

PALACKÝ UNIVERSITY OLOMOUC
FACULTY OF SCIENCE
DEPARTMENT OF ZOOLOGY

BACHELOR THESIS

**SEXUAL, SOCIAL AND PLAYFUL BEHAVIOR OF
WHITE RHINOCEROS (*CERATOTHERIUM SIMUM*)
IN ZOOLOGICAL GARDEN**



Ivana Cinková

Thesis supervisor: Prof. RNDr. Vítězslav Bičík, CSc.

Consultant: RNDr. Kristina Tomášová

Olomouc 2006

Contents

1. Introduction	3
1.1 The evolution of rhinoceroses.....	3
1.2 Taxonomy of the family Rhinocerotidae.....	3
1.3 Distribution and a brief description of four species of rhinoceros.....	4
1.3.1 The Sumatran rhinoceros <i>Dicerorhinus sumatrensis</i> (Fischer, 1814)	4
1.3.2 The Indian rhinoceros <i>Rhinoceros unicornis</i> Linnaeus, 1758	5
1.3.3 The Javan rhinoceros <i>Rhinoceros sondaicus</i> Desmarest, 1822	6
1.3.4 The Black rhinoceros <i>Diceros bicornis</i> (Linnaeus 1758)	6
1.4 The White rhinoceros <i>Ceratotherium simum</i> (Burchell, 1817)	7
1.4.1 Biological data	7
1.4.2 Southern white rhinoceros	8
1.4.3 Northern white rhinoceros.....	9
1.4.4 Numbers of rhinos in the zoological gardens.....	12
1.4.5 Social system and reproduction.....	18
2. Materials and methods	21
3. Results	24
3.1 Social and playful behaviour.....	24
3.1.1 Cohesive behaviour.....	24
3.1.2 Agonistic behaviour	25
3.1.3 Urination and defecation in social context.....	27
3.1.4 Playful behaviour.....	27
3.2 Activity budget.....	28
3.3 Sexual activities of the rhinoceroses in the years 2001-2005	29
4. Discussion	36
5. Summary	41
6. References	42

Appendix

Appendix A – Conditions of breeding

Appendix B – Veterinary report and situation in the herd in the years 2001-2005

Appendix C – Photo documentation

1. Introduction

1.1 The evolution of rhinoceroses

Superfamily Rhinoceroidea originated probably from the primitive tapirs in the Eocene. Evolutionary trends in this line included an increase in general body size, reduction of the toes and modification of teeth. There was a tendency towards molarization of the premolars and reduction or specialization of the incisors and canines. Development of horns on the skull was also frequent. A few families emerged during phylogeny: Hyracodontidae, Aymodontidae, Indricotheriidae and Rhinocerotidae. *Indricotherium* and *Baluchitherium* (family Indricotheriidae) were the largest known terrestrial mammals. They were up to 6.5 meters tall at the shoulder and the body length was more than 9 meters. According to the teeth, they were herbivores, which fed on leaves from the branches of high trees (Špínar 1984).

Family Rhinocerotidae emerged in the middle of the Eocene, when it is substantiated to inhabit Europe, Asia and North America. We have known 46 extinct genera; their biggest expansion took place in the early Oligocene. Rhinos moved to Africa only in the Miocene. In the Pliocene, rhinoceroses disappeared from North America and some their lines in Europe and Asia were dying out at that time (Musil 1987).

We differentiate the following genera in the family Rhinocerotidae: *Teleoceras*, *Rhinoceros*, *Elasmotherium*, *Dicerorhinus*, *Diceros* and *Ceratotherium*. The genus *Diceros* is known from the early Miocene of North America; in the Pliocene, it was distributed in Eurasia. The genus *Ceratotherium* diverged from the *Diceros* lineage in the late Tertiary (Špínar 1984).

1.2 Taxonomy of the family Rhinocerotidae

Family: Rhinocerotidae

Species: *Dicerorhinus sumatrensis* (Fischer, 1814)

Subspecies: *Dicerorhinus sumatrensis sumatrensis* (Fischer, 1814)

Subspecies: *Dicerorhinus sumatrensis harrissoni* (Groves, 1965)

Subspecies: ~~+~~*Dicerorhinus sumatrensis lasiotis* (Buckland, 1872)

Species: *Rhinoceros unicornis* Linnaeus, 1758

Species: *Rhinoceros sondaicus* Desmarest, 1822

Subspecies: *Rhinoceros sondaicus sondaicus* Desmarest, 1822

Subspecies: *Rhinoceros sondaicus annamiticus* Heude, 1892

Species: *Diceros bicornis* (Linnaeus, 1758)

Subspecies: *Diceros bicornis bicornis* (Linnaeus, 1758)

Subspecies: *Diceros bicornis michaeli* Zukowsky, 1964

Subspecies: *Diceros bicornis minor* (Drommond, 1876)

Subspecies: *Diceros bicornis longipes* Zukowsky, 1949

Species: *Ceratotherium simum* (Burchell, 1817)

Subspecies: *Ceratotherium simum simum* (Burchell, 1817)

Subspecies: *Ceratotherium simum cottoni* (Lydekker, 1908)

(Source: Internet 1-7)

1.3 Distribution and a brief description of four species of rhinoceros

1.3.1 The Sumatran rhinoceros *Dicerorhinus sumatrensis* (Fischer, 1814)

It is the smallest recent rhinoceros, which has two horns and a body with sparse dark hairs. It lives solitarily. Its weight ranges from 500 to 820 kg and its height at the shoulder ranges from 1.25 to 1.4 m. The biggest known length of its horn is 82 cm. A pregnancy lasts around 400 days and a newborn weighs approximately 35 kg. We differentiate two subspecies: Western (*D. s. sumatrensis*), which lives on the island of Sumatra in Indonesia and in Peninsula Malaysia and Eastern (*D. s. harrissoni*), inhabiting Borneo – a province Sabah in the Malaysian part of the island and Kalimantan, the Indonesian part of Borneo. It feeds on the young branches of the bushes, lianas and on the other different plants (Holečková & Bobek 2000).

According to the data of International Rhino Foundation from the year 2005, about 50 individuals of the subspecies *D. s. harrissoni* and 250 individuals of *D. s. sumatrensis* are surviving. Nine Sumatran rhinos live in captivity (Internet 8) and only three calves have been

born in a human care. The first calf was a female MINAH in the ZOO Melaka in the year 1987, but her mother had already been pregnant before she was captured (Holečková & Bobek 2000). Two other calves were born in the ZOO Cincinnati to the local breeding pair after five previous miscarriages – a male in 2001 and a female in 2004 (Mohd Khan *et al.* 2004). The difficulty of the breeding is caused by a strong aggression of males to females, which disappears only when a cow is in oestrus. A cow in oestrus gives no outward sign and therefore it is difficult to distinguish appropriate time. In addition, the ovulation is activated by the copulating, so it cannot be used for diagnostics of the oestrus. In the practise, it is identified by the measurement of a sexual hormone level and by monitoring of ovary size with an ultrasound. However, it is not always exact. For instance, in the ZOO Cincinnati, they joined their local pair together one day earlier and the animals started to attack and charge themselves (Suchomel 2002).

1.3.2 The Indian rhinoceros *Rhinoceros unicornis* Linnaeus, 1758

The Indian rhino is the tallest recent rhinoceros, it is from 1.75 to 2 m tall at the shoulder, it weighs 1,800-2,700 kg and has only single, 20-61 cm long, horn. It lives in India and Nepal. In the turn of 19th and 20th century, only less than 200 of these animals survived; today, their numbers has increased to 2,400 individuals (Internet 9). Chitwan National Park in Nepal is one of the places with their highest density, but their numbers have declined there from the 544 observed in 2000 to 372 in 2005. This catastrophic decline is believed to be due to increased poaching related to political instability in Nepal (Mohd Khan *et al.* 2005). In the zoological gardens, there are kept 150 individuals (Internet 8). Three of these animals are bred in the ZOO Dvůr Králové. Typical of this species is semi-prehensile upper lip; it lives solitarily and has a size of territory about six km². It inhabits mainly riverine grasslands but occasionally also utilizes some adjacent woodland. It feeds on the grass, aquatic grass-like plants and rhizomes, and sometimes grazes on rice of the natives. Contrary to the African rhinos, it has canines (Holečková & Bobek 2000). When one male is chasing another one in the fight, he does not use a horn, but the canines. A pregnancy lasts, on average, 477 days; a newborn is 62-64 cm tall at the shoulder and weighs 60-70 kg. A cow in oestrus urinates very often; scent of the urine probably attracts a bull. A whistling breath of a cow is also a specific display of the oestrus. The first part of courtship consists of a wild chase and of a fight with horns and teeth. After that, a specific behaviour ensues when a bull lowers his head under cow's belly to represent suckling (Veselovský 1976).

1.3.3 The Javan rhinoceros *Rhinoceros sondaicus* Desmarest, 1822

It is the most endangered species of rhinoceros in the world. It ranges in tall from 1.5 to 1.7 m, in weight from 900 to 2,300 kg and in body-length from 2 to 4 m. The length of a single horn is 10-25 cm in males, females have smaller horn or it can miss. It has two subspecies: Indonesian *R. s. sondaicus* and Vietnamese *R. s. annamiticus* (Internet 10). The third subspecies *R. s. inermis* died out in the past. The Javan rhinoceros inhabits tropical rainforest up to 2,000 m above sea level, in Indonesia and Vietnam; it feeds on branches, leaves, fruits and lianas. A pregnancy lasts around 480 days. In captivity, 22 individuals were kept, the last in the year 1907. It has never reproduced in captivity (Holečková & Bobek 2000).

Indonesian subspecies number 50-60 animals, furthermore the population has stagnated for the last 15 years (Internet 11). Vietnamese subspecies was believed to be extinct; but in 1989, a poacher killed one individual in the area of today's Cat Tien National Park and further presence was confirmed by photos from an automatic infrared camera ten years later (Anděra 2003). Today, this population number is 2-7 animals (Internet 12).

1.3.4 The Black rhinoceros *Diceros bicornis* (Linnaeus, 1758)

The Black rhinoceros is smaller than the second African species, the white rhinoceros. It is 1.4-1.6 m tall at the shoulder and weighs 996-1,364 kg. The anterior horn measures 50-80 cm, the posterior 35-40 cm. It exploits a wide range of habitats, from semidesert thornbush to mountain forest and wetlands and grazes on over 200 plants, especially herbs and bushes, to which it uses a prehensile upper lip. Black rhinos live solitarily and they are territorial in some areas, in the others they are semisocial and nonterritorial. Sociable tendencies seem to be a response to crowding and open habitat. A pregnancy lasts 450-480 days (Estes 1999).

It forms four subspecies, their numbers are according to the data of International Rhino Foundation from the year 2005 following: *D. b. bicornis* – 1,310, *D. b. longipes* – 5, *D. b. michaeli* – 520 and *D. b. minor* – 1,770. Only two subspecies are bred in captivity (data from February 2005): the population of *D. b. michaeli* number 175 individuals and a population of

D. b. minor 75 animals (Internet 8). Numbers of black rhinos in the nature in 1960-2005 are shown in figure 1.

In the Czech Republic, a subspecies *D. b. michaeli* is kept in the ZOO Dvůr Králové (five males and 10 females, according to the data from December 31st 2004) and 27 calves have been born there (Tomášová 2004a). Two other young ones were born in the turn of the years 2005 and 2006.

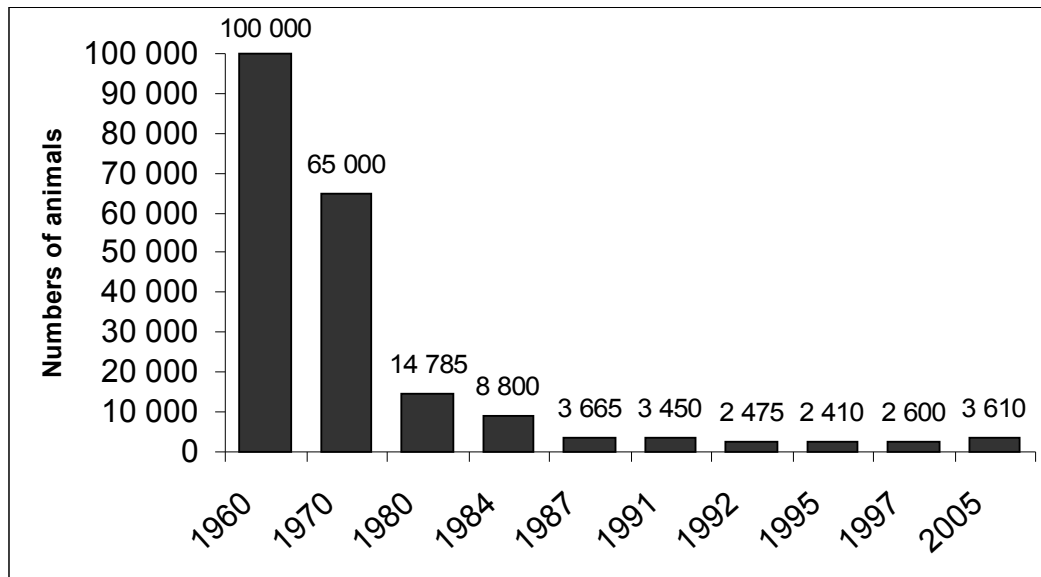


Fig. 1: Numbers of black rhinos in the nature in 1960-2005 (according to: Emslie & Brooks 1999, Internet 8)

1.4 The White rhinoceros *Ceratotherium simum* (Burchell, 1817)

1.4.1 Biological data

Two subspecies of white rhino are distinguished: northern (*C. s. cottoni*) and southern (*C. s. simum*). The differences between them are evidently more shaggy ears and tail of the northern subspecies (Holečková & Bobek 2000). Mitochondrial DNA studies indicate that the two white rhino subspecies have greater genetic differences than the four subspecies of the black rhino (Smith *et al.* 1995, *ex* Emslie & Brooks 1999). Within recorded history, no white rhino have been known to inhabit the area between the south-eastern limits of the northern

subspecies (the river Nile, northern Democratic Republic of the Congo and Uganda) and the northern limits of the southern subspecies (the Zambezi River), their distance is around 2,000 km (Hillman-Smith *et al.* 1986, *ex* Emslie & Brooks 1999).

White rhino is 1.5-1.8 m tall at the shoulder, weighs 1,800-2,700 kg and has 3.8-5 m body length. The anterior horn is larger and measures 94-102 cm (northern subspecies) or 94-201 cm (southern subspecies). The posterior horn measures up to 55 cm (Internet 13).

It inhabits a savannah including grassland with trees, water and mud wallows. It is a pure grazer with a relatively broad snout and square lips (figure 2). It is able to go 2-4 days without drinking, even in the dry season, but it often drinks twice a day when water is nearby (Estes 1999).



**Fig.2: Adaptation of white rhino to grazing:
a broad snout with a square lip**

1.4.2 Southern white rhinoceros

Ceratotherium simum simum (Burchell, 1817)

In the past, it had been widespread in southern Africa (Acocks 1988, *ex* Emslie & Brooks 1999), but it was on a brink of extinction at the end of 19th century, when numbers of this subspecies were reduced to approximately 20 animals surviving in South Africa (Emslie & Brooks 1999). However, after years of protection and many translocations, the population has

grown to 11,320 individuals in February 2005 and now, it is the most numerous of the rhino taxa (Internet 8).

South Africa is the stronghold for this subspecies today, smaller populations were reintroduced to the places within its former range, in Botswana, Namibia, Swaziland and Zimbabwe, and also outside their historical range in Ivory Coast, Kenya and Zambia (it is not clear whether the historical range of this species included Zambia) (Emslie & Brooks 1999). A growth of the population in particular African states in years 1895-2003 is shown in the table 1.

1.4.3 Northern white rhinoceros

Ceratotherium simum cottoni (Lydekker, 1908)

Formerly, this subspecies inhabited north-western Uganda, southern Chad, south-western Sudan, the eastern part of Central African Republic and north-eastern Democratic Republic of the Congo (Sydney 1965, *ex* Emslie & Brooks 1999).

In the 1970s and early 1980s the heaviest commercial poaching of rhino in eastern and central Africa occurred. In 1984, several international organization established the Garamba Project to rehabilitate Garamba National Park in Democratic Republic of the Congo (DRC) and to conserve the northern white rhino (in the other countries this subspecies became extinct till 1985). Until 1991 Park staff greatly reduced poaching in general and only a few animals were killed in the north of the Park (Martin & Hillman Smith 1999). After the start of the Garamba project, the northern white rhino population doubled, from 15 to 30, at an average rate of increase of 9.7 % (Hillman Smith *et al.* 1995, *ex* Hillman Smith & Ndey 2005). Then the civil war in adjacent Sudan moved to the south of that country. Between 1991 and 1998, Sudanese refugees were settled in areas surrounding the Park. During this time, civil unrest and economic decline in DRC has worsened which further de-stabilised the area. Five animals were killed from 1996 to 1998 because of their horns and local population of rhinos fell to only 25 individuals. At that time, the price for rhino horn was \$1,960-3,500 per kilo (Martin & Hillman Smith 1999).

Table 1: A growth of the southern white rhinoceros population in particular African states in years 1895-2003 (according to: Emslie & Brooks 1999, Emslie 2004)

	1895	1929	1948	1968	1984	1987	1991	1992	1993/4	1995	1997	2003
Angola*	0	0	0	0	?	0	0	0	0	0	0	0
Botswana	0	0	0	0	190	125	56	27	18	20	23	67
Ivory Coast	0	0	0	0	0	0	5	5	5	4	4	0
Kenya	0	0	0	0	33	47	57	74	87	122	137	218
Mozambique**	0	0	0	0	1	-	-	-	-	-	-	2
Namibia	0	0	0	0	70	63	80	91	98	107	141	186
South Africa	20	150	550	1800	3234	4137	5057	5297	6376	7095	7913	10536
Swaziland	0	0	0	0	60	80	60	46	33	41	50	61
Zambia	0	0	0	0	10	6	0	-	6	5	6	3
Zimbabwe	0	0	0	0	200	208	250	249	134	138	167	250
Total***	20	150	550	1800	3800	4665	5565	5790	6760	7530	8440	11320

* A few individuals were reintroduced to Angola, but appear to have become nationally extinct there

** A few animals were repeatedly reintroduced to Mozambique

*** Totals have been rounded to the nearest five rhino

In 1998-2003, after the end of the war, the numbers of northern subspecies stabilised with 12 births as well as losses. Since late June 2003, the poaching has increased and poachers have concentrated to the central part of the Park, which meant a bigger danger for rhinos than in the latest 20 years. Until the end of the year, five animals were killed and two calves were born (Hillman Smith *et al.* 2003).

The other nine rhinos were found dead during 2004, among them also a female with a small young and a pregnant female. The major stakeholders' meetings in July 2004 welcomed several more potential donors and an emergency strategy of over one million dollars was drawn up for in situ conservation. In addition to this, a proposal to translocation of five rhinos in safety elsewhere until the poaching could be brought under control was resolved. The aerial survey in November 2004 found only four rhinos in the park. Therefore, in January 2005, it was decided with agreement of the president and the vice-presidents to move a few animals temporarily. However, certain parties were canvassing against the move for political reasons and with elections looming they chose not to agree with the translocation. Conservationists were arrested and the World Heritage Commission of UNESCO passed a motion that Garamba would lose its World Heritage status if the rhinos became extinct in situ. Then the long talks ensued and the African Parks Foundation, with management rights, is now bringing major support to Garamba. Intensive surveys of the numbers of rhinos, elephants and giraffes are planned for early 2006 (Hillman Smith & Ndey 2005). The decline of *C. s. cottoni* in the years 1960-2005 is shown in figure 3.

Garamba National Park is situated at an altitude of 710-1,061 m and occupies an area of 492,000 ha. There are the main rivers the Dungu on the southern, the Aka along the western boundaries and the Garamba within the Park. The tropical climate has a semi-moist rainy season from March to November with temperatures between 20 and 30 °C and a dry period from November to March, when temperatures range from 6 to 39 °C. The mean annual rainfall averages about 1,260 mm. The Park covers three types of biomes: gallery forests with forest clumps and marshland, aquatic and semi-aquatic associations and savannahs ranging from dense savannah woodland to nearly treeless grassland.

Savannah woodlands are often dominated by *Combretum* spp. and *Terminalia mollis*, the main species of marshlands are *Cyperus papyrus* and *Mitragyna rubrostipulacea*. The long-grass savannah is dominated by various *Hyparrhenia* species and by *Loudetia arundinacea*, which in September can grow over two meters high, with the tallest grass *Urelytrum giganteum* up to 5 m.

Except white rhino, fauna comprises a unique elephant population of subspecies *Loxodonta africana oxyotis*, then northern savannah giraffe (*Giraffa camelopardalis congoensis*), hippopotamus (*Hippopotamus amphibius*), buffalo (*Syncerus caffer*), hartebeest (*Alcelaphus buselaphus lelwel*), waterbuck (*K. ellipsiprymnus*), kob (*Kobus kob*), warthog (*Phacochoerus aethiopicus*), bushpig (*Potamochoerus porcus*), roan antelope (*Hippotragus equinus*) and six other antelope species. The other mammals include nine primate species, five species of mongoose, golden cat (*Felis aurata*), two species of otter, leopard (*Panthera pardus*) and lion (*Panthera leo*) (Internet 14).

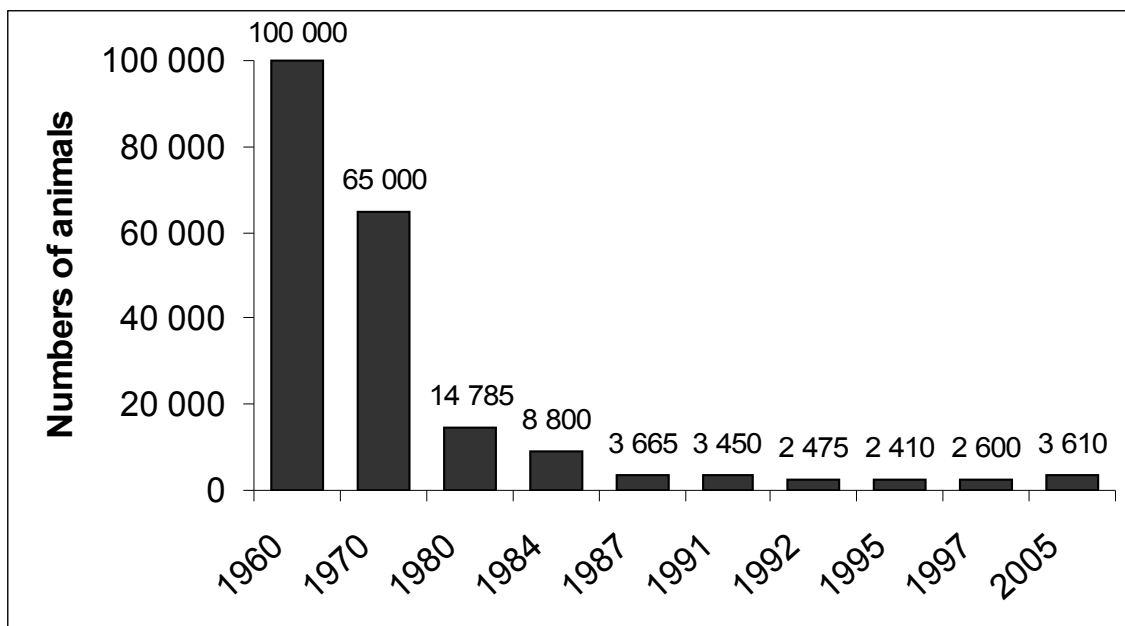


Fig. 3: The decline of northern white rhinoceroses in Africa, 1960-2005 (according to: Holečková & Bobek 2000, Hillman Smith & Ndey 2005)

1.4.4 Numbers of rhinos in the zoological gardens

The total numbers of white rhinos in captivity (according to the data from 31.12.2004) were 769 (339 ♂, 419 ♀, 3 individuals of unknown sex) (Mercado 2004). In the table 2, there are their numbers in particular continents. In 63 zoological gardens, which are members of European Endangered Species Breeding Programme (EEP) for the white rhinoceros, are kept 191 (77 ♂, 114 ♀) animals (Internet 15). In table 3, there are numbers of individuals of *Ceratotherium simum simum* in the EEP. Only 27 individuals of *Ceratotherium simum cottoni*

have bred in zoos, 22 were imported from the wild in the years 1948-1974 and five were born in the zoological garden Dvůr Králové (one female is a hybrid of both subspecies) (Mercado 2004). Their survey is show in table 4.

Table 2: World white rhino captive population (according to the data from December 31st 2004) (Mercado 2004)

Place	C.s.simum				C.s.cottoni			
	males	females	unknown sex	total	males	females	unknown sex	total
Africa	12	20	3	35			0	
Asia	72	90	0	162			0	
Australia	19	20	0	39			0	
Europe	105	135	0	240	3	5 *	0	8*
North America	100	120	0	220	1	2	0	3
Central America	19	18	0	37				
South America	8	9	0	17				
Total	335	412	3	758	4	7*	0	11*

* One female is a hybrid of the subspecies C.s.simum and C.s.cottoni

Table 3: Numbers of southern white rhinoceroses in zoological gardens in Europe (according to: Internet 15)

Country	Number of animals (♂, ♀)
Austria	5 (2.3)
Salzburg ZOO Hellbrun	5 (2.3)
Belgium	3 (1.2)
Monde Sauvage Aywaille	3 (1.2)
Bulgaria	1 (1.0)
ZOO Sofia	1 (1.0)
Czech Republic	7 (2.5)
ZOO Liberec	1 (1.0)
ZOO Ostrava	2 (1.1)
ZOO Usti nad Labem	3 (1.2)
ZOO Zlin – Lesna	1 (0.1)
Denmark	14 (6.8)
Givskud ZOO	6 (2.4)
Knuthenborg Safari Park	4 (2.2)
Kobenhavn ZOO	2 (1.1)
ZOO Aalborg	2 (1.1)
France	30 (11.19)

African Safari Plaisance du Touch	2 (1.1)
Lisieux CERZA	4 (2.2)
Parc Zoologique de la Barben	2 (0.2)
Parc Zoologique de Lille	2 (1.1)
Planete Sauvage Port St. Pere	2 (0.2)
Réserve Africaine de Sigean	5 (2.3)
Thoiry Zoological Park	3 (1.2)
Touroparc Romaneche	1 (0.1)
ZOO Amneville	4 (2.2)
ZOO de la Palmyre	2 (1.1)
ZOO Parc de Beauval	3 (1.2)
Germany	17 (8.9)
Allwetterzoo Munster	4 (1.3)
Thüringer Zoopark Erfurt	6 (3.3)
ZOO Augsburg	2 (1.1)
ZOO Duisburg	2 (1.1)
ZOO Osnabrück	2 (1.1)
ZOO Schwerin	1 (1.0)
Hungary	2 (1.1)
Budapest ZOO	2 (1.1)
Ireland	3 (1.2)
Phoenix Park Dublin	3 (1.2)
Israel	13 (6.7)
Tisch Family ZOO	3 (1.2)
ZOO Tel Aviv – Ramat Gan	10 (5.5)
Italy	2 (1.1)
Parco Natura Viva	2 (1.1)
Lithuania	1 (0.1)
Kaunas ZOO	1 (0.1)
Netherlands	19 (4.15)
Burger's ZOO en Safari	6 (2.4)
Noorder Dierenpark Emmen	3 (1.2)
Safari Beekse Bergen	10 (1.9)
Poland	9 (5.4)
ZOO Katowice (Chorzow)	4 (2.2)
ZOO Opole	1 (1.0)
ZOO Poznan	3 (1.2)
ZOO Wrocław	1 (1.0)
Portugal	2 (1.1)
Jardim Zoologico de Lisboa	2 (1.1)
Russian Federation	2 (1.1)
Rostovskii-na-Donu Zoopark	2 (1.1)
Slovakia	3 (1.2)
ZOO Bratislava	3 (1.2)
Spain	7 (4.3)
Parque de Cabarceno	5 (3.2)
ZOO Barcelona	2 (1.1)
Sweden	5 (1.4)
Boras Djurpark	5 (1.4)
United Kingdom	38 (17.21)
Colchester ZOO	2 (1.1)

Cotswold Wildlife Park	3 (1.2)
Edinburgh ZOO	1 (0.1)
Flamingo Land Holiday Village	2 (2.0)
Knowsley Safari Park	7 (3.4)
Longleat Safari Park	2 (1.1)
Marwell Zoological Park	4 (2.2)
South Lakes Wild Animal Park	2 (2.0)
Suffolk Wildlife Park	2 (1.1)
Whipsnade Wild Animal Park	9 (2.7)
Woburn Safari	4 (2.2)
Total	183 (74.109)

Table 4: Individuals of *Ceratotherium simum cottoni* in zoological gardens (according to: Mercado 2004)

Number	Sex	Name/studbook number	Location and date of birth	Date of transfer/ Breeder	Date and primary cause of death
1	M	PAUL 0015	1948 Sudan	1950 Antwerp	1968 – pleurisy
2	F	CLOÉ 0016	1948 Sudan	1950 Antwerp	1985 – adenocarcinoma
3	M	BEN 0019	1950 Uganda	1955 London	1990 – senile
4	M	BILL 0027	1954 Sudan	1986 Dvůr Králové 1956 Washington 1972 Wap San Diego	emaciation/euthanasia 1975 – impaction/complete obstruction of small intestine
5	F	LUCY 0028	1954 Sudan	1956 Washington 1972 WAP San Diego	1979 – bacterial infection of digestive tract/euthanasia
6	M	0054	1963 Sudan	1964 Khartoum 1965 Riyadh	1985 – euthanasia
7	F	0055	1963 Sudan	1964 Khartoum 1965 Riyadh	1985 – euthanasia
8	M	DINKA 0074	1952 Sudan	1957 St. Louis 1972 San Diego	1991 – old age + trauma
9	F	JOYCE 0075	1953 Sudan	1957 St. Louis 1972 WAP San Diego	1974 – biliary hepatitis/biliary cirrhosis
10	F	BEBE	1950 Uganda	1955 London	1964 – acute

		0290			inflammation of the bowel/pulmonary collapse 1978 – unknown
11	F	TOFACHA	1970 Sudan	1972 Khartoum	
12	M	0345	1968 Sudan	1973 Al Ain 1970 Khartoum	means 1978 – unknown
13	M	ANGALIFU	1972 Sudan	1973 Khartoum	means
14	F	0348 NASIMA 0351	1965 Uganda	1990 WAP San Diego 1971 Prescott 1977 Dvůr Králové	1992 – flexion of neck – horn got caught between cage/ door bars
15	M	SUDAN	1973 Sudan	1975 Dvůr Králové	
16	M	0372 SAUT 0373	1972 Sudan	1975 Dvůr Králové 1989 WAP San Diego	
17	F	NOLA	1974 Sudan	1998 Dvůr Králové 1975 Dvůr Králové	
18	F	0374 NURI 0375	1973 Sudan	1989 WAP San Diego 1975 Dvůr Králové	1982 – intracapsular fracture of hind limb/ shock – fell into moat
19	F	NADI	1972 Sudan	1975 Dvůr Králové	
20	F	0376 NESARI	1972 Sudan	1989 WAP San Diego 1975 Dvůr Králové	
21	F	0377 NASI*	1977 Dvůr Králové	1977 Dvůr Králové	
22	M	0476 SUNI 0630	mother NASIMA 1980 Dvůr Králové	1980 Dvůr Králové	parents
23	F	NABIRE	NASIMA/SAUT 1983 Dvůr Králové	1983 Dvůr Králové	parents
24	F	0789 NAJIN	NASIMA/SUDAN 1989 Dvůr	1989 Dvůr Králové	

		0943	Králové		
			parents		
			NASIMA/SUDAN		
25	F	1122	1991 Dvůr Králové	1991 Dvůr Králové	1991 – miscarriage – 296 days old fetus
			parents		
			NASIMA/SUDAN		
26	F	1123	1963 Sudan	1964 Khartoum	1967 – unknown means
27	?	1252	1948 Sudan	1949 Khartoum	1949 – enteritis
28	F	FATU	2000 Dvůr	2000 Dvůr Králové	
		1305	Králové		
			parents		
			NAJIN/SAUT		

* Female NASI is a hybrid of subspecies *Ceratotherium simum simum* and *C. s. cottoni*

1.4.5 Social system and reproduction

Every species living primarily socially or solitarily is influenced by various biotic and abiotic factors, as shown in figure 4.

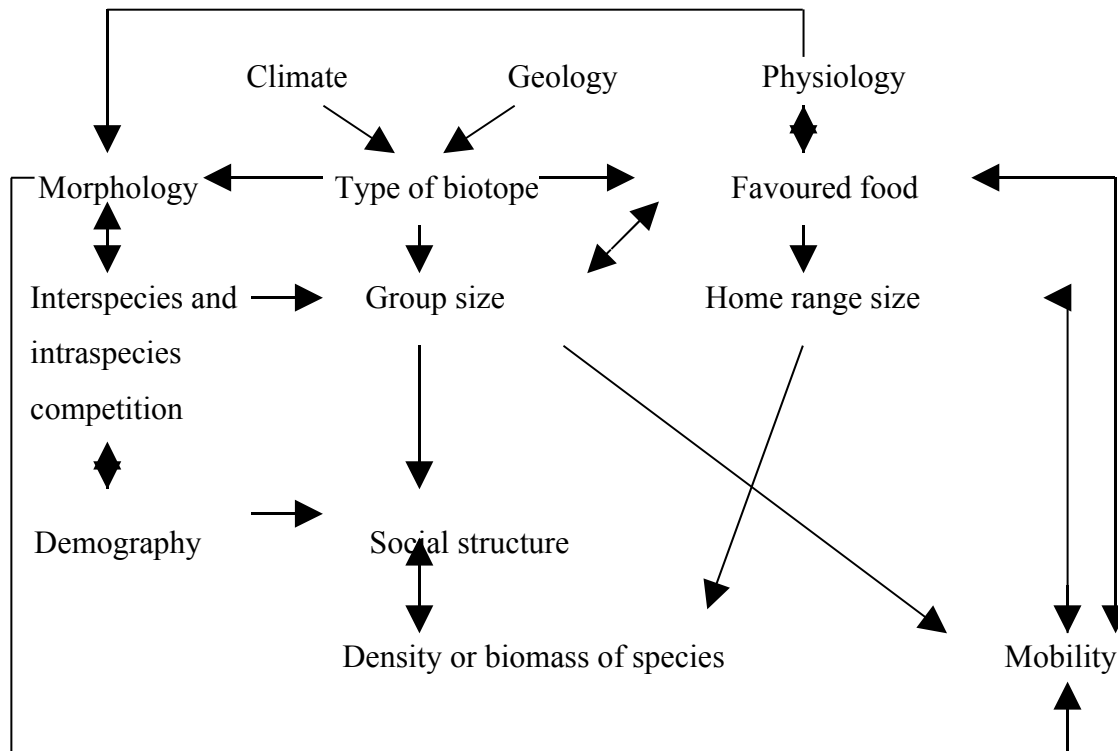


Fig. 4: Common influence of biotic and abiotic factors on group size and group forming (according to: Eisenberg 1981, *ex* Meister 1997; Poole 1985, *ex* Meister 1997)

Social behaviour relates to a life of individuals in groups (Veselovský 2005).

Positive social bonds are called social cohesion in this work as well as in works about social and reproductive behaviour from Mikulica (1991) and Kuneš (2001).

Agonistic behaviour includes both parts of aggressive behaviour (attack and escape) and displays used for threat between rivals (Veselovský 2005).

Adult white rhino bulls are solitaires; we can distinguish dominant territorial males and submissive males. Territory size of dominant male depends on the local rhino density. Cows and juveniles form groups; home range sizes of females overlap and encompass some 6-7 male's territories. However, a majority of cows spend over 50 % of rainy season inside one or another two adjacent territories (Owen-Smith 1975). In table 5, there is shown comparison among local rhino density, territory sizes of bulls and home range sizes of cows.

Table 5: A comparison among local rhino density, territory sizes of males and home range sizes of females in five southern African areas

Area	Density (km ²)	Territory sizes of males (km ²)	Home range sizes of females (km ²)
Kruger National Park ^a	0.5-1.4	6.2-13.8	7.2-45.2
Kyle National Park ^b	0.7	5.0-11.0	3.0-20.0
Ndumu Game Reserve ^c	0.6-1.8	2.5-13.9	4.7-22.9
Umfolozi Game Reserve ^d	3.0-5.7	0.75-2.6	8.9-20.5
Timbavati Private National Reserve ^e	0.1-0.2	23.4-52.9	61.8-68.3

^a Pienaar *et al.* 1993

^b Condy 1973, *ex Pienaar et al.* 1993

^c Conway & Goodman 1989, *ex Pienaar et al.* 1993

^d Owen-Smith 1975

^e Roche 2000

Sexual behaviour includes displays leading to the meeting of sexual partners and it ensures fertilization itself. For the successful fertilization, special mechanisms must exist to ensure simultaneous maturation of generative cells and a contact of partners. These mechanisms comprise besides morphologic and anatomic structures also specific physiological actions and characteristic behaviour (Anděrová 1996).

Young white rhino females undergo their first oestrus at about five years of age and they give birth to their first calf at 6.5-7 years. Young males are regarded as adult once they become solitary between 10 and 12 years of age (Owen-Smith 1975).

When a female is maturing, the ova start regularly to ripen in her Graf's follicles. A side of the ripened follicle is composed by theca cells producing oestrogen. It leads to the oestrus during which neck glands of uterus make secretions (König 2002).

2. Materials and methods

The observation was carried out in zoological garden Dvůr Králové between July and November 2005, only at the outside enclosure. At the time of my observation, a group of northern subspecies *Ceratotherium simum cottoni* consisted of following six animals: bull SUNI (at the time of my observation, he was 25 years old) and cows NESÁRÍ (33 years of age), NASI (28 years), NABIRÉ (22 years), NÁJIN (16 years) and FATU (5 years). NESÁRÍ was separated out of the herd on 21st of August due to cold nights and her articulations problems, witch could have been worse because of chilling. For veterinary report, situation in the herd in the years 2001-2005 and conditions of breeding see appendix. Photos of particular members of the herd are shown in figures 5-10.

I spent 323 hours in observation; from that number NESÁRÍ was in the herd for 214 hours. The time of observation is also smaller (312) in cows NASI and NABIRÉ due to NABIRÉ'S hoofs problems.

During observation of animals' behaviour, I recorded their locomotoric activities, postures and gestures as defined by Fraňková & Bičík (1999). For the description were used descriptive (description of components or their sequences according to the way that were shown, e. g. walk, run, etc.) and functional (activities of animals are ordered in the sequences, e. g. feeding, exploration, etc.) terms. Record of behaviour of all members of the group were affected by the method of overall ethogram (all elements of behaviour of animals), focal group sampling (every five minutes I registered the types of behaviour manifesting by animals at that time) and by the monitoring of sequence of activities. During the observation, I also made photos (all photos in this work I made myself). Only a part of the results will be presented in this thesis, the next part of it will be presented in prepared diploma thesis.

Professor Schwarzenberger from Veterinary University Vienna made original charts, which were used for evaluating of sexual activities of rhinos. They demonstrate ovarian activity of females by measurement of level of 20-oxo-pregnanes in faeces. In ZOO Dvůr Králové, faecal samples are taken two times a week and then are frozen at the temperature of $-20\text{ }^{\circ}\text{C}$. For processing 0.5 g of faeces are mixed with 1,0 g of powdered aluminium oxide, 0,5 ml of water and 4 ml of methanol. Samples are vortexed for 30 min and then defatted by vortexing for 10 s in 3 ml of petroleum ether. Methanol fractions are transferred into a new vial, diluted in buffer and analysed using enzyme immunoassays (non-specific antibodies (IgG), specific antibodies against 5α -pregnane- 3β -ol-20-one 3HS:BSA and 5β -pregnane- 3α -

ol-20-one 3HS:BSA). Then samples are incubated through a night, plates are washed in buffer and incubated with a substrate. Enzymatic reaction is stopped by sulphuric acid and concentration of hormones is determined by photometric analysis (Schwarzenberger *et al.* 1998).



Fig. 5: Suni



Fig. 6: Nabiré



Fig. 7: Fatu



Fig. 8: Nájin



Fig. 9: Nesári



Fig. 10: Nasi

3. Results

3.1 Social and playful behaviour

3.1.1 Cohesive behaviour

The following predetermined acts, postures and mimic gestures of cohesive behaviour were observed:

- 1/ Rubbing its head against another animal
 - the animal rubbed its cheek or its posterior horn and cheek against the side, cheek or thighs of another individual (figure 16).
- 2/ Rubbing its head and neck against another animal
 - the animal put its head and neck on the back of another lying individual and rubbed its chin against it.
- 3/ Touch and/or rubbing its horn against another animal
 - the animal rubbed its anterior horn against various parts of body of another animal (figure 17).
- 4/ Leaning its horn against another animal
 - the rhinoceros leaned its horn or its horn and lips from the side or from behind against another standing or lying individual.
- 5/ Placing its head and neck on another animal
 - the animal placed its head and neck from the side on back of a partner (figure 18).
- 6/ Touch and/or rubbing its lips against another animal's body
 - the animal touched or moves lips over a skin of another individual.
- 7/ Pressing its hind part to another animal
 - the animal pressed its hind part to another lying or standing individual in T- or L- posture (figure 19). It can be derived from an infantile behaviour. Calves often adopt this posture during a fright.
- 8/ Placing its head from behind between the hind legs of another standing animal
 - this activity was used by a male towards females, but it appeared also between females.
- 9/ Raising the head of another animal with its forehead

- the animal raised head or neck of a partner with its posterior horn and its forehead.

10/ Approaching to another animal

- the individual approached to a partner and remained in his proximity. This behaviour was recorded only when it was not affected by another stimulation (feeding, a conflict between animals or a human factor).

11/ Following

- the individual followed his partner without pre-estimated direction of followed animal (figure 20).

12/ Lying side by side

- the animals lay side by side with heads and axis of a trunk in the same line. They touched themselves (touch of sides; head and neck are pressing to a head, a forelimb or to a shoulder blade region of another animal) or it could have been a distance up to 1 m between them (figure 21).

13/ Standing side by side

- the rhinoceroses stood side by side with their heads and axis of a trunk in the same line. They touched themselves or it could have been a distance up to 1 m between them (figure 22).

14/ Walking side by side

- the animals walked in the same direction, a distance between them could have been up to 1 m.

15/ Rubbing its side against that of the other in passing

- it served as a greeting between animals.

3.1.2 Agonistic behaviour

During my observation, I registered following predetermined postures and mimic gestures:

Defensive behaviour – active defence

1/ Snarl

- the head was thrust forwards, ears laid back, and mouth opened to let out a loud rasping roar. Sometimes it was coupled with a few advancing steps, and occasionally an advancing snarl ended in a horn prodding gesture or a clash of horns. This posture is mostly used by a weak animal towards a strong animal – by

a cow towards a bull or in the wild, by a submissive bull towards a territorial α -bull (Owen-Smith 1975).

2/ Protest turning head (heads) and/or body towards the disturbing animal.

3/ Snort

- a weak form of protest against approaching of another animal. The head was raised and ears laid back or forward. If the latter individual had moved back, the animal continued in its previous activity.

4/ Snort ended in a clash of horns

- the head was lowered, ears laid back. If the latter individual had not moved back after snort, a clash of horns followed.

5/ Growl

- the head was lowered, ears laid back. If the latter individual had moved back, the animal continued in its previous activity.

6/ Growl ended in a clash of horns

- the head was lowered, ears laid back.

7/ Protest exercising a few steps forward towards the other animal

- the head was lowered, ears laid back. Sometimes it was coupled with a growl or a horn prodding gesture.

8/ Threat with moving head

- the animal stood on all four feet, turned its head aside and swung suddenly the head drawing with it a big bow from side to side. Sometimes it was coupled with a growl.

9/ Clash of horns

- one animal with lowered head and ears laid back attacked the other and clashed horns with it. In the intensive attacks, a tail was curled. This display was sometimes also coupled with a growl. Owen-Smith (1975) interpreted the horn clash threat as a „symbolic” attack.

Subdued aggressive behaviour

1/ Pressing

- the animal pressed against another individual with its body side or with its neck and head in such situations when the animal competed with another/others for the place of rest, for forage or for exclusive contact with the partner.

2/ Attacking another animal with horn to body blows.

3.1.3 Urination and defecation in social context

The displays of bulls during defecation and urination depend on their social rank. Submissive bulls, adolescents and cows urinate in a stream. A cow in oestrus urinates frequently and emits little squirts of urine (Owen-Smith 1975).

Because in conditions of zoological gardens is mostly not possible to keep two bulls together, a single male behaves automatically as a territorial α -male. Typical of this behaviour is scrape marking ensued by spray-urination (spasmodic bursts of urine serving to marking of a territory) and powerful kicking movements before and after defecation at a dungheap (figures 25-26).

On rare occasions, bulls can also urinate in a stream (Owen-Smith 1975). I recorded a combination of urination in a stream and spray-urination in bull SUNI 12 x (n=619). Frequency of urination was 1,9 per hour.

Before defecation, but also during a day, all rhinos inspected their dungheaps. The male also scattered dung with his horn and after defecation made kicking movements, so that his dung was broken up and scattered over the heap.

3.1.4 Playful behaviour

The following activities were noted:

1/ Head tossing

- the standing animal tossed its head in a vertical line. I registered this behaviour only in FATU.

2/ Hustling of a stone on a ground with shutting tight lips

- the animal hustled a small stone on a ground with shutting tight lips. This behaviour was observed only in cows (except NESÁRÍ).

3/ Digging in a ground with its horn

- the animal dug with its horn in soft soil (sand or mud). This activity was very frequent in time, when new sand was brought into their enclosure. I recorded that mostly in SUNI.

4/ Tossing a branch with its horn

- the animal lifted a branch up with its anterior horn or balanced it between its anterior and posterior horns. I noted this activity in FATU and SUNI.

5/ Manipulating a bush with its horn

- the animal manipulated a bush and broke branches. I registered that only in bull.

6/ Running

- this manifestation was observed in FATU most frequently, but appeared also in NÁJIN.

7/ Running and head tossing

- the animal ran and tossed its head in a vertical line at the same time. I recorded that only in FATU.

8/ Running and hustling against a side of another animal

- the animal was running and hustled its side against a side of another standing or walking individual. This behaviour was noted only once in FATU.

9/ Play horn wrestling

- the animals stood opposite themselves and wrestled with their horns. Observed length was from one minute to 32.5 minutes (between SUNI and NASI). It occurred mostly between bull and cow and it can be also a part of sexual behaviour as well as cohesive behaviour (figures 27, 29).

3.2 Activity budget

Evaluating of activity budget can help to judge animals' health. The activity budget of particular animals is shown in table 6.

The activity of animals is influenced by their age and by health condition. A biggest part of rest (lying and standing) was noticed in the oldest female NESÁRÍ (56.66 %). Conversely, in according to the age the third oldest bull SUNI, a part of rest is comparable with the youngest females FATU (33.99 %) and NÁJIN (35.16 %). In bull SUNI, I recorded also the biggest part of walking from total activity in comparison to cows.

Table 6: Activity budget of observed animals (%)

	Lying ^a	Standing ^b	Hanging around ^c	Walking ^d	Running ^e	Feeding ^f
Nasi	42.6	3.5	20.7	11.5	<0.1	21.7
Nabiré	43.2	5.8	21.1	9.9	<0.1	20.0
Nesári	55.5	1.2	11.2	7.9	0.0	24.2
Nájin	27.1	8.1	26.2	16.0	0.1	22.5
Fatu	30.4	3.6	24.8	17.3	0.2	23.7
Suni	31.0	3.7	24.1	21.0	0.1	20.1

^a rest, sleep

^b the animal stood passively, without moving, the head was lowered. The animal sometimes leaned its head or horn against a ground, a stone or against another individual.

^c a low activity

^d the middle activity

^e a high activity

^f feeding on a prepared food

3.3 Sexual activities of the rhinoceroses in the years 2001-2005

During my observation in the year 2005, when bull SUNI was with the herd of cows, any mating was not noticed. The following data were taken from rhino keepers' records, if it is not written differently. In previous years (2001-2004), a regular mating of bull SAÚT with NÁJIN occurred, but cow did not conceive. In the year 2000, NÁJIN missed in the herd as she became in advanced grade of gravidity and she gave birth to female FATU on 29.6.2000. Both returned to the herd on 12 July 2001 and only nine days after that, mating of NÁJIN with SAÚT was noticed. Until 15.3.2005, they bred even 18 times. SAÚT was interested also in cows NESÁRÍ and NABIRÉ, but copulation did not occur. In October 2001, NESÁRÍ had health problems, she was losing her condition and she was going down in a social rank, which resulted in disputes (Tomášová, *in verb.*). NESÁRÍ was taken out of the herd and in June 2003, she was socialised with bull SUNI, who had lived alone. Sexual activities of rhinoceroses in the years 2001-2005 are shown in table 7.

Table 7: Sexual activities in the group of northern white rhinoceroses in ZOO Dvůr Králové in the years 2001-2005 (according to the records of rhino keepers and according to my observation, marked *)

DATE	INTENSITY OF SEXUAL ACTIVITY	MALE	FEMALE	NOTES
21.03.2001	Interest of male	SAÚT	NESÁRÍ	The bull followed the cow.
31.05.2001	Attempted mating	SAÚT	NABIRÉ	The bull placed his chin on cow's rump several times.
01.06.2001	Interest of male	SAÚT	NABIRÉ	The bull followed the cow.
02.06.2001	Interest of male	SAÚT	NABIRÉ	The bull followed the cow.
03.06.2001	Interest of male	SAÚT	NABIRÉ	The bull followed the cow.
07.06.2001	Attempted mating	SAÚT	NESÁRÍ	Attempted mounting of the bull.
21.07.2001	MATING	SAÚT	NÁJIN	Duration of mating 28-30 minutes.
26.08.2001	Attempted mating	SAÚT	NÁJIN	Mounting of the bull.
27.08.2001	MATING	SAÚT	NÁJIN	Duration of mating 15 minutes.
09.10.2001	Attempted mating	SAÚT	NÁJIN	The bull placed his chin on cow's rump several times.
10.10.2001	MATING	SAÚT	NÁJIN	Duration of mating 20 minutes.
05.11.2001	MATING	SAÚT	NÁJIN	Duration of mating 18 minutes.
07.12.2001	Attempted mating	SAÚT	NÁJIN	The bull placed his chin on cow's rump several times, mounting of the bull.
25.01.2002	MATING	SAÚT	NÁJIN	Duration of mating 20 minutes.
18.03.2002	Attempted mating	SAÚT	NÁJIN	
19.03.2002	MATING	SAÚT	NÁJIN	Duration of mating 13 minutes.
14.04.2002	MATING	SAÚT	NÁJIN	Duration of mating 18 minutes.
22.06.2002	MATING	SAÚT	NÁJIN	Duration of mating 23 minutes.
24.09.2002	MATING	SAÚT	NÁJIN	Duration of mating 18 minutes.
20.10.2002	Attempted mating	SAÚT	NÁJIN	The bull placed his chin on cow's rump several times.
21.10.2002	Interest of male	SAÚT	NÁJIN	
19.11.2002	MATING	SAÚT	NÁJIN	Duration of mating 27 minutes.
24.03.2003	Attempted mating	SAÚT	NÁJIN	
25.03.2003	MATING	SAÚT	NÁJIN	Duration of mating 30 minutes.
17.04.2003	MATING	SAÚT	NÁJIN	Duration of mating minimally 20 minutes.
23.06.2003	MATING	SAÚT	NÁJIN	Duration of mating 21 minutes.
19.07.2003	MATING	SAÚT	NÁJIN	Duration of mating 23 minutes.
12.09.2003	Attempted mating	SAÚT	NÁJIN	The bull placed his chin on cow's rump several times.
14.09.2003	MATING	SAÚT	NÁJIN	Duration of mating 21 minutes.
28.09.2003	Attempted mating	SUNI	NESÁRÍ	The bull placed his chin on cow's rump several times, attempted mounting of the bull.
29.09.2003	Attempted mating	SUNI	NESÁRÍ	The bull placed his chin on cow's rump several times.
30.09.2003	Interest of male	SAÚT	NABIRÉ	

11.10.2003	Attempted mating	SAÚT	NÁJIN	
12.10.2003	Attempted mating	SAÚT	NÁJIN	The bull placed his chin on cow's rump several times.
08.11.2003	Attempted mating	SAÚT	NÁJIN	Mountings of the bull.
04.12.2003	Attempted mating	SAÚT	NÁJIN	
29.12.2003	MATING???	SAÚT	NÁJIN	Mounting of the bull, a mating might have occurred.
30.12.2003	MATING	SAÚT	NÁJIN	Duration of mating 22 minutes.
19.04.2004	MATING	SAÚT	NÁJIN	Duration of mating 20 minutes.
27.06.2004	Attempted mating	SAÚT	NÁJIN	
30.06.2004	Attempted mating	SUNI	NESÁRÍ	The bull placed his chin on cow's rump several times.
01.07.2004	Attempted mating	SUNI	NESÁRÍ	The bull placed his chin on cow's rump several times, attempted mounting of the bull.
04.07.2004	Interest of male	SUNI	NESÁRÍ	
05.07.2004	Interest of male	SUNI	NESÁRÍ	
06.07.2004	Interest of male	SUNI	NESÁRÍ	
07.07.2004	Interest of male	SUNI	NESÁRÍ	
25.07.2004	MATING	SAÚT	NÁJIN	Duration of mating 35 minutes.
11.08.2004	Attempted mating	SUNI	NESÁRÍ	The bull placed his chin on cow's rump several times.
12.08.2004	MATING	SUNI	NESÁRÍ	Duration of mating 25 minutes (1x10 + 1x15 minutes).
21.09.2004	Interest of male	SUNI	NESÁRÍ	
22.09.2004	Interest of male	SUNI	NESÁRÍ	
23.09.2004	Interest of male	SUNI	NESÁRÍ	
24.09.2004	Interest of male	SUNI	NESÁRÍ	
25.09.2004	Interest of male	SUNI	NESÁRÍ	
01.10.2004	MATING	SAÚT	NÁJIN	Duration of mating 18 minutes.
26.10.2004	Interest of male	SUNI	NESÁRÍ	
28.12.2004	Interest of male	SAÚT	NÁJIN	
29.12.2004	Attempted mating	SAÚT	NÁJIN	
15.03.2005	MATING	SAÚT	NÁJIN	Duration of mating 20 minutes.
13.04.2005	Attempted mating	SAÚT	NÁJIN	Mountings of the bull.
14.04.2005	Attempted mating	SAÚT	NÁJIN	Mountings of the bull.
06.07.2005*	Interest of male	SUNI	FATU	The bull followed the cow.
07.07.2005*	Interest of male	SUNI	FATU	The bull followed the cow.
08.07.2005*	Interest of male	SUNI	FATU	The bull followed the cow.
22.07.2005*	Interest of male	SUNI	FATU	The bull followed the cow.
23.07.2005*	Attempted mating	SUNI	FATU	The bull followed the cow and placed his chin on cow's rump several times.
24.07.2005*	Attempted mating	SUNI	FATU	The bull placed his chin on cow's rump several times.
25.07.2005*	Attempted mating	SUNI	FATU	The bull followed the cow.
01.08.2005*	Interest of male	SUNI	NÁJIN	The bull followed the cow.
02.08.2005*	Interest of male	SUNI	NÁJIN	The bull followed the cow.
03.08.2005*	Interest of male	SUNI	NÁJIN	The bull followed the cow.
04.08.2005*	Attempted mating	SUNI	NÁJIN	The bull placed his chin on cow's rump several times.
16.08.2005*	Interest of male	SUNI	NESÁRÍ	The bull followed the cow.

17.08.2005*	Interest of male	SUNI	NESÁRÍ	The bull followed the cow.
18.08.2005*	Attempted mating	SUNI	NESÁRÍ, NASI	The bull followed the cow, attempted mounting NESÁRÍ by the bull.
18.09.2005	Attempted mating	SUNI	FATU	The bull placed his chin on cow's rump several times.
06.10.2005*	Interest of male	SUNI	FATU	The bull followed the cow.
07.10.2005*	Attempted mating	SUNI	FATU	The bull placed his chin on cow's rump several times.

Typical behaviour of the bull was olfactory control of secretions of cows. The male took urine or even dung with his lips or tongue into his mouth, disintegrated it and then made a typical „Flehmen“ posture with rolled up upper lip (figure 28). In this way, he diagnosed a sexual hormones level in females by Jacobson's organ. This behaviour was more often in males than females. The bull often urinated on these analysed secretions. „Flehmen“ posture sometimes also occurred after a control of cow's genital region by the bull.

1-3 days before mating or attempted mating, the bull more often inspected urine of a cow, followed her and sniffed at her genital region. Noticeable bull's displays were repetitive wheezy exhalations with a throb produced at the initiation of each exhalation – hiccing, made by bull approaching to a cow. During these manifestations, his head was raised and tail curled.

In the first part of courtship, the female reacted each time to the approach of the bull with defensive threats. After some time, the first contacts between animals occurred – rubbing their heads and horns, and play horn wrestling. The bull also tried to place his head on the rump of a cow. This phase was often influenced by presence of another cow, which limited contacts between animals during courtship. If a cow in oestrus stayed in proximity of another cow threatening the bull, he had to stay in a big distance. When SUNI was sexually interested in FATU, she stayed in a close proximity of her mother NÁJIN, who threatened the bull.

Schwarzenberger *et al.* (1998) classified the length of luteal (LP) and follicular (FP) phase of oestrous cycle in white rhino females based on 20-oxo-pregnanes concentrations in faeces. Onset of the LP was defined as the first point after values had increased by > 50 ng/g and remained at > 120 ng/g of faeces for at least two consecutive values. The end of the LP was defined as the first of two consecutive values that were less than 120 ng/g faeces. Oestrous cycle length was calculated from the beginning of one LP to the beginning of the next. According to oestrous cycle length and LP 20-oxo-pregnanes values, females could be classified into four categories: (1) females with regular, ~ 10 weeks oestrous cycles and high

luteal phase 20-oxo-pregnanones concentration (> 800 ng/g of faeces); (2) females with oestrous cycles ranging in length from 4-10 weeks with luteal phase 20-oxo-pregnanones concentrations of 250-750 ng/g of faeces; (3) females with no apparent oestrous cycle regularity, but some luteal activity (20-oxo-pregnanones values 100-200 ng/g faeces); (4) females exhibiting no luteal activity (20-oxo-pregnanones values < 100 ng/g faeces).

Hermes *et al.* (2006) examined reproductive health in 54 females of white rhinoceros including females from ZOO Dvůr Králové (except FATU). NÁJIN (15 years old at the time of this study) was classified in category (2) or (3) (see Schwarzenberger *et al.* 1998). Oestrous cycle of NABIRÉ (18 years old) was classified in category (3) and cystic endometrial hyperplasia was detected in her (diffuse multi-focal and confluating cysts). NASI (24 years old) was classified in category (3) or (4) with findings of cystic endometrial hyperplasia (diffuse multi-focal and confluating cysts) and leiomyoma in the uterus (larger tumour masses > 5 cm). Oestrous cycle of NESÁRÍ (26 years old at the time of study) was classified in category (3) or (4); cystic endometrial hyperplasia (single endometrial cysts) and leiomyoma in the uterus (larger tumour masses > 5 cm) were detected in her.

Graphs of Professor Schwarzenberger from Veterinary University Vienna show the luteal activity in NÁJIN in the years 2000-2005 and in NESÁRÍ in the years 2002-2003 (figures 11-14).

Fig. 11: NÁJIN'S oestrous cycle in comparison with observed matings in the years 2000-2001

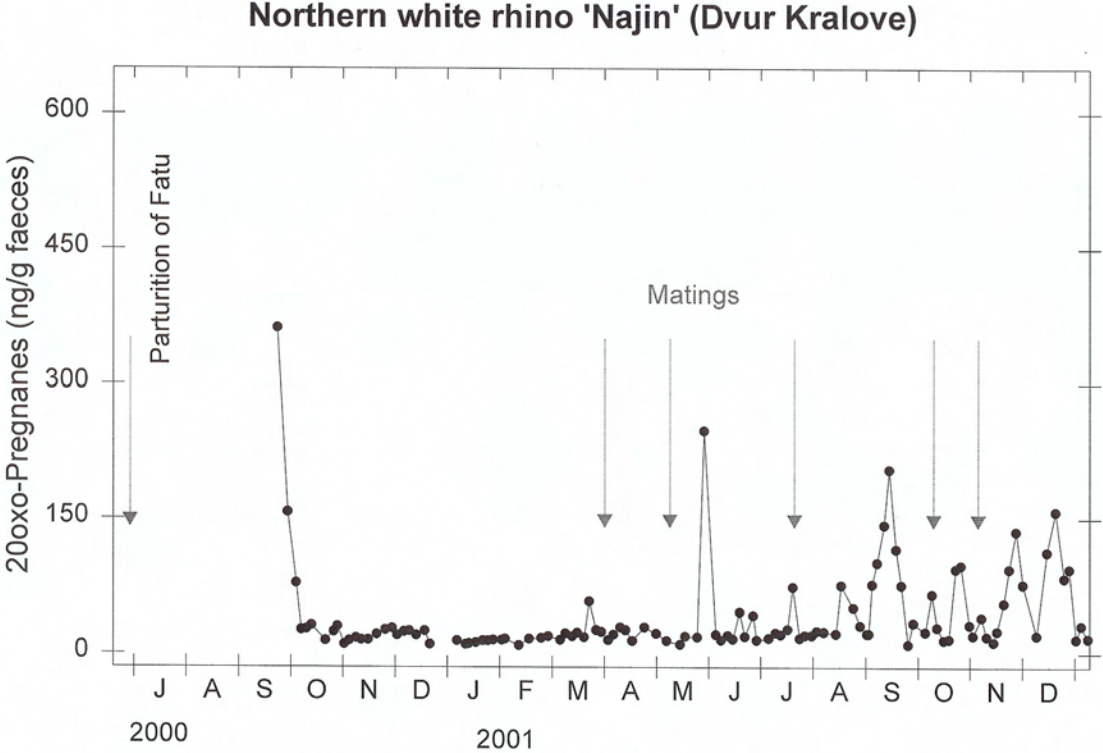


Fig. 12: NÁJIN'S oestrous cycle in comparison with observed matings and attempted matings in the years 2002-2003

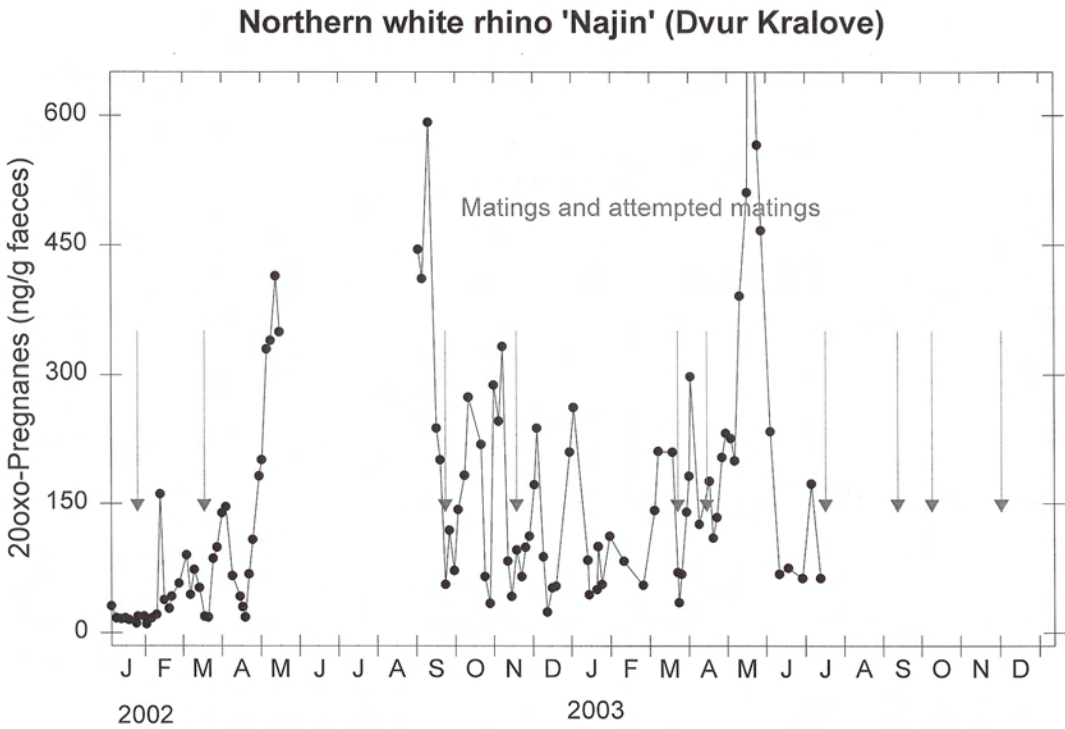


Fig. 13: NÁJIN'S oestrous cycle in comparison with observed matings and sexual interest of bull in her in the years 2004-2005

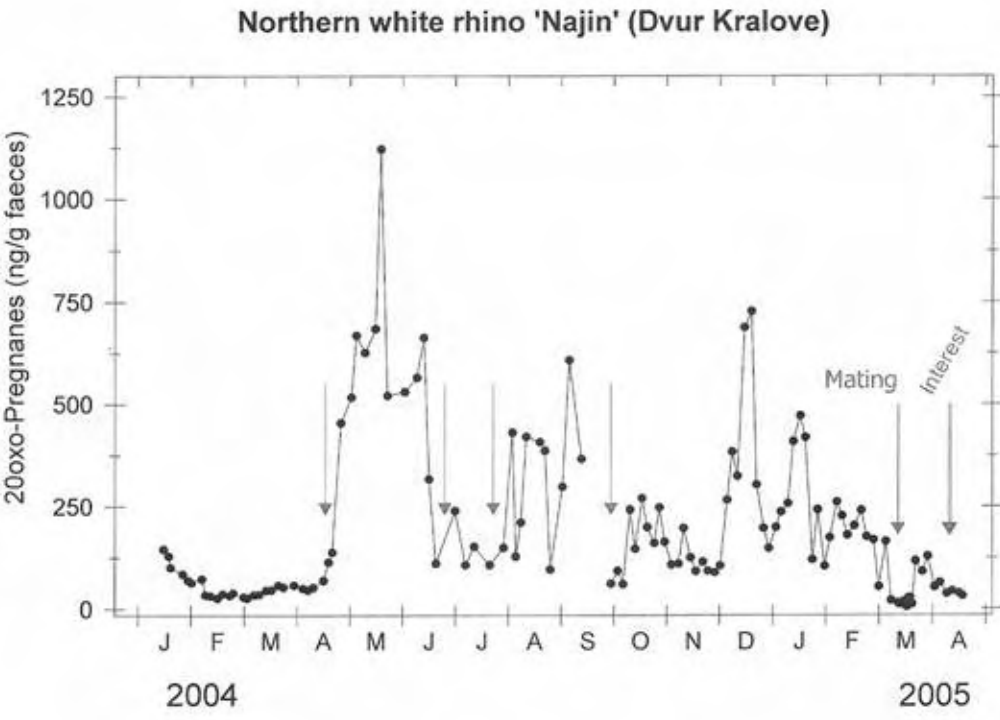
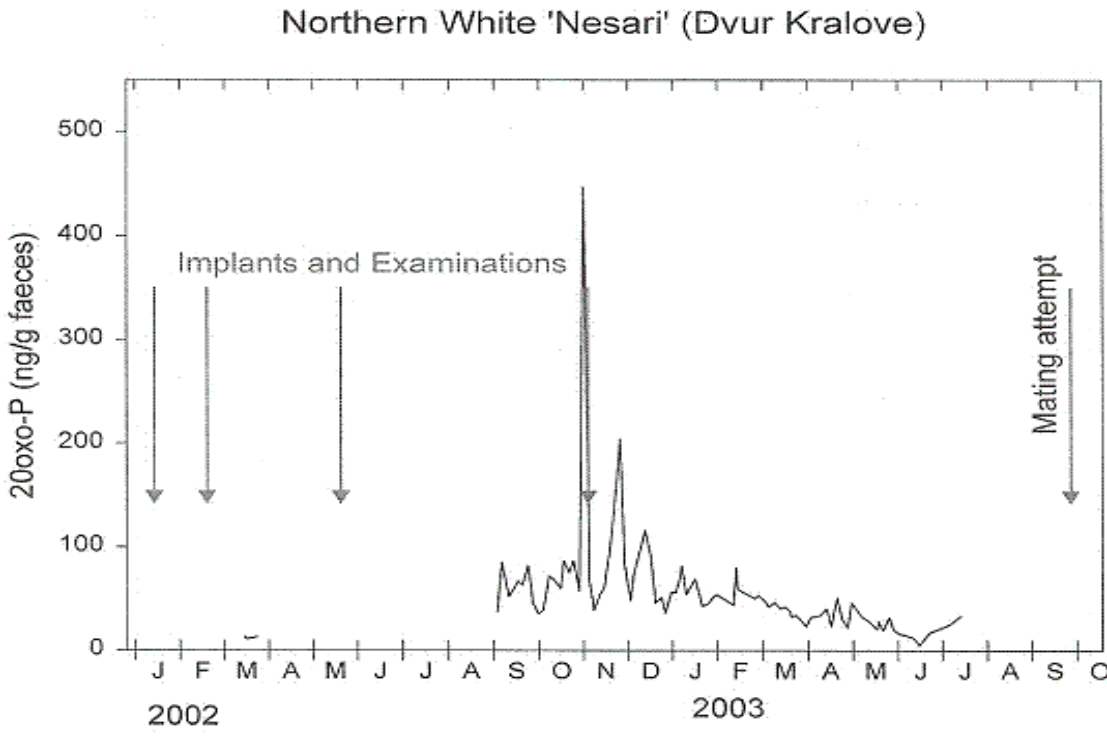


Fig. 14: NESÁRÍ'S oestrous cycle in comparison with attempted mating (the first four arrows show the application of hormone implants and examination of the cow)



4. Discussion

Behaviour of white rhinoceroses in captivity is influenced by many factors, above all by an enclosure size, group structure and group size, in which they are kept. In conditions of zoological gardens is mostly not possible to breed two bulls together, so a single bull automatically behaves as a territorial α -male.

Territorial behaviour of a bull in the nature may be characterized by four following features: (1) a bull rarely leaves the confines of his territory, except when forced to make excursions to water during the dry season. (2) Ritualized encounters – when two territorial bulls meet at a common boundary, they repeatedly advance towards each other with raised heads, touch horns, then back apart to wipe the anterior horn over the ground. Occasionally, they may clash horns shortly. (3) Confinement of oestrous cow – a bull blocks a leaving of cow from his territory. (4) Territorial bulls exhibit specialized techniques of defecation and urination (Owen-Smith 1971).

Rachlow *et al.* (1998) investigated the differences in body size and in the testosterone levels between territorial and nonterritorial males in Matobo NP in Zimbabwe. There was no significant difference in body size, but territorial males had significantly larger neck and chest girths. Among adult males, faecal testosterone was not related to age. However, faecal testosterone levels were significantly higher in territorial than in nonterritorial adult males.

Territoriality has also impact on semen quality of males. Hermes *et al.* (2005) examined in white rhino males in captivity a dependence among semen quality, group structure and group size, in which they are kept. Based on the percentage of progressively motile spermatozoa, semen was categorized in three groups: (1) high motility (> 75 %); (2) intermediate (50-70 %); (3) low (< 50 %). In a multi-male group housed with six females, only the dominant male showed high semen quality. All the other males showed intermediate or low semen quality. Then the management of the breeding of multi male group was changed, one formerly subdominant male was granted his own territory with exclusive access to cycling females. After six months, the semen quality of this male had improved from the low to the high category upon re-evaluation. Males housed individually without any accompanying male or female showed high semen quality, but only three of six males housed as a single territorial bull with one to three females had high semen quality. Reasons for that need further investigation.

During 323 hours of my observation I recorded 619 spray-urinations of bull SUNI (12 of them were in combination with urination in stream), i. e. 1.9 per hour. Owen-Smith (1975) stated in his study from Umfolozi Game Reserve in South Africa, that the mean number of urination of α -male within his territory was 2x per hour, along territory boundaries 10x per hour. He observed 636 urinations of α -male and only seven of them were in a continuous stream. For urination, he recorded on average 3-5 spasmodic bursts of urine. Kuneš (2001) registered in zoological gardens Dvůr Králové and Ústí nad Labem in two different bulls a frequency of spray-urination 2x per 3 hours and 2x per 9 hours.

As well as in works of Mikulica (1991) and Kuneš (2001), predetermined types of cohesive behaviour were recorded. I did not register activities „Touch its lips against another animal’s flank“ and „Lying with its head on a flank of another lying animal“. These activities observed in adult cows can be derived from an infantile behaviour.

Owen-Smith (1975) described in free ranging white rhinoceroses seven types of cohesive behaviour: (1) grazing of animals in close proximity or side by side, (2) following another animal, (3) walking side by side, (4) lying of animals in close proximity, (5) making panting sound as a contact or proximity maintaining signal, (6) rubbing its head or horn against another animal, (7) rubbing its side against another animal in passing.

In captivity, white rhino cows kept in groups consisting from more than two females form subgroups. Stable bonds occur especially between two cows; formations of trios are not frequent. Between cows in stabile bond, frequent cohesive manifestations and only few agonistic displays can be observed (Mikulica 1991, Meister 1997, Kuneš 2001, Kuneš & Bičík 2001-2002). Kuneš & Bičík (2001-2002) had described in zoo Dvůr Králové, before NÁJIN gave birth to FATU, this subgroups of cows: NÁJIN – NESÁRÍ and NABIRÉ – NASI. During my observation, stabile bonds were evidently formed by NASI with NABIRÉ and by NÁJIN with her daughter FATU. NESÁRÍ did not form a stabile bond with any cows and she gave only few cohesive manifestations to the other females.

Owen-Smith (1975) described, that about 80.7 % of free ranging adult cows were accompanied by calf. Cow without calf is usually observed with one or more adolescents (25.3 %), 2.9 % of cows are accompanied by another adult cow and 13 % are accompanied by adult bull, but this relationship lasts only from two to three weeks.

A bond between cow and her daughter can last for a long time in the nature. Owen-Smith (1973, *ex* Meister 1997) and Hillman-Smith (1997, *ex* Meister 1997) observed that home range of a young female is often situated in close proximity from home range of her supposed

mother. In black rhinos, a relationship between mother and her daughter is fragmented with birth of her next daughter, but sons are driven away with birth of next calf (Joubert & Eloff 1971, *ex* Meister 1997).

While in free nature, a stable bond between two adult cows is fragmented due to pregnancy of one from the cows, in zoological gardens can their bond outlast also during and after taking care of a calf (O'Connor 1982, *ex* Meister 1997). Relationship between NÁJIN and NESÁRÍ, described in ZOO Dvůr Králové in the years 1998-2000 by Kuneš & Bičík (2001-2002), did not exist at the time of my observation probably not only due to pregnancy and parturition of NÁJIN, but also because of a long separation of both cows, which lasted almost five years (NESÁRÍ was taken out of the herd because of health reasons, see appendix B).

Social dominance exists in the wild only between adult bulls, who are territorial or subdominant (Owen-Smith 1975). Cows do not have a social organization in the wild, but in the conditions of zoological gardens, they are hierarchized.

Agonistic behaviour was registered in predetermined types as described by Kuneš (2001). I did not record the activity „Aggressive following towards the other animal“, which he observed only in at that time dominant female NABIRÉ. At the time of my observation, NABIRÉ had problems with walking, which could have caused her going down in a social rank.

Bull SUNI was a common target of agonistic behaviour of cows, but in most instances, he retreated after a conflict. A retreat of α -bull after a conflict with cow(s) or submissive bulls was also described in nature, so it is not an artefact of breeding in zoological gardens (Owen-Smith 1973, *ex* Meister 1997). The most frequent agonistic display of cows to a bull was defensive behaviour. While this behaviour induced a retreat of the bull, it could be interpreted as a submissive gesture. Behaviour of a bull corresponds to high ranked, dominant animal, when:

- 1) he is not always an initiator of aggressive interactions,
- 2) he can lose some particular conflicts with a subdominant animal, who uses a relationship with other group members or who has a momentary „superiority“,
- 3) he ends confrontations and turns away from a subdominant animal,
- 4) he yields „precedence“ to a subdominant individual in particular competitive situations.

White rhinos kept in groups generate real hierarchy, in which a bull occupies a permanent high rank. Between cows, actual hierarchy is exerted, which can be altered according to a situation in a herd (Meister 1997).

The most frequent observed playful behaviour of adult animals is horn wrestling, usually between cow and bull, who commonly initiates this behaviour. Play horn wrestling is also ordinary between adolescents or between bull and adolescent. In this case, the stimulation generally comes from an adolescent, but a bull prolongs this (Meister 1997, own observation). At the beginning of my observation, in July, a frequent initiation of play horn wrestling with bull SUNI by adolescent female FATU could be recorded. An intensity of play horn wrestling between them was going down during August and at that time FATU started to use more often a defensive threat towards bull, above all „Snarl” and „Snort”. This behaviour could have been connected with a start of oestrus in her in days 6.7.-8.7. and 22.7.-25.7., when the bull was sexually interested in her.

A character of play with object was various; the vehement attacks of different objects could be registered in some instances. Activity „Manipulating a bush with its horn“, observed in SUNI, was ended by spray-urination. Meister (1997) proposed that a play with objects ended in bulls by spray-urination represents a conflict with imaginary rival. This behaviour can be a typical dominant manifestation or it can eventually occur during frustration (e. g. after an aggressive contact with another animal). This reorientated behaviour originates from the conflict between offensive and escaping motivation, animal does not defend against aggressive attack of another individual, but after that, its target of attack can be another weak individual or bushes and little trees, which substitute a rival (Veselovský 2005).

Free ranging white rhinoceros spends about a half of day with feeding, third with resting and a rest of time dedicating to walking, drinking, wallowing and to social life (Estes 1999). During my observation, animals have spent less than 25 % of time with feeding, the biggest percentage of time they dedicated to lying. The biggest part of walking from total activity I registered in SUNI. Meister (1997) also described a bigger part of time spending with walking in males than in females. Males dedicate this time especially to a control of an enclosure and to scent marking.

Reproduction of white rhinos in nature is not seasonally restricted. However, there are year-to-year variations, which could be related to the prevailing rainfall regimes. Oestrus

seems to be stimulated by conditions of freshly sprouting green grass following rain (Owen-Smith 1975). The length of oestrus ranges from 24 to 48 hours, mating occurs mainly in the second half of oestrus (Meister 1997).

Reproduction of white rhinoceroses in captivity is very low, the reasons for that need further investigation. Reproduction is influenced by various factors as an enclosure size, group size and group structure, including social ranking of animals (Mikulica 1991). Cows kept in groups with a bull, who they do not know from their youth, are often been reproduced. A regular oestrus goes primarily in cows housing minimally for five months in the year for 24 hours together with a bull (Tomášová 1999). In the group of rhinos in the ZOO Dvůr Králové, a regular mating of NÁJIN with SAÚT went on from the year 2001, but cow did not become pregnant. A total examination with ultrasound of both animals was carried out in April 2004 and did not locate any reproductive problems (Tomášová 2004b). The exchange of the bull SAÚT for SUNI took place in 2005; however, expected results have not occurred for the present.

5. Summary

Social, reproductive and playful behaviour were observed in the group of the northern white rhinoceroses (*Ceratotherium simum cottoni*) in the Zoological garden Dvůr Králové.

The bull SAÚT was exchanged for SUNI in June 2005. The reason for this was that although a regular mating between SAÚT and NÁJIN occurred from the year 2001, the cow did not come to pregnancy. Expected results of this exchange have not come for the present, because no mating was noticed. The bull was sexually interested in NÁJIN only once; but in FATU, probably, the oestrous cycle was activated. In days of sexual interest of the bull in her, FATU stayed in close proximity of her mother, who threatened the bull.

Social behaviour was registered in both types – cohesive and agonistic. From 17 predetermined types of cohesive behaviour, I noted only 15. Activities „Touch with its lips against a flank of another animal“ and „Lying with its head on a flank of another lying animal“ did not occur in behaviour of animals. A close relationship was recorded in pairs of cows NABIRÉ – NASI and NÁJIN – FATU. NESÁRÍ did not form a stable bond with any cows and she gave only few cohesive manifestations to the other females.

I observed agonistic behaviour in two types: subdued aggressive behaviour and defensive behaviour – active defence. From 12 predetermined types, I recorded 11. I did not register activity „Aggressive following towards the other animal“.

A majority of manifestations of playful behaviour I registered in a young female FATU. The most frequent playful behaviour was horn wrestling, usually between bull and a cow.

6. References

- **Anděra, M. (2003):** Přežijí nosorožci? *Vesmír* **3**, 163-166.
- **Anděrová, R. (1996):** Úvod do etologie. Praha: Česká zemědělská univerzita.
- **Emslie, R. (2004):** Rhino population sizes and trends. *Pachyderm* **37**, 107-110.
- **Emslie, R. & Brooks, M. (1999):** African Rhino. Status Survey and Conservation Action Plan. IUCN/SSC African Rhino Specialist Group. IUCN, Gland, Switzerland a Cambridge.
- **Estes, R. D. (1999):** Rhinoceroses. In: Estes, R. D. (Ed.): *The Safari Companion: A Guide To Watching African Mammals Including Hoofed Mammals, Carnivores and Primates*, Chelsea: Chelsea Green Publishing Company, pp. 190-199.
- **Fraňková, S. & Bičík, V. (1999):** Srovnávací psychologie a základy etologie. Karolinum, Praha.
- **Hermes, R., Hildebrandt, T. B., Blottner, S., Walzer, C., Silinski, S., Patton, M. L., Wibbelt, G., Schwarzenberger, F., Göritz, F. (2005):** Reproductive soundness of captive southern and northern white rhinoceros (*Ceratotherium simum simum*, *C.s. cottoni*): evaluation of male genital tract morphology and semen quality before and after cryopreservation. *Theriogenology* **63**, 219-238.
- **Hermes, R., Hildebrandt, T. B., Walzer, C., Göritz, F., Patton, M. L., Silinski, S., Anderson, M. J., Reid, C. E., Wibbelt, G., Tomasova, K., Schwarzenberger, F. (2006):** The effect of long non-reproductive periods on the genital health in captive female white rhinoceros (*Ceratotherium simum simum*, *C.s. cottoni*). *Theriogenology* **65**, 1492-1515.
- **Hillman Smith, K., Smith, F., Tshikaya, P., Ndey, A., Watkin, J. (2003):** Poaching upsurge in Garamba National Park, Democratic Republic of Congo. *Pachyderm* **35**, 146-150.
- **Hillman Smith, K. & Ndey, J., A. (2005):** Post-war effects on the rhinos and elephants of Garamba National Park. *Pachyderm* **39**, 106-110.
- **Holečková, D. & Bobek, M. (2000):** Mládě milénia. Praha: Zoologická zahrada Dvůr Králové n. L., Český rozhlas a ESCAD Trade.
- **König, H. E. (2002):** Anatomie domácích savců. 2.díl. Splanchnologie, cévní a nervová soustava. Bratislava: H & H.

- **Kuneš, M. (2001):** Rozmnožovací a sociální chování nosorožce tuponosého v zoologických zahradách. Diploma thesis, Palacký University Olomouc.
- **Kuneš, M. & Bičík, V. (2001-2002):** Social and sexual behaviour in captive breeding groups of white rhinoceros. Acta Univ. Palacki. Olomuc., Facultas Rerum Naturalium, Biologica **39-40**, 81-99.
- **Martin, E. & Hillman Smith, K. (1999):** Entreports for Rhino Horn in Khartoum and Cairo Threaten Garamba's White Rhino Population. Pachyderm **27**, 76-85.
- **Meister, J. (1997):** Untersuchungen zum Sozial- und Reproduktionsverhalten von Breitmaulnashörnern (*Ceratotherium simum*) in zoologischen Einrichtungen. Thesis, University Erlangen-Nürnberg.
- **Mercado, H. (2004):** Studbook population in numerical order Northern White rhinoceros. In: Ochs, A. (Ed.): International Studbook for the White rhinoceros, Berlin: Zoologischer Garten Berlin, pp. 404-409.
- **Mikulica, V. (1991):** Social Behaviour in Two Captive Groups of White Rhinoceros (*Ceratotherium simum simum* and *Ceratotherium simum cottoni*). Zoologische Garten N. F. **61**, 365-385.
- **Mohd Khan bin, M. K., Foose, T. J., Strien van, N. (2004):** Asian Rhino Specialist Group report. Pachyderm **37**, 15-18.
- **Mohd Khan bin, M. K., Foose, T. J., Strien van, N. (2005):** Asian Rhino specialist Group report. Pachyderm **38**, 16-18.
- **Musil, R. (1987):** Vznik, vývoj a vymírání savců. Praha: Academia.
- **Ochs, A. (2004):** International Studbook for the White rhinoceros. Berlin: Zoologische Garten Berlin.
- **Owen-Smith, R. N. (1971):** Territoriality in the White Rhinoceros (*Ceratotherium simum*) Burchell. Nature **231**, 294-296.
- **Owen-Smith, R. N. (1975):** The Social Ethology of the White Rhinoceros *Ceratotherium simum* (Burchell 1817). Z. Tierpsychol. **38**, 337-384.
- **Pienaar, D. J., Bothma, J. P., Theron, G. K. (1993):** White rhinoceros range size in the south-western Kruger National Park. J. Zool. **229**, 641-649.
- **Rachlow, J. L., Berkeley, E. V., Berger, J. (1998):** Correlates of Male Mating Strategies in White Rhinos (*Ceratotherium simum*). Journal of Mammalogy **79**, 1317-1324.
- **Roche, C. (2000):** Notes on Territory and Home Range Size of White Rhinoceros in the Southern Timbavati. CCA Ecological Journal **2**, 130-133.

- **Schwarzenberger, F., Walzer, C., Tomasova, K., Vahala, J., Meister, J., Goodrowe, K. L., Zima, J., Strauß, G., Lynch, M. (1998):** Faecal progesterone metabolite analysis for non-invasive monitoring of reproductive function in the white rhinoceros (*Ceratotherium simum*). *Animal Reproduction Science* **53**, 173-190.
- **Suchomel, J. (2002):** Nejistý osud nosorožce sumaterského. *Živa* **3**, 133-135.
- **Špínar, Z. V. (1984):** Paleontologie obratlovců. Praha: Academia.
- **Tomášová, K. (1999):** 7 let koordinace evropského chovu nosorožců širokohubých. In: Výroční zpráva zoologické zahrady Dvůr Králové, pp. 173-183.
- **Tomášová, K. (2004a):** Deborah. In: Výroční zpráva zoologické zahrady Dvůr Králové, pp. 297-302.
- **Tomášová, K. (2004b):** Nosorožci. In: Výroční zpráva zoologické zahrady Dvůr Králové, pp. 204-209.
- **Veselovský, Z. (1976):** Hlasy džungle. Praha: Orbis.
- **Veselovský, Z. (2005):** Etologie: biologie chování zvířat. Praha: Academia.

- Internet 1: A taxonomy of perissodactyls
<http://savci.upol.cz/lichokop.htm>
- Internet 2: *Dicerorhinus sumatrensis sumatrensis*
<http://www.redlist.org/search/details.php?species=6556>
- Internet 3: *Dicerorhinus sumatrensis harrissoni*
<http://www.redlist.org/search/details.php?species=6555>
- Internet 4: *Dicerorhinus sumatrensis lasiotis*
<http://www.redlist.org/search/details.php?species=6554>
- Internet 5: *Rhinoceros sondaicus sondaicus*
<http://www.redlist.org/search/details.php?species=19497>
- Internet 6: *Rhinoceros sondaicus annamiticus*
<http://www.redlist.org/search/details.php?species=19498>
- Internet 7: *Diceros bicornis longipes*
<http://www.redlist.org/search/details.php?species=39319>
- Internet 8: A population size of rhinos in nature and in captivity
<http://www.rhinos-irf.org/rhinoinformation/populationtable.htm>
- Internet 9: The Indian rhinoceros
<http://www.rhinos-irf.org/rhinoinformation/indianrhino/index.htm>

- Internet 10: The Javan rhinoceros
<http://www.rhinos-irf.org/rhinoinformation/javanrhino/index.htm>
- Internet 11: *Rhinoceros sondaicus sondaicus*
<http://www.rhinos-irf.org/rhinoinformation/javanrhino/subspecies/indonesian.htm>
- Internet 12: *Rhinoceros sondaicus annamiticus*
<http://www.rhinos-irf.org/rhinoinformation/javanrhino/subspecies/vietnamese.htm>
- Internet 13: The White rhinoceros
<http://www.rhinos-irf.org/rhinoinformation/whiterhino/index.htm>
- Internet 14: Garamba National Park
<http://sea.unep-wcmc.org/sites/wh/garamba.html>
- Internet 15: European Endangered Species Breeding Programme (EEP) for white rhinoceros
<http://www.wreep.net>

Appendix

Appendix A – conditions of the breeding

In summer season, feeding of rhinoceroses comprises ZOO C feeding mixture (1.9 kg per animal), a roll, 1/2 of a spoon of mineral salt lick, germinated corn (1 kg per animal; if it can't be provided, the animals are fed with ZOO C mixture – 2.5 kg per animal), grass and hay as supplementation of feeding (minimum of 8 kg per animal).

In winter season, feeding consists of hay, ZOO C mixture (2.6 kg per animal), dried germinated seeds (1 l per animal), 1/2 of a spoon of mineral salt lick, carrot (2 kg per animal), 1/2 of a loaf of bread, a roll, germinated corn (1 kg per animal; if it can't be provided, the animals are fed with ZOO C mixture – 2.5 kg per animal) and of a mixture with ascorbic acid (1 l per animal three times a week, every third week is a month gap).

A plan of rhinos' enclosure is shown in figure 15.

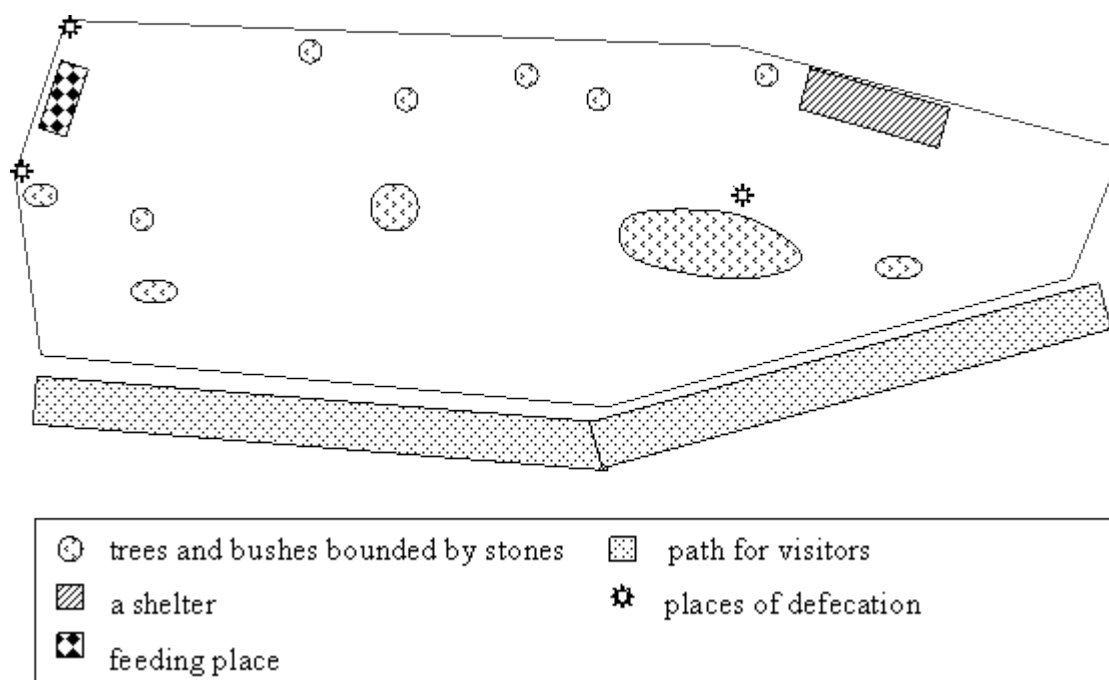


Fig. 15: A plan of enclosure of white rhinoceroses in ZOO Dvůr Králové; an enclosure size about 3000 m²

Appendix B – veterinary report and status in the herd in the years 2001-2005

The following data were gathered from notes of rhino keepers, if it is not written in a different way.

In the year 2001, a herd comprised a bull SAÚT and cows NESÁRÍ, NASI and NABIRÉ. Cow NÁJIN with her daughter FATU were separated out of the herd, bull SUNI lived alone. In April 2001, NÁJIN had clenched with her horn into a barrier and she broke off her horn, injure was treated by Genciána. The horn weighed 10.35 kg. NÁJIN and FATU were joined to the herd in July. At the beginning of October, NESÁRÍ had problems with walking; she badly treaded fully on foot. She was treated by feeding of mixture with ascorbic acid two times a day and by giving a bigger amount of bedding into her box according to a recommendation of MVDr. Váhala. NESÁRÍ was separated out of the herd.

In range from January to March 2002, hormone implants Deslorelin (it functions about 6-8 months) were injected to a skin plica next to the rectum of cows NESÁRÍ, NASI and NABIRÉ to treat recognized pathological findings in reproductive organs (see Hermes *et al.* 2006). These implants stopped ovarian activity to suppress cysts on ovaries. After six months, an ultrasound examination was carried out in these females, which demonstrated a reduction of cysts (Tomášová, *in verb.*).

In the period from January 29th to February 17th 2003, feeding of a regenerative articulation medicaments Chondro Nutri Horse with chondroitinsulfat (12 pills a day) to NESÁRÍ and SAÚT started. Regenerative articulation medicaments (Chondro Nutri Horse, GelaPony Arthro, GelaPony Fast and arthral nutrition Orling) were fed in turns to NESÁRÍ and NABIRÉ with small intervals until the year 2005. NESÁRÍ was socialized with SUNI on May 26th 2003 and they built another breeding group. The new situation combined with the treatment led to the improvement of NESÁRÍ'S general condition.

In January 2004, NASI was also fed with Chondro Nutri Horse (12 pills a day).

On May 4th 2005, NESÁRÍ was associated with other cows and SUNI was joined to them on June 7th. At days 14.-17. August, NABIRÉ had problems with walking and together with NASI, they were separated out of the herd. On 21st August, NESÁRÍ was taken out of the herd because of cold nights and her problems with articulations. From September 1st, NESÁRÍ, NABIRÉ and NASI were fed with liquid shark cartilage (1 dcl per animal). At the

end of October, all rhinoceros had a cold and were treated with the mixture with ascorbic acid (1 l per animal per day).

In November, NESÁRÍ had auricular problems and in days 29.11.-12.12., a mixture of two ampoules of an antibiotic Chronicin with a bottle of a medicament Otopet were spattered in her ears 2-3 times a day. In December 13.-19., she was treated with mixture of medicaments Surolan and Otopet. After this therapy, NESÁRÍ'S troubles disappeared.

A white effusion from vagina, sometimes bloody, occurred in NASI in the years 2001-2005.

Appendix C – photo documentation



Fig. 16: FATU is rubbing her head against NESÁRÍ



Fig. 17: FATU is rubbing her horn against NASI



Fig. 18: FATU is placing her head on NESÁRÍ'S back



Fig. 19: NASI is pressing her hind part to NABIRÉ



Fig. 20: FATU is following NÁJIN



Fig. 21: Lying side by side (FATU and NÁJIN)



Fig. 22: Standing side by side (NÁJIN and FATU)



Fig. 23: A common rest of NASI, NESÁRÍ and NABIRÉ



Fig. 24: Cows (mainly NASI) are threatening SUNI with snort and are facing him because of occupation of their favourite resting place



Fig. 25: Spray-urination of the bull



Fig. 26: Scrape marking of the bull



Fig. 27: Play horn wrestling between SUNI (on the left side) and NASI (on the right side)



Fig. 28: „Flehmen” posture of the bull after olfactory control of urine



Fig. 29: Play horn wrestling between SUNI and FATU on July 22nd, when the bull was sexually interested in her



Fig. 30: SUNI is approaching FATU with raised head and curled tail on day of sexual interest in her



Fig. 31: SUNI is placing his head on the rump of FATU, but in these cases, she sought proximity of her mother (on July 24th)



Fig. 32: SUNI is lying side by side with NESÁRÍ on day of sexual interest in her, on August 17th



Fig. 33: Feeding behaviour – cows are standing side by side, a bull is standing facing them

