of contact is not a reliable indicator of oestrus as high frequency of contact even occurred without any peak in oestrogen metabolites. This behaviour can not be used to plan introduction of the animals for mating. In too many cases the animals would be introduced to each other while the female is not in oestrus. The frequency of erections is a more reliable indicator of oestrus. Every time the male had an erection a median of 5 days later, an oestrogen metabolite peak occurred. An erection is also an easy recognizable behaviour which can be identified by unskilled personal. It is only necessary to monitor the animals on a regular basis. A few erections might be missed but once an erection has been detected it is likely that the female will come into oestrus and mating trials and introductions of the animals can be scheduled accordingly.

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