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SOCIAL AND SEXUAL BEHAVIOUR IN CAPTIVE BREEDING GROUPS OF WHITE RHINOCEROS

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Abstract

The aim of the study was to discovere the causes of low numbers of births of white rhinoceroses in the zoological gardens. For that purpose social relations in a group and behaviour of rhinoceroses in the period of the oestrus were analysed. In cooperation with the Institute of biochemistry of Veterinary University in Vienna endogenous levels of progesterone metabolites in faeces were monitored. The observation was carried out in northern white rhinoceros group (*Ceratotherium simum cottoni*, n = 5) in Zoo Dvůr Králové nad Labem and in southern white rhinoceros group (*Ceratotherium simum simum*, n = 3) in Zoo Ústí nad Labem.

Influence of oestrus on behaviour was evaluated by logistical regression. Social behaviour was evaluated by chi-square test. For each animal index attractivity and aggressivity was determined.

In dominant females the decrease of aggressive behaviour towards male wasn't statistically significant neither in oestrus period nor in other periods. On the other hand lower degree of male aggressive behaviour towards the females in period of oestrus was ascertained. In general 12 categories of cohesive behaviour were registered. In group of *C. simum cottoni* fivefold matting and twelve attempts for matting were observed. In group of *C. simum simum* no sexual interactions were noted. The most often agonistic activities in both subspecies were defensive behaviour of females, which was aimed towards the males.

It can be stated that higher numbers of social interactions were realised due to conditions of breeding in captivity. The males were often attacked by females. In free nature are in such situation only some

submissive males that are not participating in reproduction. Lower level of testosterone in territorial males and irregular cycles of ovulation with low luteal activity of females were the main causes of poor reproduction rate of white rhinoceroses in zoological gardens. An excessive social interaction in breeding of rhinoceroses in captivity replaces such units of behaviour, which are missing in their ethogram. Higher status in social hierarchy has no special advantage e. g. in approach to food sources. The tendency in zoological gardens is to preserve certain individual distance. Premeditated changes of social relations can contribute to a successful reproduction. Just these changes were evidently the main cause of successful matting in the East Bohemian Zoo Dvůr Králové nad Labem. The young were born on June 29th 2000 after 482 days of pregnancy.

Introduction

The white rhinoceros occurs in two subspecies, *Ceratotherium simum simum* and *Ceratotherium simum cottoni*. The subspecies *C. s. simum* was originally spread south of Zambezi River. The population of that southern white rhinoceros is relatively numerous. There were counted about 7,819 individuals in eight African countries in the year 1996 and the figures of this particular animal have recorded an increase to the total of 8,441 individuals in the year 1998 (Internet 1). On the contrary, it is necessary to stress that the northern white rhinoceros *C. s. cottoni*, which had been living in Sudan, Uganda, SAR and Zaire, became nearly extinct. While there had been 2,250 northern white rhinoceros in Zaire in 1963 (Hillman 1985) stated only 13–15 individuals in 1984. In accordance with last rhinoceroses addition from 21. 4. 2000, only 25 individuals were recorded (Internet 2). These 25 animals in the National Park Garamba (Democratic republic of Congo) represented the last compact group of *Ceratotherium simum cottoni* in free nature.

In the zoological gardens of the world lived 704 southern white rhinoceroses in 1998 (Göltenboth 1999). Zoological garden Ústí nad Labem is one of the most favourable in reproduction of these subspecies. Six rhinoceroses were born here. The northern white rhinoceros is at present bred only in two zoological gardens. The Wild animal Park San Diego kept only one male and two females. The East Bohemian Zoological Garden Dvůr Králové nad Labem kept three males and five females. But also two females from the Zoo San Diego belong to Zoo Dvůr Králové nad Labem. This zoological garden is at present the only one where these rhinoceroses were reproduced. Last northern white rhinoceros is female FATU that was born on June 29th 2000. Another four young animals were born in Zoo Dvůr Králové. It is evident, that group of the northern white rhinoceroses in the Zoo Dvůr Králové is world unique. In spite of such an indisputable success it must be stated that potentiality of the reproduction has not been fully exerted. That is the reason for a research programme, a part of which the ethological research represents.

Materials and methods

The results were obtained within the years 1998–2000. The ethological investigations were carried out in two groups of white rhinoceros. They were concentrated in

particular on the animals kept in groups. The behaviour of the animals kept separately is not the topic of this report. The group of northern white rhinoceros (*Ceratotherium simum cottoni*, NASI – one of the females is a hybrid of *C. s. simum* × *C. s. cottoni*) in the Zoological garden Dvůr Králové nad Labem consisted of five adult individuals, one bull and four cows. The bull was 26, the cows were 26, 21, 15, 9 years old when the study was commenced. The enclosure in which these animals were observed had an irregularly oblong shape, maximum length 100 m, maximum width 30 m, the whole area was about 3,000 m^2.

The group of southern white rhinoceros (*C. s. simum,* n = 3) in the Zoo Ústí nad Labem consisted of three adult individuals, one bull and two cows. In the year when the study started the bull was 32, the cows were 31 and 28 years old.

The enclosure for this group was also of an irregularly oblong shape, the whole area being 1,164 m^2.

In both enclosures the rhinoceroses had free access to the water. The bulky forage (green grass, hay) was given ad libitum in the enclosures. In the evening or in the morning the rhinoceroses were admitted into their pavilion, where the food concentrates (pellets and others) and hay were prepared for them on the floor in separate boxes.

The major part of the observations was carried out from May till September, i. e. in the warm months, in which it was possible to leave the animals outside in the enclosures all day and night long. Generally they were observed for 322 hours daytimes in both groups. The group of northern white rhinoceros was observed for 246 hours. From that number, female NÁJIN spent in the observed herd 138 hours, i. e. 690 animal/hours. When NÁJIN missed in the studied group as she became in advanced grade of gravidity the group was observed for 108 hours, i. e. 432 animal/hours, in its enclosure. The group of southern white rhinoceros was observed for 76 hours, i. e. 228 animal/hours, in its enclosure.

Frequency and duration of the acts and postures, inclusing mimic gestures were registered. For the description were used functional and descriptive terms. Record of behaviour were effected by the method of overall ethogram, sampling and by the monitoring of sequention of activities.

The observed sexual behaviour of animals was compared with endocrinology values of progesterone metabolites where were analysed in faecal samples collected twice a week. This examination was performed in Institute of biochemistry Veterinary University in Vienna for needs of Zoo Dvůr Králové. Effect of oestrus on behaviour was evaluated by logistical regression.

The protocol records of the social behaviour from three-year observation period were summarised in the matrices. The evaluation of these data about both scanted groups started with basic comparison in tables and graphs. The significance of differences in the both agonistic and cohesive relations was evaluated according to the chi-square test. The index aggressivity in accordance with Sachser (1985) and Mikulica (1991) was also used for evaluation of the agonistic behaviour. In the cohesive

behaviour the "attractiveness" of partners was evaluated in a way which is analogous to the index of aggressivity. The results gained according to following formulae

$$\frac{Ag^{+}}{Ag^{+} + Ag^{-}} \quad \text{and} \quad \frac{KOH^{+}}{KOH^{+} + KOH^{-}}$$

where

Ag^{+} is the sum of all aggressive activities towards other animals,
Ag^{-} is the sum of all aggressive activities of group members addressed to the animal,
KOH^{+} is the sum of all cohesive activities addressed to the animal,
KOH^{-} is the sum of all cohesive activities recorded in behaviour of the animal.

Results

A) ***Cohesive behaviour***

The following activities were observed:

(i) contacts with a partner by head:
  – rubbing its head against another animal
  – touch and/or rubbing its horn against another animal
  – leaning its horn against another animal
  – touch and/or rubbing its lips against another animal's body
  – lying with its head on a flank of another lying animal
  – placing its head from behind between the hind legs of another standing animal
  – raising the head of another animal with its forehead
(ii) contacts with a partner by body:
  – pressing its hind part to another animal
  – rubbing its side against that of the other in passing
(iii) approaching to another animal
(iv) following
(v) lying, standing and walking side by side.

In group of *C. s. cottoni* were recorded 14 and in herd of *C. s. simum* 11 types of cohesive behaviour. By the animals from the group of *C. s. cottoni* 1,065 cohesive manifestations have been noted, i. e. 4.3 cohesive activities/hour. In group of *C. s. simum* 175 cohesive interactions were registered, thus 2.3 cohesive manifestations/hour. Most cohesive interactions were registered lying near by other animals, standing and walking side by side, rubbing or touching by the head or horn against other partner, pressing its hind part to another animal in T-posture.

The activities such as the lying with head on flank of another lying animal or placing its head from behind between the hind legs of another standing animal observed in adult cows can be derived from an infantile behaviour.

In comparison with numeric numbers of cohesive and agonistic interactions between animals there has been showed clear mutual positive preference between females. In group of *C. s. cottoni* between females NÁJIN and NESÁRÍ, on the other side between NABIRÉ and NASI. In group of three animals *C. s. simum* was expected distinct mutual preference between ZAMBA and SAŠA. Similar indications were accrued from the testing by χ^2 test. Here was validated dependence of finding in social activities different individuals in group. The frequency of elements of cohesive behaviour is shown in Table 2.

When evaluating the mutual providing cohesive activities it can be seen that in the group *C. s. cottoni* the female NASI is the most active animal. By the numerical evaluation of the addressees of cohesive activities the female NABIRÉ with 349 recorded activities and acts directed towards her is leading. The lowest frequency was addressed to male SAÚT (Table 1).

Table 1 *Ceratotherium simum cottoni* – cohesive behaviour

		Addressees with number of obtained cohesive manifestations from another individuals					
	Name	SAÚT	NESÁRÍ	NABIRÉ	NASI	NÁJIN	Total
Number of cohesive manifestations towards another individuals	SAÚT	–	84	70	26	69	249
	NESÁRÍ	4	–	33	68	81	186
	NABIRÉ	10	15	–	160	2	187
	NASI	1	66	244	–	10	321
	NÁJIN	4	113	2	3	–	122
	Total	19	278	349	257	162	1065

Seven relations out of 10 dyadic relations in the group of *C. s. cottoni* showed by selected $p = 0.005$ (Table 3).

When evaluating cohesive behaviour by means of the attractivity index (Fig. 1) female NABIRÉ stands on the top of the whole sequence, followed by the female NESÁRÍ. The bull SAÚT is suppressed to the last place.

In the group of *C. s. simum* the most active animal in providing cohesive activities proved to be the female ZAMBA, the lowest frequency showed the male DAN. On the contrary most cohesive activities were addressed to female SAŠA. Only five cohesive manifestations were noted in behaviour of male DAN (Table 4). Dyadic relations in the group *C. s. simum* are shown in Table 5.

The attractivity ladder naturally differs from the index rank of the animals in the group (Fig. 1) which is SAŠA – ZAMBA – DAN.

Table 2 Cohesive behaviour

Types of cohesive behaviour	*C. s. cottoni*					*C. s. simum*			Total	%
	NESÁRÍ	NABIRÉ	NASI	NÁJIN	SAÚT	SAŠA	ZAMBA	DAN		
1. Rubbing its head against another animal	14	15	15	8	5	4	4	3	68	5.5
2. Touch and/or rubbing its horn another animal	9	16	44	12	6	3	4	1	95	7.7
3. Leaning its horn against another animal	–	6	–	2	4	1	1	–	14	1.1
4. Touch and/or rubbing its lips	–	–	6	6	–	–	–	–	12	1.0
5. Lying with head on a flank of another lying animal	6	–	–	–	–	–	5	–	11	0.9
6. Placing head between the hind legs of another animal	–	2	6	–	–	–	–	–	8	0.6
7. Raising the head of another animal with its forehead	–	–	8	4	–	–	–	–	12	1.0
8. Pressing its hind part to another animal	–	14	14	2	–	–	–	–	30	2.4
9. Rubbing its side against that of the other in passing	4	5	20	–	–	4	4	–	37	3.0
10. Approaching to another animal	41	9	8	8	88	4	11	15	184	14.8
11. Following	31	15	81	17	142	5	16	8	315	25.4
12. Lying, standing and walking side by side	81	105	119	63	4	41	41	–	454	36.6
Total	186	187	321	122	249	62	86	27	1240	100

Table 3 *Ceratotherium simum cottoni* – estimation of differences in cohesive behaviour in dyadic relations (* = $p < 0.005$)

Compared pairs	df	χ^2	$P > \chi^2$
NABIRÉ – NESÁRÍ	1	12.822	0.0003*
NABIRÉ – NÁJIN	1	–	1.0000
NABIRÉ – NASI	1	34.416	0.0000*
NABIRÉ – SAÚT	1	66.265	0.0000*
NESÁRÍ – NÁJIN	1	10.460	0.0012*
NESÁRÍ – NASI	1	0.060	0.8070
NESÁRÍ – SAÚT	1	70.782	0.0000*
NÁJIN – NASI	1	6.690	0.0097
NÁJIN – SAÚT	1	61.325	0.0000*
NASI – SAÚT	1	20.444	0.0000*

Table 4 *Ceratotherium simum simum* – cohesive behaviour

		Addressees with number of obtained cohesive manifestations from another individuals			
Number of		DAN	SAŠA	ZAMBA	Total
cohesive	DAN	–	15	12	27
manifestations	SAŠA	0	–	62	62
towards	ZAMBA	5	81	–	86
another animals	Total	5	96	74	175

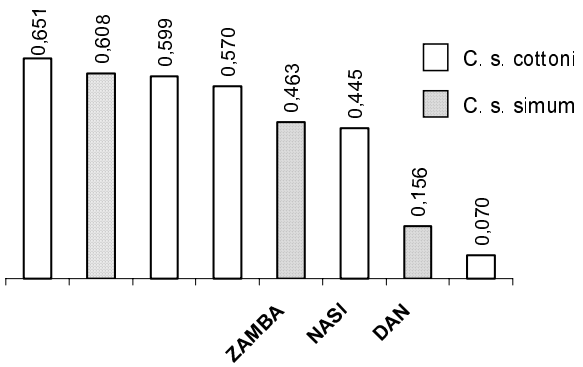

Fig. 1: Attractivity indexes of animals of both groups

Table 5 *Ceratotherium simum simum* – estimation of differences in cohesive behaviour in dyadic relations (* = $p < 0.005$)

Compared pairs	df	χ^2	$P > \chi^2$
DAN – SAŠA	1	17.11	0.0001*
DAN – ZAMBA	1	9.00	0.0027*
SAŠA – ZAMBA	1	6.68	0.0098

B) ***Agonistic behaviour***

The following activities were noted:

1. *Subdued aggressive behaviour*
   (i) Overprinting to another animal with its side, forehead or horn as an aspect of competition for place to the resting, feeding and for exclusive contact with partner.
   (ii) Attacking another animal with horn to body blows.

2. *Defensive behaviour – active defence*
   (i) Snarl display: the head was thrust forwards, ears laid back, and mouth opened to let out a loud rasping roar; sometimes the snarl was coupled with a few advancing steps, and occasionally an advancing snarl ended in a clash of horns or a horn prodding gesture. It is fullest form of the protest aimed to an approaching partner.
   (ii) Protest turning head (heads) and/or body towards the disturbing animal.
   (iii) Threat by the snorting without clashing horns.
   (iv) Alarm growling without clashing horns.
   (v) Protest exercising a few steps forward towards the other animal.
   (vi) Threat with moving head.
   (vii) Threat by the snorting ended in a clash of horns.
   (viii) Protest growling ended in a clash of horns.
   (ix) Attacking by means of clashing horns.
   (x) Aggressive following towards the other animal.

The frequency of particular elements of agonistic behaviour both groups are shown in Table 6. The most frequent activity was female SAŠA (63.6 % of all aggressive activities in group of *C. s. simum*), on the other hand there were dominant females NABIRÉ and NESÁRÍ (33.3 % and 32.9 % of all aggressive activities in group of *C. s. cottoni*). The results matrix of agonistic behaviour of the group *C. s. cottoni* is given in the Table 7 and in Table 8 for the group of *C. s. simum*.

Table 6 Agonistic behaviour

Types of agonistic behaviour	*C. s. cottoni*					*C. s. simum*			Total	%
	NESÁRÍ	NABIRÉ	NASI	NÁJIN	SAÚT	SAŠA	ZAMBA	DAN		
1. The overprinting	11	12	12	2	5	6	1	3	52	4.7
2. The attacking another animal with horn to body blows	11	28	3	2	2	1	–	–	47	4.3
3. Snarl display	90	85	18	15	15	33	12	9	277	25.2
4. Protest turning head and/or body towards another animal	34	34	28	19	20	21	15	7	178	16.2
5. Threat by the snorting without clashing horns	45	23	14	12	7	55	20	7	183	16.6
6. Alarm growling without clashing horns	26	14	3	8	4	15	10	6	86	7.8
7. Protest as a few steps forward towards the other animal	9	16	2	15	9	15	3	–	69	6.3
8. Threat with moving head	–	2	–	5	–	–	–	–	7	0.6
9. Threat by the snorting ended in a clash of horns	7	6	6	10	6	12	2	4	53	4.8
10. Protest growling ended in a clash of horns	19	14	-	3	5	6	–	1	48	4.4
11. Attacking by means of clashing horns	17	11	7	6	14	16	3	–	74	6.7
12. Aggressive towards the other animals	–	27	–	–	–	–	–	–	27	2.5
Total	269	272	93	97	87	180	66	37	1101	100

Table 7 *Ceratotherium simum cottoni* – agonistic bahaviour

		Addressees with number of obtained agonistic manifestations from another individuals					
	Name	SAÚT	NESÁRÍ	NABIRÉ	NASI	NÁJIN	Total
Number of agonistic manifestations towards another individuals	SAÚT	–	22	31	11	23	87
	NESÁRÍ	159	–	67	35	8	269
	NABIRÉ	171	70	–	10	21	272
	NASI	55	22	5	–	11	93
	NÁJIN	71	5	10	11	–	97
	Total	456	119	113	67	63	818

Table 8 *Ceratotherium simum simum* – agonistic behaviour

		Addressees with number of obtained agonistic manifestations from another individuals			
Number of agonistic manifestations towards another individuals		DAN	SAŠA	ZAMBA	Total
	DAN	–	28	9	37
	SAŠA	170	–	10	180
	ZAMBA	63	3	–	66
	Total	233	31	19	283

In the group of northern white rhinoceroses were noted overall 88 suppress aggressive exposures. In the group of southern subspecies were observed only 11 these activities. The most of suppress aggressive behaviour shown dominant females in both groups (SAŠA, n = 7, i. e. 63.6 % and NABIRÉ, n = 40, i. e. 45.5 %). In this category were recorded especially attacking another animal with horn to body blows.

Defensive behaviour was most frequent form of aggressive manifestations. Generally were observed 10 sorts of these activities.

Most manifestations of defensive behaviour were threatening acoustic displays of different intensity, protest turning the head or body towards the disturbing animal, attacking another animal ended up by the clash horns and also snarl display.

In the group of *C. s. cottoni* were recorded 730 and in the group of *C. s. simum* 272 manifestations of defensive behaviour. Most these protest activities were addressed to male in both groups (62 % in group of *C. s. cottoni* and 95 % in group *C. s. simum*).

Dominant females SAŠA, NABIRÉ and NESÁRÍ provided the most of these manifestations of active defence. Globally has been observed 818 aggressive manifestations in the group of *C. s. cottoni*. During the whole time of observation, it is 246 hours, thus were noted round 3.3 aggressive activities per hour. In the group of *C. s. simum* has been noted 272 aggressive manifestations during 76 hours. In average it is 3.6 aggressive activities per hour.

In dyadic relations evaluated by chi-square test (Table 9 and 10) numerous differences in quantity of attacks, threats and further elements of agonistic behaviour, through which the animal inhibits the partner's behaviour, can be found. In all relations can be seen that no significant dominance of one animal over the other one can be found. The highest number of submissive positions can be found in bulls in both groups.

Table 9 *Ceratotherium simum cottoni* – estimation of differences in agonistic behaviour in dyadic relations (* = $p < 0.005$)

Compared pairs	df	χ^2	$P > \chi^2$
NABIRÉ – NESÁRÍ	1	0.1601	0.6890
NABIRÉ – NASI	1	7.9326	0.0049*
NABIRÉ – SAÚT	1	245.147	0.0000*
NESÁRÍ – NASI	1	6.2920	0.0121
NESÁRÍ – SAÚT	1	236.8085	0.0000*
NASI – SAÚT	1	100.0430	0.0000*
NÁJIN – NABIRÉ	1	10.272	0.0014*
NÁJIN – NESÁRÍ	1	7.162	0.0074
NÁJIN – NASI	1	0.793	0.3732
NÁJIN – SAÚT	1	100.559	0.0001*

Table 10 *Ceratotherium simum simum* – estimation of differences in agonistic behaviour in dyadic relations (* = $p < 0.005$)

Compared pairs	df	χ^2	$P > \chi^2$
DAN – SAŠA	1	151.12	0.0001*
DAN – ZAMBA	1	59.42	0.0001*
SAŠA – ZAMBA	1	6.69	0.0097

Aggressivity index should evaluate participating of the animal in the conflicts in the group and thus give the additional information about the position of the animal in its group. The highest index is given in female SAŠA, both bulls being situated at the end of the sequence. Fig. 2 includes all the observed animals of the both groups.

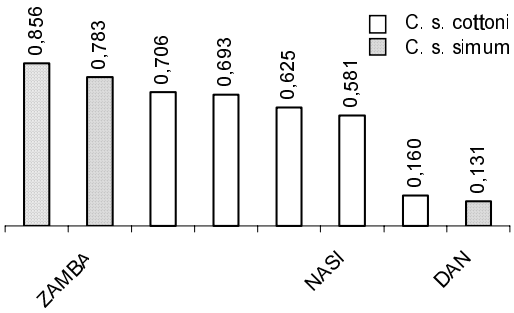

Fig. 2: Aggressivity index

On the basic of results of social behaviour it is possible to compile a chart of hierarchy in each group:

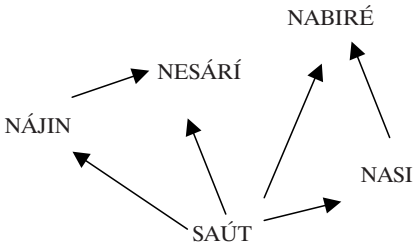

Fig. 3: *Ceratotherium simum cottoni*

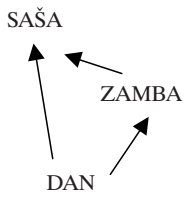

Fig. 4: *C. simum simum*

C) ***Sexual behaviour***

In general 46 sexual interactions were observed between male and females in northern white rhinoceros group in years 1998–2000 (Table 11). From this only 5× matting and 12× attempt at matting were observed. In the group of southern white rhinoceros no sexual interactions were noticed. Probably because of great age of all animals in group.

All females in the group of *C. s. cottoni* have irregular oestrus cycles and extremely low levels of luteal activity. Practically, measured values of 20-oxo-pregnanes, like main progesterone metabolites, no exceeded level of 200 ng/g faeces in luteal phase. It reflected that female sex organs are not in good function disposition. Only in female NÁJIN three cycles appeared one bimonthly and two monthly cycles from October 1998 to February 1999. In this time was the group of females *C. s. cottoni* put together with a new male SAÚT, which was returned from deponation in San Diego Wild Animal Park in July 1998. This change induced oestrus cycle in female NÁJIN and at that time matting with male SAÚT was noticed four times. After copulation from March 5th 1999

Table 11 Sexual activity in group of *Ceratotherium simum cottoni*

Date of sexual activity	Intensity of sexual activity	Female	Male	Date of sexual activity	Intensity of sexual activity	Female	Male
06. 04. 1998	Interest of male	Nabiré	Suni	01. 07. 1999	Interest of male	Nabiré	Saút
03. 09. 1998	Interest of male	Nesárí	Saút	05. 08. 1999	Attempt for matting	Nabiré	Saút
04. 09. 1998	Interest of male	Nesárí	Saút	12. 08. 1999	Interest of male	Nesárí	Saút
11. 09. 1998	Interest of male	Nájin	Saút	13. 08. 1999	Interest of male	Nesárí	Saút
13. 09. 1998	Interest of male	Nájin	Saút	30. 08. 1999	Interest of male	All females	Saút
14. 09. 1998	MATTING	Nájin	Saút	12. 09. 1999	Attempt for matting	Nesárí	Saút
15. 09. 1998	Interest of male	Nájin	Saút	24. 09. 1999	Interest of male	Nabiré	Saút
19. 09. 1998	Interest of male	Nesárí	Saút	27. 09. 1999	Interest of male	Nabiré	Saút
20. 09. 1998	Attempt for matting	Nesárí	Saút	28. 09. 1999	Interest of male	Nabiré	Saút
22. 09. 1998	Attempt for matting	Nesárí	Saút	08. 10. 1999	Interest of male	Nesárí	Saút
28. 09. 1998	MATTING	Nájin	Saút	09. 10. 1999	Interest of male	Nesárí	Saút
27. 10. 1998	Attempt for matting	Nájin	Saút	02. 11. 1999	Attempt for matting	Nesárí	Saút
28. 10. 1998	MATTING	Nájin	Saút	28. 11. 1999	Interest of male	Nájin	Saút
28. 11. 1998	Attempt for matting	Nájin	Saút	11. 02. 2000	Interest of male	Nájin	Saút
29. 11. 1998	Interest of male	Nájin	Saút	19. 05. 2000	Interest of male	Nesárí	Saút
05. 03. 1999	MATTING	Nájin	Saút	20. 05. 2000	Interest of male	Nesárí	Saút
02. 04. 1999	Interest of male	Nabiré	Saút	26. 06. 2000	MATTING	Nabiré	Saút
02. 04. 1999	Interest of male	Nasi	Saút	31. 07. 2000	Interest of male	Nabiré	Saút
09. 04. 1999	Interest of male	Nabiré	Saút	01. 09. 2000	Interest of male	Nabiré	Saút
10. 04. 1999	Attempt for matting	Nabiré	Saút	02. 09. 2000	Interest of male	Nabiré	Saút
11. 04. 1999	Attempt for matting	Nabiré	Saút	15. 10. 2000	Interest of male	Nesárí	Saút
14. 04. 1999	Attempt for matting	Nesárí	Saút	19. 10. 2000	Interest of male	Nesárí	Saút
15. 05. 1999	Attempt for matting	Nájin	Saút	28. 11. 2000	Attempt for matting	Nesárí	Saút

she came to pregnancy. After 482 days of pregnancy female FATU was born. In spite of such an indisputable success it must be stated that the potentiality of the reproduction has not been fully satisfied rhinoceros in captivity. Irregular or missing luteal activity occurs in more than 50 % of population white rhinoceros in captivity (Schwarzenberger et al. 1999).

In the females NESÁRÍ and NASI higher luteal activity appeared in the period from spring to autumn months. In this period are females along with male in enclosure for time of 24 hours/day. From total 46 observed sexual interactions between male and females, almost 83 % occurred in the spring (24 %) and autumn (59 %) months.

Influence of oestrus on select sorts of behaviour was tested by logistical regression. Lower aggressivity of SAÚT (male *C. s. cottoni*), higher frequency of following females by male and higher number of olfactory controls of female faeces and urine by male in the time of oestrus were proved. These behavioural categories were evaluated as a dependent on oestrus. Aggressivity of NABIRÉ and NESÁRÍ (the most aggressive females in group of *Ceratotherium simum cottoni*) as well as male spray urination frequency were evaluated as independent on oestrus. Results of testing are shown in Table 12.

Table 12 Significance of the difference in behaviour in dependency on oestrus (* = $p < 0.005$)

Sort of test behaviour	df	χ^2	$p > \chi^2$
Agressive behaviour – NABIRÉ	3	6.47	0.0909
Agressive behaviour – NESÁRÍ	3	5.95	0.1141
Agressive behaviour – SAÚT	3	11.10	0.0112*
Frequency of following females by male	3	14.41	0.0024*
Number of olfactoric controls of female faeces and urine by male	3	8.20	0.0420*
Frequency of male urine marking (spray urination)	3	6.59	0.0862

In Figs. 5–10 are shown average values of tested behaviour with error abscissae in animals of *C. s. cottoni*.

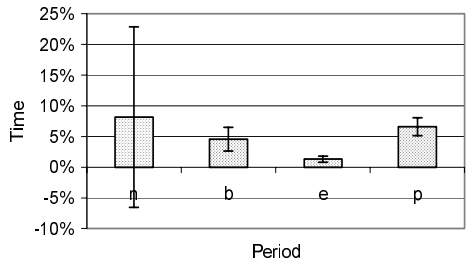

Fig. 5: Aggressive behaviour of male

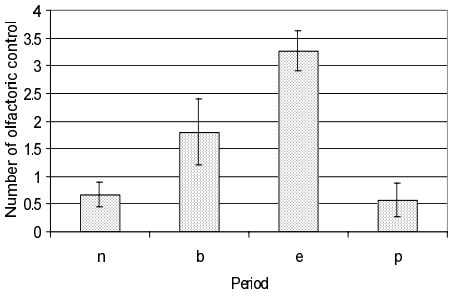

Fig. 6: Number of olfactoric controls of female faeces and urine by male SAÚT

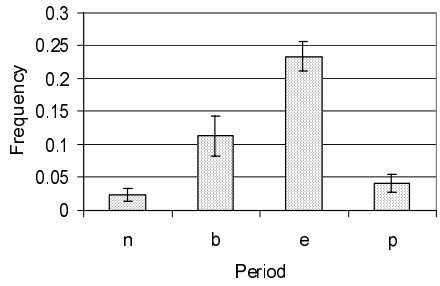

Fig. 7: Frequency of following female by male

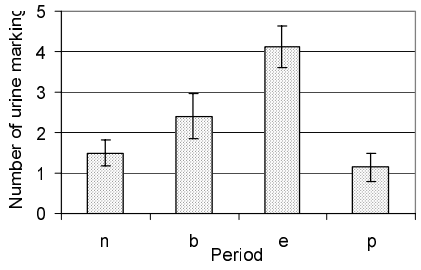

Fig. 8: Number of urine marking by male

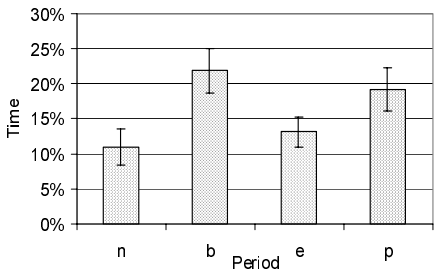

Fig. 9: Aggressive behaviour of NABIRÉ

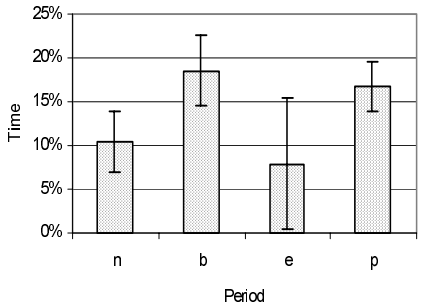

Fig. 10: Aggressive behaviour of NESÁRÍ

n – period except oestrus
b – period 2–3 days before oestrus
e – period of oestrus
p – period 2–3 days after oestrus

Discussion

Social behaviour of both rhinoceros groups was very strongly marked by accumulation of the animals on a limited area of the enclosure. Social behaviour of white rhinoceroses in free nature was studied by Owen-Smith (1975) who observed only six cohesive interactions and as very sporadic instances. Mikulica (1991) observed 15 cohesive activities in environment of zoological gardens. In the group of *C. s. cottoni* were noted 12 and in group of *C. s. simum* 8 cohesive behaviour types. There were proved different social commitments between animals. A very striking feature in the group *C. s. simum* was a long-term bond between the cows SAŠA & ZAMBA. In the group *C. s. cottoni* a certain tendency towards mutual preference between females NESÁRÍ & NÁJIN and NABIRÉ & NASI was observed too. Also behavioural patterns from section of infantile behaviour such as lying with its head on a flank of another lying animal, placing its head between the hind legs of another animal, raising the head of another animal with its forehead and pressing its hind part to another animal were observed.

The analysis of the cohesive behaviour of the rhinoceroses does not allow making unambiguous conclusions. Ranking the animals according to the index indicates only a certain sexual dimorphism in behaviour. The analysis of the cohesive behaviour has brought important information, however, it is not deciding for the interpretation of the basic social relations in the group.

In general 1,065 cohesive interactions were observed in group of northern white rhinoceros during 246 hours. It is 4.3 cohesive manifestations in an hour. In group of southern white rhinoceros 2,3 cohesive manifestations in an hour were recorded. Female NASI from group of *C. s. cottoni* was evaluated as the most sociable animal with 321 manifestations towards other animals. On the other hand two dominant females NABIRÉ and NESÁRÍ showed practically the same number of cohesive interactions towards other individuals in group. By the attractivity index the most attractive animal was female NABIRÉ. Dyadic relations in a group were very important. In both groups males ended the scale attractivity.

Tactile contacts by rubbing its side against that of the other in passing as described by Owen-Smith (1975) were not recorded in environment of zoological garden by Mikulica (1991). He claims that in the milieu of enclosures and stables these activities cannot be distinguished from other body contacts due to rather little room. We observed and distinctly distinguished this activity as manifestation of the cohesive behaviour. Especially in behaviour of female NASI these activities were recorded.

In captive rhinoceroses in narrow enclosure cohesive manifestations are practised as a substitute of other missing behaviour activities. The higher number of cohesive activities is an adaptation for unnatural conditions in captivity. It is the way of compensation (Mikulica 1991).

The often observed contact activity of the agonistic behaviour, clashing horns, is in fact harmless not only when it is performed mildly, but even if loud strokes can be heard. The most frequently noted activity of the agonistic activity of all observed was a snarl display. Owen-Smith (1975) used this term when the animal opened its jaws to

give out a loud roar. A weaker adult animal used to do so against a stronger individual, in our case it was most often a cow against a bull. Laurie (1982) described similar tusks in the Greater Indian one-horned rhinoceros.

Social dominance resulting from agonistic behaviour is considered the most important part of social behaviour by many ethologists. Dewsbury (1982) indicates that the fundamental element and basis for the definition of dominance is a stable asymmetry in the agonistic behaviour of two or more animals. Subordinated animals can play greater part than dominant animals in determination of the relation "dominance – submissivity".

The dominance indexes in calculation of which not only aggressive activities of the animals are calculated, but where elements of submissive behaviour are also included into evaluation are interesting and obviously also more objective. The results given in Fig. 2 show that both bulls in the two groups had the lowest index, their rank was the lowest of all animals. The males in both groups were the most frequent objects of aggressive activities. Hence the social stress of both males incorporated into groups is high. In this connection let us mention that the behaviour of a beta-male in free nature, whose behaviour is inhibited by the presence of the alpha-male in the area, suppresses the reproductive abilities in such an extent that Leuthold (1977) marked the beta males as social castrates. Mikulica (1991) opened question, to what extent such very frequent aggressive activities of females towards the male form a social stress that suppresses reproduction abilities of the males. We agree with them that the unnatural position of the males in the group of animals on a limited area of enclosures will have a negative influence on abilities and willingness of the males to mate. Also Rachlow et al. (1999) referred that level of testosterone is very different among territorial (alpha) and beta males.

This problem is only one of more factors that have an influence on abilities to mate. Second and maybe more important factor are changes in social composition of breeding group. Exchange of bulls in group of *C. s. cottoni* females evoked starting oestrous cycles in female NÁJIN and followed repeated matting with new male. NÁJIN conceived and after 482 days of pregnancy female FATU was born. The bull DAN in group of *C. s. simum* is father of six rhinoceroses that were born in Zoo Ústí nad Labem. Thus stress as a result of repeated aggression play an important role but more important for successful reproduction is to change social attachment in group.

Schwarzenberger et al. (1998) diagnosed by non-invasive method amount of progesterone metabolites from faeces samples in northern white rhinoceroses kept in Zoo Dvůr Králové and in southern white rhinoceroses in Zoo Ústí nad Labem. From January 1998 to April 2000 were also collected faecal samples and for the needs of Zoo Dvůr Králové amount progesterone metabolites was investigated. All females had an extremely low luteal activity and excepting NÁJIN also irregular oestrous cycles. NÁJIN had two oestrous cycles in the period from October to November 1998 with three oestrus cycles at the beginning of each month. During this period male several times mated her. In all females the higher luteal activity in the period from spring to autumn can be observed. In this period females along with male are in an enclosure for 24 hours/day. It's evident that this arrangement improved function of

reproductive organs. It is one of the ways of successful breeding in zoological gardens. From total 46 observed sexual interactions between male and females from 1998–2000 24 % occured in spring and 59 % in autumn.

From the results evaluating the influence of oestrus on behaviour lower aggressive behaviour of male in the period of oestrus was statistically determined. Also higher frequency of following females by male and higher number of olfactory controls of female's urine and faeces were evaluated as statistically significant. Thus these behaviour categories can be indications impending oestrus. On the basis of endocrinology values of the amounts of progesterone metabolites period of oestrus cannot be determined when another one comes. Behavioural examination is in this instance only one good indicator impending oestrus.

The captive animals are under influence of numerous stresses. For the rhinoceros living in the described conditions it represented mostly a constant visual contact with the partners and necessity to react to their behaviour, reduced distance between individuals and no possibility to leave the area governed by a stronger individual. An important part in effect of stress also plays the animal's individuality, the habits and ability of the animals to adapt themselves. The basic criterion for the bearable rate of the stress can only be the reproduction of the animals. From this study it's evident that both bulls of observed groups are highly resistant to stress and more important for successful mating are changes and transfers between zoological gardens.

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