Breeding the white rhinoceros at Dvur Kralove Zoo

Dana Holeckova

The white or square-lipped rhinoceros
Ceratotherium simum
(Burchell, 1817)

Taxonomy:

Class:	Mammals *(Mammalia)*
Order:	Odd-toed ungulates (*Perissodactyla*)
Family:	Rhinoceroses (*Rhinocerotidae*)

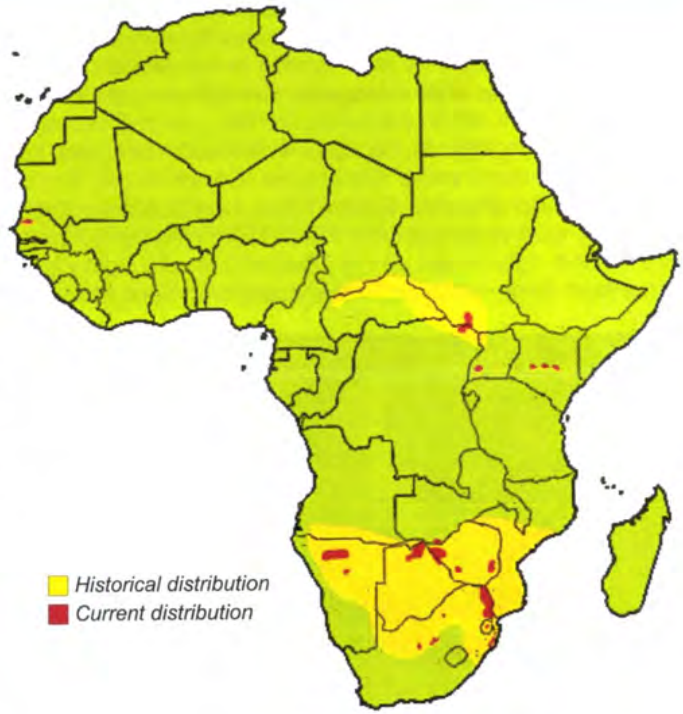
The northern white rhino Sudan in Kenya, 2009 (dh)

Distribution

Originally, the white rhinoceros inhabited two separate ranges, from which the northern territory included grassland regions of Central Africa west of the River Nile, in particular Sudan, Chad, Zaire (now Democratic Republic of Congo), Central African Republic and Uganda, while the other part covered the southern portion of Africa south of the Zambezi River with the exception of desert areas, i.e. Angola, Botswana, Zimbabwe, Mozambique, Namibia, Swaziland and the Republic of South Africa. The northern subspecies is now almost extinct in the wild; the southern form was on the brink of extinction around 1900. Once the southern white rhino population was on the increase, reintroductions and introductions took place from SA into both historical range countries as well as those out of range, where the former comprised Botswana, Zimbabwe, Namibia, Swaziland and Mozambique, while the latter covered Zambia, Kenya, Uganda (TRENSE 1989; TENYWA 2009) and Senegal.

Biological data (GOLTENBOTH *et al.* 1995, PENNY 1988)

Weight:	1,700-2,400 kg.
Wither height:	150-185 cm
Horn length:	The anterior horn is longer in females compared to males (MILLS and HES 1997), measuring up to 101 cm (the greatest length as measured in a male of the northern subspecies: 101.6 cm - LANG 1920), or even up to 201 cm



The range of the white rhinoceros
(according to EMSLIE and BROOKS 1999)

	(southern subspecies); the posterior horn up to 95 cm; record measures: 297.5 cm for the front horn and 279 cm for the rear horn (TRENSE 1989).
Body length incl. head:	360-420 m
Oestrus cycle:	20-45 days (SCHWARZENBERGER 1995b)
Gestation period:	480-514 (548) days; normally 490 days
Number of young:	1
Birth weight:	35-80 kg, 50 kg on average
Eyes opening:	At birth
Nursing period:	12 months, in some cases only 6, in other cases even longer (maximum is 2 years)
Sexual maturity:	Males 7-8 years (however, males become dominant only when 10-12 years old); females 6-7 years
Reproductive age:	Females in the wild 30-35 years, males up to 40 years; females give birth every 2-2.5 (3) years
Longevity:	40-50 years in the wild; 35-40 years in captivity, exceptionally even 48 years.

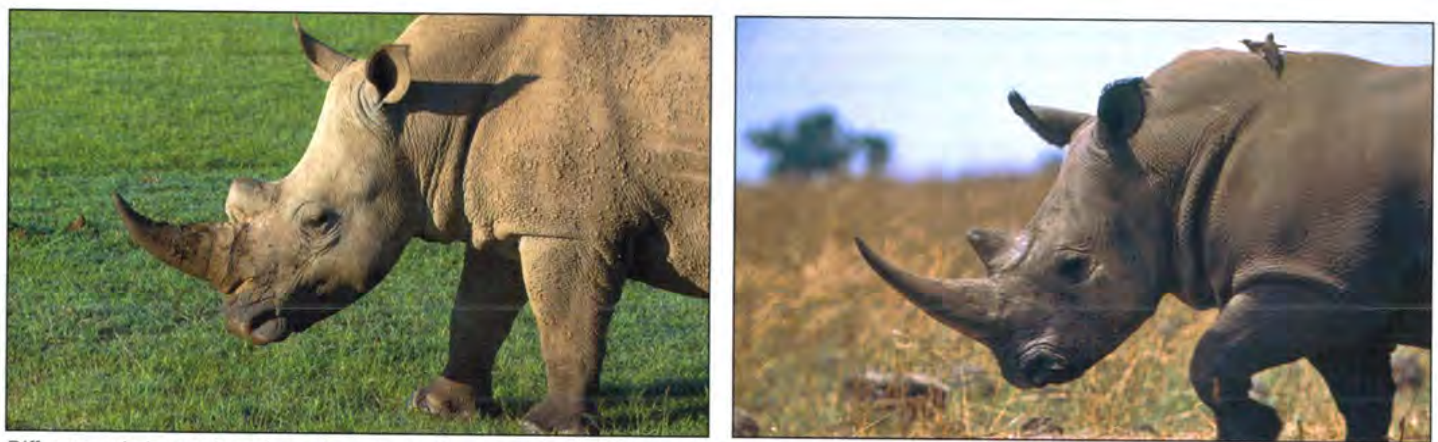
Subspecies

The species is called white as the Dutch word 'wijde' (wide) was misconstrued in English (white). However, in terms of colour, no difference exists between the species, as both are grey in tone.

The discovery of the southern subspecies and the species generally happened in Kimberley, South Africa, in 1817, with the northern form identified in Uganda only in 1907 (PENNY 1988) and described in 1908 (ANDERA 1999), although the latter was observed by Major Gibbons as early as 1900 (HELLER 1913). The two range areas were 1,930 km apart (LANG 1920). Given that both populations have been isolated for 1.8 million years, as well as considering the clear morphological differences found especially on the skull, but also in the number of vertebrae (HELLER 1913), each subspecies should rather be considered a separate species (ROBOWSKI pers. comm.). In prehistoric times, they were widely distributed throughout the southern and eastern regions of Africa (MILLS and HES 1997). Besides climate change during the Ice Age, hunting by humans annihilated the white rhino elsewhere (EMSLIE and BROOKS 1999).

- The **southern white rhinoceros** (*Ceratotherium simum simum*) is currently the most numerous rhino subspecies widespread throughout the southern African sub-region, and has been successfully introduced even into some out-of-range countries of Eastern and Western Africa (Kenya, Uganda, Senegal); reintroduction took place in Botswana, Namibia, Zimbabwe and Swaziland (MILLS and HES 1997).
- The **northern white rhinoceros** (*Ceratotherium simum cottoni*) used to occur in five countries of Central Africa west of the River Nile - Uganda, Sudan, Chad, Central African Republic and the Democratic Republic of Congo (former Zaire). In Uganda, they were exterminated in 1982 (TENYWA 2009). At present, there are perhaps a few surviving animals in southern Sudan.

Visually, both subspecies do not differ very greatly from each other, with the most visible difference being the shorter facial part in the northern form, which additionally seems to have hairier edges of ears.



Differences between the subspecies - the southern form to the left (dh), the northern form to the right (agp)


The southern (left) and the northern white rhino subspecies (right) (dh)

Habitat

The native habitat of the white rhino consists of open grasslands - steppes and a shrubby savannah with access to water, with medium-length to short grass cover being the most preferred parts.


The southern form of the white rhino, Kimberley, SA, 2008 (left); the same in Kruger NP, SA, 1998 (dh)

Diet

White rhinos are herbivore grazers that eat grass and are the largest existing pure grazers out of all animal species. with lips adapted to make up a sort of bar (hence the alternative name square-lipped). It usually drinks twice a day, but is able to withstand two to four days without water (ESTES 1990).

The white rhino in Garamba NP, The Democratic Republic of Congo

The northern form of the white rhino in Garamba NP, 2000 (fhs)

Northern white rhinos in Garamba NP (agp)

The white rhino in Garamba NP, The Democratic Republic of Congo

Rangers in Garamba NP: encountering a rhino (agp)

A. Puttger-Conradt in Garamba NP (left); northern white rhino skulls (right) (agp)

A northern white rhino habitat in Garamba NP (agp)

Native sites of the southern white rhinoceros in southern Africa

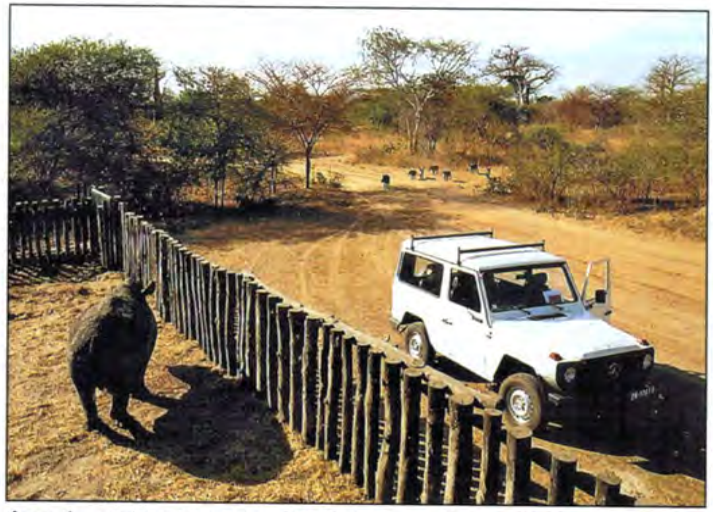

Southern white rhinos in Kimberley, 2008 (left) and Pilanesberg (right), 1998 (dh)


As regards Swaziland, the southern white rhino was successfully reintroduced into the country - Mkhaya Game Reserve and a boma, 2007. (dh)


Southern white rhinos in Swaziland, 2008 (zc)

Kenya - an out-of-range country for southern white rhinoceroses

The southern white rhinoceros was introduced into Kenya, which is an out-of-range country for the subspecies; a picture from Ol Pejeta Conservancy. (dh)



A southern white rhinoceros, Bandia Reserve, Senegal (dh)

A young southern white rhino playing, Ol Pejeta, Kenya (dh)

Ecology

The white rhino is more territorial than the black rhino. They can run at speeds up to 40 km/h over a short distance (PENNY 1988). Feeding takes about a half of the active time of the white rhino, taking place both day and night. In the middle of the day, white rhinos are resting in the shade or inside pot-holes. They usually drink at dawn or shortly after dark. If moving over long distances in times of drought, then they drink every 3 to 4 days.

White rhinos are partly social animals. Females and juveniles live rarely a solitary life, usually associating in pairs, when the female is followed by her most recent calf. Adult females with no calves will tolerate one or multiple juveniles; two adult females can also be seen together when without offspring. Unlike females, adult males live separately (ESTES, 1991).

Dominant males occupy exclusive territories, which they share with one or several subordinate males. The territory size depends on the quality and quantity of food and usually varies between 2 and 5 square km. Only dominant bulls demarcate their territory by urine and faeces at the border of their home range and along their paths. Large piles of dung indicate the border of the territory. Outside its home range, the dominant male acts as a subordinate animal, travelling to water and back without urine-marking the area through which it passes outside its territory.

Adult females are found alone only with their recent calf, while juveniles form groups of 3-10 animals. At the same time, the home range of a female covers 6-20 sq km and may overlap with territories of several males.

Males reach sexual maturity at 10-12 years of age, while females at 5-7 years. Oestrus takes place at monthly intervals throughout the year, while the majority of calves are born in the dry season (MILLS and HES 1997). The gestation period lasts 16 months. Beginning to graze from 2 months of age, calves are nursed by cows until one year of age (ESTES 1991).

Females enter heat around 6-12 months after the birth of the previous young. Territorial males seek to retain the female in their home ranges 5-10 days before oestrus, as generally only the dominant male will mate. The mating as such lasts 20 minutes or longer (OWEN-SMITH in MILLS and HES 1997).

Females are pregnant about 18 months. Normally, the calf will walk in front of the female (ESTES 1991) and remains with its mother 2 to 3 years. The female leaves her most recent calf shortly before the birth, living only with her new young after the delivery. Once a juvenile rhino is driven off from his mother, it tends to associate with other subadult individuals or joins an adult female without a calf, which is typical for the white rhinoceros (PENNY 1988).

When they reach adultship, white rhinos have no natural enemies, but young may be endangered by young lions and spotted hyenas (ESTES 1991).

An oestrous female with a young tracked by three males - Lewa (dh)

An oestrous female with a young accompanied by a dominant male, both being tracked by another male from a distance - Ol Pejeta, Kenya (dh)

Juvenile males live together - Lewa. (dh)

An adult female usually stays with her most recent calf - Ol Pejeta, Kenya. (dh)

Conservation

In the list of the most protected species under CITES Appendix I of the Washington Convention, under which the trade in live specimens and their derivatives (including horn) is prohibited, only the northern subspecies was included in 1975, followed by the southern subspecies in 1977.
Population growth as a result of protection of the southern form in South Africa and successful reintroduction into other countries was the reason that in 1994 the southern subspecies was deleted from Appendix I and included in Appendix II of CITES, which has allowed for trade in live specimens, including the export of trophies obtained from legally hunted animals (EMSLIE and BROOKS 1999).
According to the IUCN Red List, the northern subspecies nears extinction and the species as such is classified as near threatened, with its population rising (IUCN Red List 2009).
Today, the white rhino is threatened almost exclusively by poaching, which has driven the northern subspecies to the very brink of extinction, devastating currently the southern form population in Zimbabwe (IRF).
Despite the internationally organised protection efforts, the demand for horn is not diminishing in both Yemen and particularly in China and Vietnam, where the powder horn is used in traditional medicine. Price for 1 kg of horn is USD 10,000 in South Africa and even EUR 30,000 in China.

Conservation measures

Protection of both species is monitored by the African Rhino Specialist Group (AfRSG) to the IUCN. This organization has been publishing statistics on the occurrence by subspecies and country every 2 years since the early 1990s.

The southern white rhinoceros (*Ceratotherium simum simum)*
In 1892, the southern subspecies came near extinction, as only a few individuals remained in the valley of the River Umfolozi in South Africa. The valley was declared a game reserve by the South African government in 1897. Since then, the numbers started to rise, with about 30 animals living in 1930. Until 1960, the numbers increased to 1,500 rhinos living in the valley of the River Umfolozi as well as in the neighbouring Hluhluwe Reserve. At the same time, the only wild population in 1960 existed in South Africa (EMSLIE 2005). To avoid the risk of devastating the habitat by excessive grazing, about 500 animals were brought with time to other parks and zoos around the world (KLOS 1981). A breeding herd was established in Whipsnade, UK, managed by the Zoological Society of London (PENNY 1988).
In 1984, more than 3,300 southern white rhinos lived in South Africa, and the capacity available at those sites was used up. Consequently, they permitted in the Pilanesberg National Park to shoot up to 10 rhinos per year by trophy hunters, where the price of each was USD 10,000 (PENNY 1988).
By the end of 2003, i.e. roughly 100 years after the start of the strict protection of the remaining wild population of the southern form, there lived 11,320 animals in 379 populations in the wild, which is therefore one of the biggest conservation successes (EMSLIE 2005). According to recent data (EMSLIE *et al.* 2009), the wild population of the southern form comprises about 17,500 individuals. More information about reintroduction and introduction programmes is contained in the Population development chapter.
The latest conservation activities have focused on addressing the "Zimbabwe Crisis", as in Zimbabwe poaching has increased sharply since 2008, which adversely affects the reintroduced population of white rhinos as well (*www.rhino-irf.org*).

The northern white rhinoceros (*Ceratotherium simum cottoni)*
The northern subspecies was discovered in the Belgian Congo in 1907 (PENNY 1988). At that time, this form was common in the open grassy habitats of Central and Eastern Africa, within the territories of five countries - Chad, Sudan, Uganda, Zaire (Congo) and Central African Republic (HOLECKOVA and BOBEK 2000). Unlimited killing by sports hunters and later by commercial poachers began led to its extinction in most of the range (PENNY 1988). The civil war in Congo caused a reduction of the residual population from 1,000 to about 100 individuals. In the period from 1961 to 1964, animals were captured from sites in Uganda and moved as part of protecting the remaining population into Murchison Falls National Park, Uganda, where the last individual was however seen in 1982 (TENYWA 2009), as all had been killed by poachers. In 1986, the last location counting 17 individuals remained in Garamba National Park, Zaire (former Belgian Congo, now the Democratic Republic of the Congo). An extensive project to save the species in Garamba NP was supported by the World Wildlife Fund - WWF (PENNY 1988).

As it results from the 2007 Annual Report of the African Parks Foundation (COLLET 2008), Garamba National Park was established in 1938 as one of the first national parks in Africa and lies at the northeast corner of the Democratic Republic of the Congo at Sudanese border. As this park was the last refuge of the northern white rhino and the Congolese giraffe, it was declared a UNESCO World Heritage Site in 1980.

As of 12 November 2005, Garamba NP started to be managed by the African Parks Foundation in cooperation with ICCN (Institut Congolais pour la Conservation de la Nature). In 2007, the Garamba NP population was formed of maximum four animals, with only a few direct and indirect sightings made during the year (COLLET 2008). Surveys were conducted according to FFI's information, and while in 2006-2007 traces were still found, the 2008 survey in cooperation with professional trackers from Kenya failed to locate any rhinos or signs of a rhino. Rhino occurrence was not confirmed even in the course of 2009. Surveys still continue, conducted by park staff patrols and community rangers. FFI also conducted a survey in southern Sudan, where credible reports of observation of three rhinos were received within the November 2008 expedition and further surveys are under preparation for March 2010 (Rob BRETT, pers. comm.). Despite these conservationist activities and significant amount of funds expended, northern white rhinos have found themselves at the brink of extinction in the wild.

There is an ongoing international project titled "Last Chance to Survive", jointly organised by Dvur Kralove Zoo, the Ol Pejeta Conservancy, Kenya, Fauna and Flora International, AfRSG, Back to Africa and Kenya Wildlife Service, under which 4 (2.2) individuals from Dvur Kralove Zoo were imported to Kenya on 20 December 2009 (for more details, see page 257 and *www.northernwhite-rhinolastchance.com*).

A cow with a calf (the southern form) in Ol Pejeta, Kenya, 2009 (dh)

White rhino conservation in the field: rhino translocation in Kenya

Conservation activities include dehorning using a handsaw or chain saws. (dh)

Crating a heavily sedated rhino using ropes and electric stock-whip and subsequent release at a new site (dh)

POPULATION DEVELOPMENT

The development of numbers of the two white rhino subspecies is compiled in the following table.

The abundance of the white rhinoceros in the wild (according to EMSLIE *et al.* 2007)

Population/Year	1920	1960	1970	1981	1984	1993	1999	2003	2005	2008
Southern wild	110?	1,500	2,000	3,150	3,920	5,700	8,440	11,320	14,543	17,480
Northern wild	3,000	2,250	700	100	17	31	25	10	4	4 ?
Total wild	**3,110**	**3,750**	**2,700**	**3,250**	**3,937**	**5,731**	**8,465**	**11,330**	**14,550**	**17,484**

The southern white rhinoceros *(Ceratotherium simum simum)*

Discovered as a species by Burchell in 1817, this subspecies was subsequently driven to extinction in much of the South African part of the continent. SELOUS described a rapid loss of wild populations between 1872 and 1877, as white rhinos were killed without any restrictions (PENNY 1988). At the end of the 19 and 20 century, the southern form faced the risk of total extinction, as probably 20, according to several authors (EMSLIE and BROOKS 1999), or 15 (Stevenson-Hamilton) or even only 10 (Heller) animals survived in a single wild location within the territory between the White Umfolozi and Black Umfolozi rivers (now Hluhluwe-Umfolozi Park, KwaZulu-Natal, South Africa) (LANG 1920).

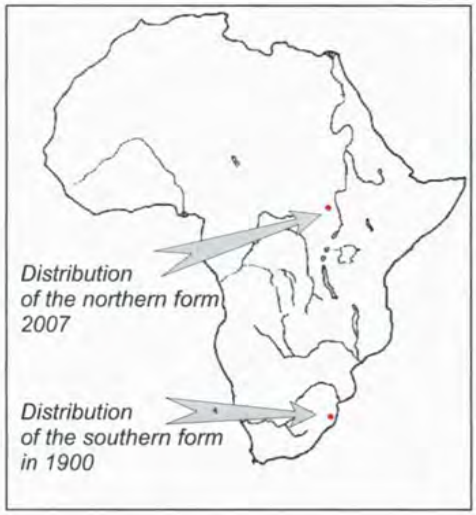
Thanks to the strict protection the population was increasing; although there was still only a single wild population remaining in Umfolozi-Natal (EMSLIE 2005) still in 1960, the southern subspecies was saved, and by 1970 its numbers had increased to 2,000 rhinos (MILLS and HES 1997). Surplus animals were successfully moved into Kruger and Pilanesberg national parks in South Africa (MILLS and HES 1997). The first major translocation of rhinos took place in 1963 and 1964, when 97 individuals were captured and transported over a distance of 650 km to Kruger National Park. By 1972, they relocated a total of 203 rhinos to the parks above, plus 1,109 rhinos were moved from the Natal park to the game reserves in southern Africa and zoological gardens or various safari parks (EMSLIE *et al.* 2009). In 1989, the first auction for the sale of rhinos to private game reserves was conducted, and by 2009, 3.5 thousand southern white rhinos from Umfolozi were donated or sold to protected areas or private game reserves; additionally, nearly 1,000 individuals had been moved from Kruger National Park since the mid-1990s (EMSLIE *et al.* 2009).

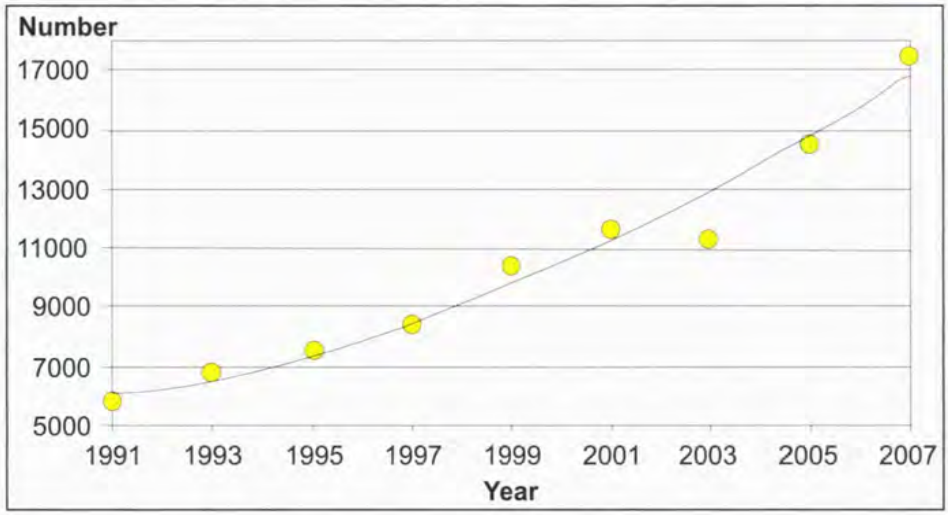
By the end of 2003, about 11,320 rhinos in 379 populations lived in the wild, which is one of the biggest conservation successes (EMSLIE 2005).

(dh)

If the population is protected, it shows annual growth of 6-10% per year (EMSLIE 2008). The progressive increase in numbers in the wild since 1991 is shown by the following chart.

The increase in wild populations of the southern form of the white rhinoceros in 1991-2007 (EMSLIE 2008)





The abundance of the southern white rhinos per African country in the period 1890-2007
(according to EMSLIE and BROOKS 1999, EMSLIE 2000, EMSLIE 2002, EMSLIE *et al.* 2007, Emslie 2009; supplemented)

Country	1895	1929	1948	1968	1984	1987	1991	1992	1993/4	1995	1997	1999	2001	2003	2005	2007
SA	20	150	550	1,800	3,234	4,137	5,057	5,297	6,376	7,095	7,913	9,754	10,988	10,536	13,521	16,273
Angola	0	0	0	0	?	0	0	0	0	0	0	0	0	0	0	0
Botswana	0	0	0	0	190	125	56	27	18	20	23	31	39	67	99	106
Ivory Coast	0	0	0	0	0	0	5	5	5	4	4	0	0	0	0	0
Kenya	0	0	0	0	33	47	57	74	87	122	137	164	170	218	234	303
Mozambique	0	0	0	0	1	0	0	0	0	0	0	2	0?	2	7	9
Namibia	0	0	0	0	70	63	80	91	98	107	141	164	170	186	293	370
Swaziland	0	0	0	0	60	80	60	46	33	41	50	50	50	61	75	89
Zambia	0	0	0	0	10	6	0	0	6	5	4	5	5	3	2	1
Zimbabwe	0	0	0	0	200	208	250	249	134	138	167	208	218	250	308	341
Senegal	0	0	0	0	0	0	0	0	0	0	0	0	2	2?	2?	2?
Uganda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6
TOTAL	20	150	550	1,800	3,800	4,665	5,565	5,790	6,760	7,530	8,440	10,377	11,640	11,320	14,543	17,500
Total no of countries	1	1	1	1	9	7	7	7	8	8	8	8	9	9	10	10

The Republic of South Africa
In South Africa, where the southern subspecies was described in the Kimberley region in 1895, a small number survived in a single park - Hluhluwe-Umfolozi Park, KwaZulu-Natal, where the only wild population lived up to 1960s, thanks to strict protection (EMSLIE and BROOKS 1999).
Subsequently, animals were exported to both other countries and zoological parks (KLOS 1981). In the period from 1967 to 1981, translocation of 2,648 rhinos occurred, which by 1996 had increased to a total of 4,350 individuals moved. In terms of genetics, all southern white rhinos' origin is the Umfolozi population (EMSLIE and BROOKS 1999). Despite exports of hundreds of animals to both zoos (KLOS 1981) and other African countries, the wild population in South Africa is on the increase; in 2007, it comprised more than 16 thousand animals (EMSLIE 2009). At the same time, a limited number of southern white rhinos are hunted by trophy hunters annually. Unfortunately, poaching organised from China and Vietnam, outfitted with modern weapons and helicopters, has recently occurred even in South Africa (CURRIE pers. comm.). From January until the end of November 2009, 100 rhinos were poached in South Africa, with additional 150 animals legally shot by trophy hunters (EUSTAGE 2009).

Angola
Angola used to be a part of the historical range of the southern form, which however became extinct in this territory in 1895. In the 1980s, reintroduction activities took place in the area, but the animals were wiped by poachers (EMSLIE and BROOKS 1999).

Botswana
In Botswana, the southern form became extinct during the 19 century. Since the late 1960s until 1981, 94 individuals were reintroduced and the population increased to 190 rhinos by 1984. However, intense poaching reduced the populations to 17-27 animals by 1992. Gradually, several holding facilities were established where the remaining animals lived under protection, so in 1997 23 animals lived in Botswana (EMSLIE and BROOKS 1999). In 1999, Botswana hosted 31 rhinos, which by 2001 increased to 39 and by 2007 to 106 animals (EMSLIE 2009).

Mozambique
The historical range of the southern form was reaching as far as Mozambique before 1895. In 1972, 83 rhinos were reintroduced to two sites. As the entire population had been wiped by poachers by 1987, the white rhino already became extinct twice in the country (EMSLIE and BROOKS 1999). The next reintroduction attempt took place around 1999, and in 2007, 9 rhinos lived in Mozambique (EMSLIE 2009).

Namibia
The original Namibia's population of the southern form was extinct, but recovered through reintroduction. In 1993, there were 99 animals in one national park and six private wildlife reserves. By 1999, the numbers increased to 141 individuals in ten populations (EMSLIE and BROOKS 1999). The stock continues to rise, formed of 370 rhinos in 2007 (EMSLIE 2009).

Swaziland
The southern form was reintroduced to Swaziland in the early 1980s, with 80 rhinos living here in 1987. As a result of poaching, 50 rhinos were killed in 1990-1992. Since December 1992, when the protection was improved, no rhino has been killed. Thanks to the effective protection, the numbers have gradually increased, so 50 animals ranged in Swaziland in 1997 (EMSLIE and BROOKS 1999) and already 89 rhinos lived in the country in 2007 (EMSLIE 2009). This can be attributed to the adoption of the law under which poaching is punishable by death, promoted with the help of Ted Reilly, the legendary defender of Swaziland's wildlife (HOLECKOVA 2008).

Zimbabwe
With the original population wiped out in 19 century, a new stock of southern white rhinos was reintroduced from South Africa in the 1970s and 1980s. In 1984, the wild population consisted of 200 individuals, and even 250 animals in 1991. Subsequently, poaching reduced the numbers to 134 in 1993-1994. In 1997, Zimbabwe had 167 white rhinos, and over a third (35%) of them was a private property (EMSLIE and BROOKS 1999). In 2007, there were 341 southern whites (EMSLIE 2009). However, there has been a significant increase in poaching since that time, which is referred to "Zimbabwe Crisis", as dozens of both black and white rhinos have been killed (*www.rhino-irf.org*).

Hunting rhinos in Swaziland was stopped by the change in the law, helped to promote by the legendary conservationist Ted Reilly (driving) - Mkhaya Reserve, 2007 (dh)

Southern white rhinos in the Mkhaya Reserve, Swaziland, 2007 (dh)

Signs of poachers in Zimbabwe (pr)

Zambia

It is believed that the historical range of the southern white rhino probably did not extend beyond the Zambezi River so the recent introduction of the southern white rhino to Zambia cannot be considered reintroduction. Small numbers were imported in the early 1980s, and in 1984, Zambia had ten southern white rhinos, however, by 1991, all the introduced animals had been poached. In 1993, six more southern white rhinos were introduced into a single location, at which six animals still lived in 1997 (EMSLIE and BROOKS 1999). In 2007, Zambia recorded solely one southern white rhino (EMSLIE 2009).

Kenya

Kenya was out of the historical range of the white rhino in modern times. A small population of the southern form counting 33 white rhinos was introduced in Kenya in 1984, and had reached 137 by 1997, with the majority of these being in private ownership (EMSLIE and BROOKS 1999), especially in the Lewa, Solio and Ol Pejeta conservancies. In 2007, Kenya already had 303 white rhinos (EMSLIE 2009).

The white rhino never lived in Kenya and Tanzania in modern times, although they did a few thousand years ago, as evidenced by the excavation of a skull in Olduvai Gorge, Tanzania (left). (dh) The southern form in Lewa Conservancy (right) (dh)

Uganda

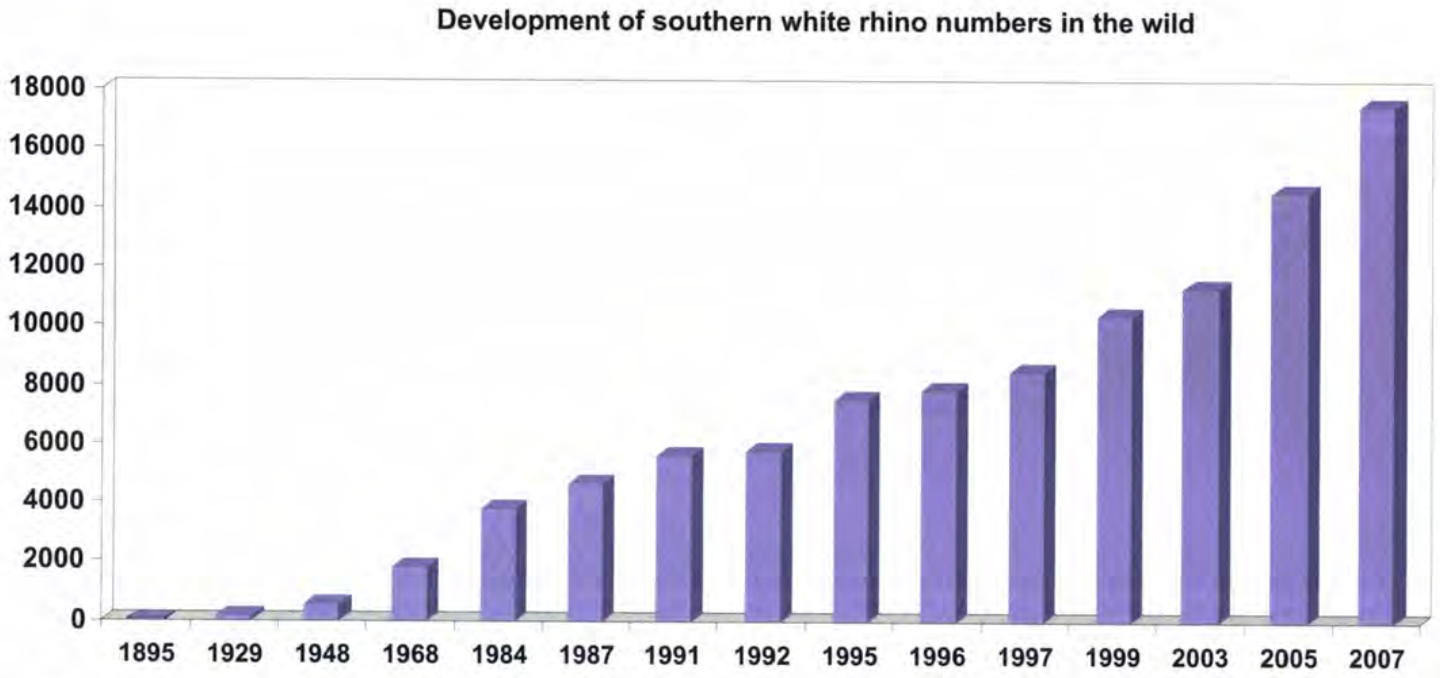
Uganda's native subspecies is the northern form, which was wiped out around 1980. Six (3.3) animals of the southern form were imported into the breeding facility in Nakasongola. Here they produced their first calf in June 2009; this animal was the first baby rhino in the country after a period of over 20 years (TENYWA 2009). Additional 2 (1.1) individuals aged 14 and 15 years are kept since 2001 in the UWEC Zoo, Entebe, to which they had arrived from Solio Ranch, Kenya (SEGUYA pers. comm., TENYWA 2009). A total of nine individuals lived in Uganda in 2009 (TENYWA 2009).

A pair of the southern form living at UWEC Zoo, Entebe, Uganda - 2009 (dh)

Development of southern white rhino numbers since 1895

(FOOSE 1993, HOLECKOVA and BOBEK 2000, EMSLIE *et al.* 2007, MILLIKEN *et al.* 2009)

Year	1895	1929	1948	1968	1984	1987	1991	1997	1999	2003	2005	2007
Numbers	20 ?	150	550	1,800	3,800	4,665	5,565	8,440	10,377	11,320	14,540	17,500



The northern white rhinoceros (*Ceratotherium simum cottoni)*

The northern white rhinoceros occurred in five countries, where it was more common than the southern subspecies still in 1960, with the latter living only in a single population in South Africa at that time. As a result of poaching since the early 1950s until the late 1960s, the population was severely decimated, with only some 29 wild individuals left by 1984 (PENNY 1988).

In 1920, the population of this subspecies was still estimated to contain 2-3 thousand animals; discussions concerning the need to protect the northern white rhino in game reserves and the possibility of trapping animals and importing them into captivity already began at that time (LANG 1920). In 1938, Garamba National Park was founded in Congo, where there were 100 individuals. Due to conservation measures, this population had enlarged by 1961 to 1,000-1,300 individuals. As a result of a civil war, the population declined to 100 animals in the early 1960s. By 1976, the numbers increased to 490 +/- 270 rhinos (i.e. 220 to 760 animals). Continued poaching, with even employees of the park involved, led to a decline to 13-20 individuals and 14 individuals in 1983 and 1984, respectively (PUTTGER-CONRADT 2008). Most animals were killed in just 6 years in the period 1980-1986, when the initial population numbered about 821 individuals, which eventually dropped to only 17 animals (PENNY 1988). Subsequently, a conservation project started with the support of many international institutions, granted in 1984-1995 with a total of USD 3,078,686, which in particular came from WWF, FZS, UNESCO, and the IRF. The population reached its peak in 1992, when it consisted of 32 animals. In 1995, the group contained only four breeding females, following the natural death of the fifth one (Smith *et al.* 1995). Without the activities of the German zoologist Armin Puttger-Conradt, the northern white rhino would have been probably poached already by 1990 (PÜTTGER-CONRADT 2008, in: HOLECKOVA 2008).

In the 1990s, two civil wars followed. During the first war, in 1997, soldiers and rhino poachers killed several rhinos, the park rangers were disarmed and even did not receive wages a few months. During the second war, which began in August 1998, rangers in the park still continued the work, but did not have enough vehicles or even a good radio connection. The local authorities were well-disposed to rhino protection and regular financial support of the International Rhino Foundation (IRF), as well as supplies and medicines from the World Wildlife Fund (WWF) were successfully managed for Garamba. Aerial census in July and August 2000 found 25 animals (HOLECKOVA 2001).

Unfortunately, the status got worse and the population dropped to about 10 animals. At that time, it was agreed that five animals would be captured and moved to the Ol Pejeta Conservancy, Kenya, where they had built bomas for the rhinos. The action above failed due to ungrounded scandalizing of the conservation activities in the Congolese press, with the rhinos left to the mercy of poachers, as both foreign workers and park rangers were no longer safe in the territory of Garamba NP (HOLECKOVA 2008).
Currently, this form of a rhinoceros stands on the brink of extinction, as the 2008 and 2009 efforts to locate any individuals in Garamba National Park failed. Sporadic reports of 2 to 3 animals came periodically only from southern Sudan (VIGNE pers. comm.).
As part of the Last Chance to Survive project, 4 (2.2) individuals were imported from Dvur Kralove Zoo to Kenya in December 2009 (see more details on page 257 and *www.northernwhiterhinolastchance.com*).

Chad
The northern form once ranged as far as southern Chad; by the 1960s, there was evidence of only a few animals and by 1983, there has been no evidence (EMSLIE and BROOKS 1999).

Democratic Republic of the Congo (formerly Zaire)
The historical range in the former Belgian Congo comprised the north-eastern parts of the country, where the only surviving population remained in Garamba National Park on the northern border with Sudan. In 1938, there lived about 200 northern white rhinos in the park, which increased to between 1,000 and 1,300 animals by 1960. Once the Congo achieved independence from Belgium, a civil war broke out (1960-1963), and most of the rhino in Garamba NP were killed by poachers so the Garamba's rhino population fell to approximately 100-200 animals by 1965. In 1976, the population in Garamba NP was estimated at 490 individuals (+/- 270). In eight following years, the majority of them were killed, with last 15 surviving animals in 1984, which subsequently increased to 31 rhinos by 1995. In 1997, another civil war broke out, Zaire was declared the Democratic Republic of the Congo and poaching in the park increased. In 1998, at least 25 rhinos lived in Garamba, indicating that the rhino population had not been so much affected by poachers as those of elephants and buffaloes. The outbreak of another civil war in 1998 caused further problems to the northern white rhino status (EMSLIE and BROOKS 1999).
During the first war in 1997, soldiers and rhino poachers killed several rhinos, the park rangers were disarmed and even did not receive wages a few months. During the second war, which began in August 1998, rangers in the park still continued the work despite the consultants left, lacking enough vehicles and even a good radio connection. Given that the local authorities were in favour with rhino protection, Garamba could receive regular financial support from the International Rhino Foundation (IRF), as well as supplies and medicines from the World Wildlife Fund (WWF). With just two aerial counts, in 1998 and 2000, three calves under 6 months were discovered during the latter. Total 2000 population was formed from 25 (12.11.2) animals (HOLECKOVA 2001).

The population of northern white rhinos in Garamba NP in 2000 (processed according to 2000 IRF data)

	Males	Females	Sex not determined	Total
Number of adults	6	7	-	13
Number of subadults	2	3	-	5
Number of juveniles	4	1	2	7
Total	**12**	11	2	**25**

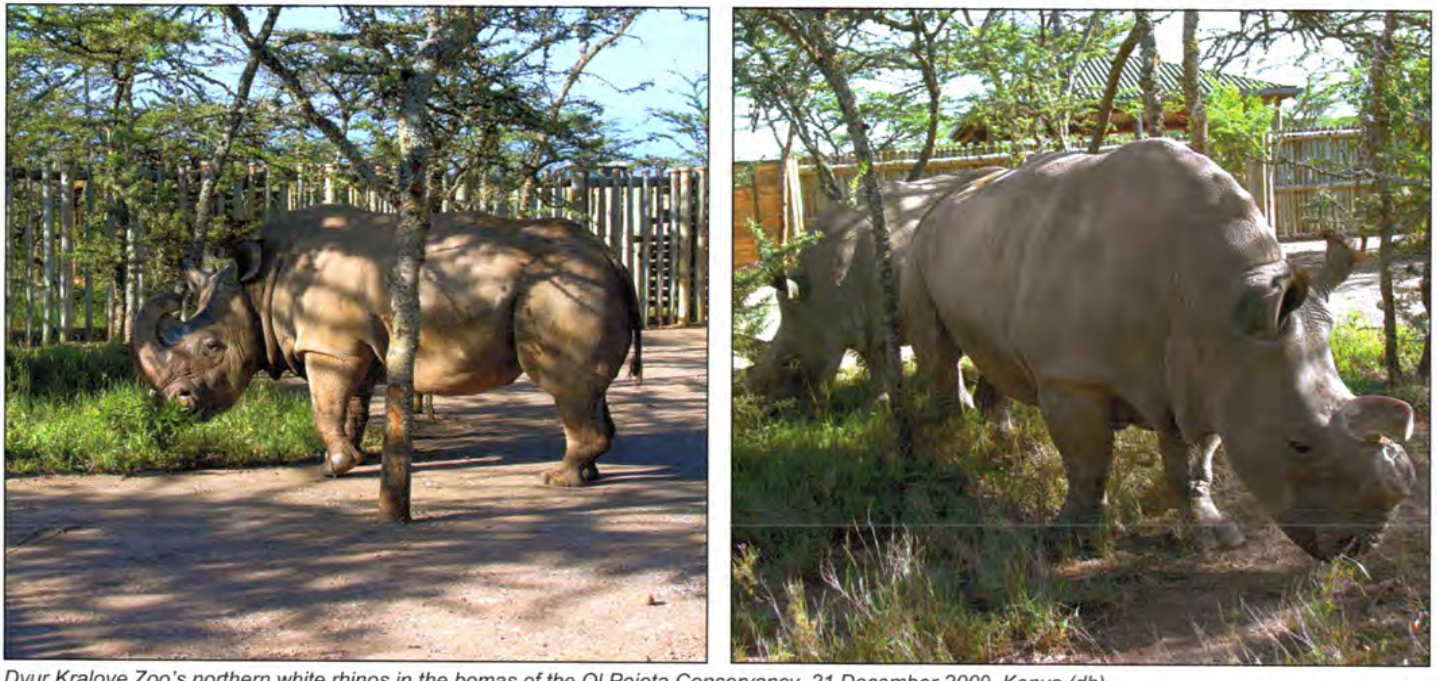
Sadly, the population continued to decline, and in 2007, Garamba was estimated to have four last rhinos (EMSLIE 2009). However, none was found again throughout 2009 (Rob BRETT, pers. comm.).

Uganda
The northern form once ranged over parts of north-western Uganda. In the 1960s, there were still 80 animals living there; however, the subspecies is thought to be nationally extinct as of 1982 (EMSLIE and BROOKS 1999). The last individual was seen in the territory of Murchison Falls in 1982 (TENYWA 2009).

Central African Republic
The original range of the northern form was extending as far as the eastern part of the Central African Republic. Only a few animals were recorded in the period from 1960 to 1983; by 1984, the white rhino was exterminated in the country (EMSLIE and BROOKS 1999).

Sudan
The northern form once ranged over south-western Sudan, with estimated 1,000 animals still roaming the country back in 1960. By 1971, only some 400 animals were left, while ten years later, there were less than 300 rhinos and in 1983, less than 50 individuals remained. Since 1984, there have been unconfirmed reports of a few rhinos in southern areas in the Shambe region (EMSLIE and BROOKS 1999). The latest report on the observation of three animals from a helicopter comes from the end of December 2009 (CURRIE pers. comm.).

Kenya
In Kenya, white rhinos never lived in the modern times. The Ol Pejeta Conservancy, a private reserve in Kenya, was selected as a site for planned translocation of five northern white rhinoceroses from Garamba National Park, the Democratic Republic of the Congo. Originally, ten remaining animals were considered for the move. However, this activity, which might have saved the last surviving animals from Garamba failed, disapproved by the Congolese authorities. In December 2009, 4 (2.2) last individuals with breeding potential were imported to the same place from captivity, from Dvur Kralove Zoo, within the project named Last Chance to Survive (for more details, please see page 257 and *www.northernwhiterhinolastchance.com*).



Dvur Kralove Zoo's northern white rhinos in the bomas of the Ol Pejeta Conservancy, 21 December 2009, Kenya (dh)

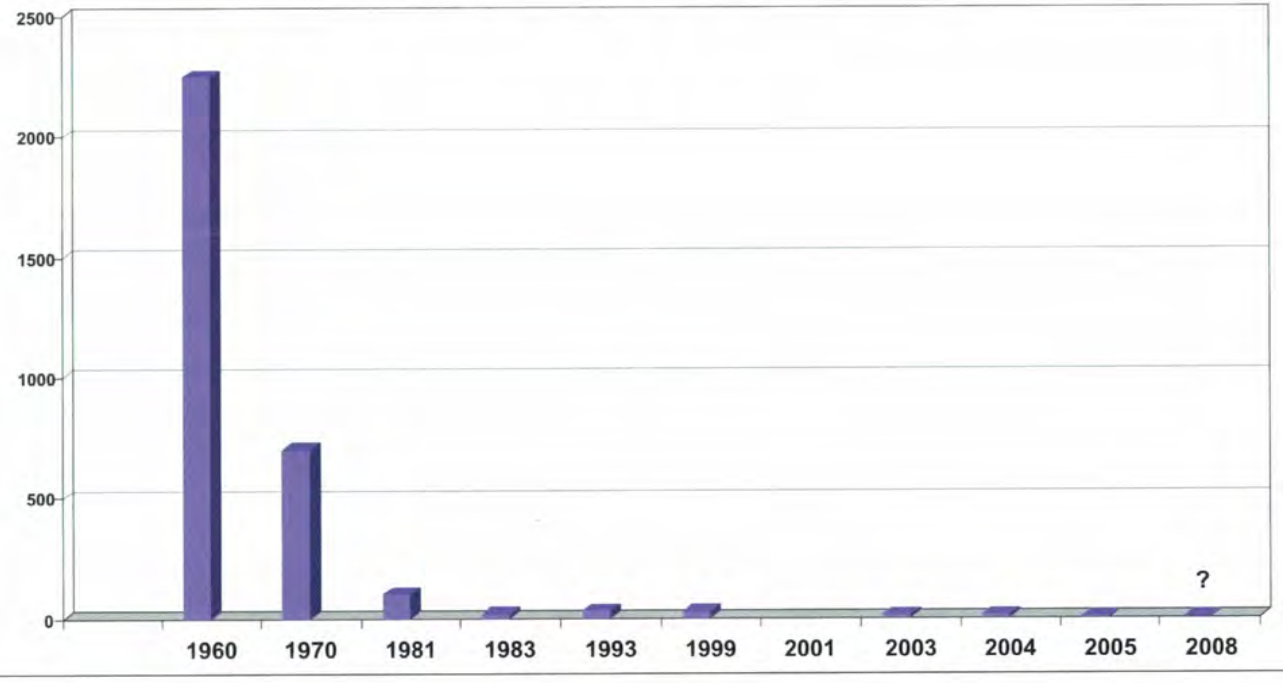
The abundance of the northern white rhinos per African country in the period 1960-2009
(according to EMSLIE and BROOKS 1999, PENNY 1988, EMSLIE *et al.* 2009, supplemented)

Country	1960	1971	1976	1983	1984	1991	1997	2003	2008	2009
Zaire/DRC	1,150	250	490	13-20	17	30	25	10	4	0 ?
Sudan	1,000	400	?	< 50	10	0 ?	0	0	0?	3 ?
Uganda	80	Several	Several	2-4	1	0	0	0	0	0
Central African Rep.	Several	Several	Several	Several	1	0	0	0	0	0
Chad	Several	Several	?	0 ?	0	0	0	0	0	0
Kenya	-	-	-	-	-	-	-	-	-	4
TOTAL	**2,230**	**650**	**500 +**	**<< 70**	**29**	**30**	**25**	**10**	**4**	**7 ?**
No. of countries	5	5	3	4	4	1	1	1	1	2

Development of wild northern white rhino numbers since 1900
(FOOSE 1993, HOLECKOVA and BOBEK 2000, EMSLIE *et al.* 2007, MILLIKEN *et al.* 2009; supplemented)

Year	1900	1960	1970	1981	1983	1993	1999	2003	2004	2005	2008	2009
Numbers	Thousands	2,250	700	100	15	31	25	10	14	4	?	3 ?

Development of northern white rhino numbers in the wild



CAPTIVE BREEDING

First zoo animal:

- Southern form 1946 Pretoria, South Africa (OCHS 2005)
- Northern form 1949 Khartoum, Sudan (OCHS 2005)

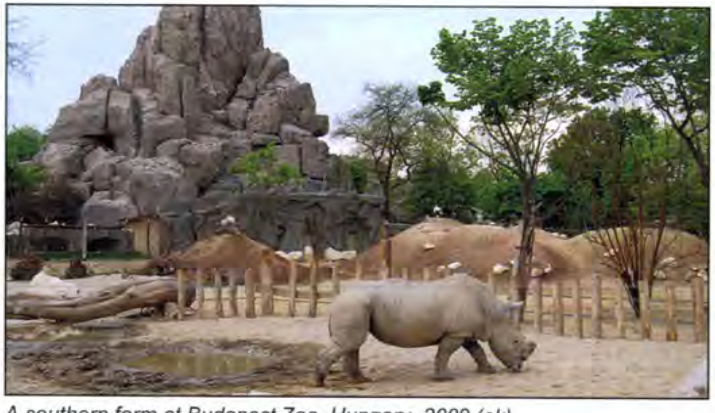
First animal born and reared in the zoo situation:

- Southern form 1967 Pretoria, South Africa (OCHS 2005)
- Northern form 1980 Dvur Kralove, the Czech Republic (OCHS 2005)

According to the International Studbook (OCHS 2005) and BLASZKIEWITZ (1991), the first animal kept in captivity was female Zuluana (Stdbk #58) of Umfolozi origin, who was imported into Pretoria Zoo, SA, on 25 July 1946. Zuluana lived to be 41 years old there, as she died on 21 March 1987 (OCHS 2005). The first northern form animal (Stdbk #1252) lived at Sudanese Khartoum Zoo, where this animal, wild-caught in southern Sudan, however died on 29 January 1949 around two weeks upon arrival even prior being transported into Europe.
The very first captive-born individual of the southern form as reported by the International Studbook (OCHS 2005) was a male Zapele (named "Dutch" later on, stdbk #61). This rhino was born to female Umfazi in Pretoria Zoo on 8 June 1967, who however had been pregnant when she arrived in Pretoria from Natal. Dutch lived 20 years. The first calf conceived at a zoo situation was born on 23 October 1969, which happened in Pretoria as well - named Seventy (Stdbk #76) in his native zoo, this male was later on called Balthazar in Antwerp, Belgium, and the Dutch Beekse Bergen Safari Park. Balthazar lived for 34 years and died in 2003.
The first individual of the northern form was born at Dvur Kralove Zoo in 1980 (Suni DK 5, Stdbk #630). This animal is still alive, even though held since 2009 in the Ol Pejeta Conservancy, Kenya.
The most recent ISB release (FRESE 2009) registered 1,672 (777.883.12) white rhinos as per 2 December 2009, including 27 (10.16.1) pure northern white rhinos.

Captive population

As following 1960 a decision was adopted to reduce the wild-ranging population of the southern subspecies in South Africa, dozens of animals were shipped to zoological parks all over the world (KLOS 1981). Projected activities included establishing a breeding population within the grounds of the Whipsnade Animal Park managed by the Zoological Society London. Transfer of 40 animals by truck and ship was planned in the beginning; however, only 20 (8.12) southern white rhinos entered Whipsnade, with 34 calves born by 1970 (PENNY 1988).
The increased captive white rhino numbers result from the table below showing that while in 1969 only 86 white rhinos were kept in zoos, the 1980 number already reached 562 animals (i.e. increase by 553%), whereas 405 rhinos were brought in from the wild and 121 calves were born in captivity (KLOS 1981).



A southern form at Budapest Zoo, Hungary, 2009 (ek)

A calf born following artificial insemination with its mother in the outdoor enclosure at Budapest Zoo, Hungary, 2009 (ek)

Development of the global white rhino stock in captivity
[according to KLOS (1981), updated based upon studbooks]

Year	Imported from the wild	Born	Died	Status as per 1 Jan
1969	8 (5.3)	1 (1.0)	-	86 (42.44)
1970	57 (23.34)	1 (1.0)	1 (0.1)	95 (48.47)
1971	101 (30.71)	2 (2.0)	1 (0.1)	152 (72.80)
1972	58 (24.34)	5 (4.1)	-	254 (104.150)
1973	43 (18.25)	8 (4.4)	5 (1.4)	317 (132.185)
1974	56 (25.31)	14 (8.6)	5 (3.2)	363 (153.210)
1975	41 (17.24)	5 (3.2)	9 (6.3)	428 (183.245)
1976	17 (7.10)	17 (10.7)	7 (1.6)	465 (197.268)
1977	14 (6.8)	16 (9.7)	1 (0.1)	492 (213.279)
1978	9 (5.4)	17 (11.6)	7 (3.4)	521 (228.293)
1979	1 (0.1)	27 (16.11)	6 (1.5)	540 (241.299)
1980	0	8 (3.5)	12 (6.6)	562 (256.306)
TOTAL 1969-1980	405 (160.245)	121 (72.49)	54 (21.33)	—
1991				709 (346.362.1)
1993	0	12 (4.8)	8 (5.3)	698 (343.355)
1994	0	11 (5.6)	7 (2.5)	702 (342.360)
1996	5 (2.3)	14 (5.7.2)	41 (22.19)	697 (334.361.2)
1998	17 (4.13)	18 (8.10)	24 (12.12)	714 (338.375.1)
2000	5 (3.2)	26 (12.14)	23 (10.13)	772 (350.422)
2004	14 (9.3.2)	14 (9.3.2)	12 (7.5)	756 (226.419.1)
2005	?	24 (12.12)	21 (11.10)	758 (338.417.3)

On 31 December 1990, there were a total of 709 (346.362.1) white rhinos living in 245 collections, including 12 animals of the northern form, of which 10 (3.7) were held by Dvur Kralove Zoo, while 2 (2.0) stayed at San Diego WAP. From 1987 to 1990, 45 (24.20.1) calves were born and 31 (11.20) animals died (KLOS and FRESE 1991).
On 1 January 1995, the International Studbook registered 562 (235.327) southern white rhinos imported from the wild and 459 (252.205.2) born in captivity, making a total of 1,021 (487.532.2) animals registered, which included 694 (340.354) live individuals. In addition, 49 (23.26) southern white rhinos had been born in the second generation (F2) in captivity by that time; on 1 January 1995, 34 (17.17) of that number were live animals that had never reproduced.

According to the International Studbook (GOLTENBOTH and OCHS 1997), 696 (334.360.2) southern white rhinos and 11 (5.6) northern white rhinos lived in captivity on 1 January 1997. The latest ISB release (LANGE and OCHS 2005) reports that on 1 January 2005, the captive stock comprised 747 (334.410.3) animals, with 82 calves born, 77 deaths and 46 white rhinos imported from nature reserves from 1 January 2001 to 31 December 2004. The above information shows the determination of the population increase by imports from Africa's nature reserves. At the same time, the global captive stock decreased by 3.2% compared with 2000 - see the following table.
On 31 December 2009, 8 (3.5) individuals of the northern form lived in captivity, of which 7 (2.5) animals were owned by Dvur Kralove Zoo; the group included 2 (1.1) rhinos at San Diego WAP, 2 (0.2) at Dvur Kralove Zoo and 4 (2.2) in the Ol Pejeta Conservancy, Kenya.

The history of the white rhino captive stock per region (according to the International Studbook)

Region	1990 (no. of indiv./%)	1996 (no. of indiv./%)	1998 (no. of indiv./%)	2000 (no. of indiv./%)	2004 (no. of indiv./%)
Africa	46 / 6.5%	64 (36.26.2) / 9.2%	53 (30.22.1) / 7.4%	45 (17.28) / 5.8%	35 (12.20.3) / 4.7%
Asia	131 / 18.6%	157 (74.83) / 22.5%	158 (72.86) / 22.1%	170 (75.95) / 22.0%	162 (72.90) / 21.7%
Australia	14 / 2.0%	13 (8.5) / 1.9%	14 (9.5) / 2.0%	28 (13.15) / 3.6%	39 (19.10) / 5.2%
Europe	245 / 34.9%	227 (103.124) / 32.6%	234 (109.125) / 32.8%	249 (116.133) / 32.3%	240 (105.135) / 32.1%
North & Central America	193 / 27.5%	217 (104.113) / 31.1%	237 (110.127) / 33.2%	263 (121.142) /34.1%	254 (118.136) / 34%
South America	49 / 7.0%	19 (9.10) / 2.7%	18 (8.10) / 2.5%	17 (8.9) / 2.2%	17 (8.9) / 2.3%
Middle East	25 / 3.6%	-	-	-	-
Total (increase in %)	**709 (346.362.1)**	697 (334.361.2) (- 1.7%)	714 (338.375.1) (+ 2.4%)	772 (350.422) (+ 8.1%)	747 (334.410.3) (- 3.2%)

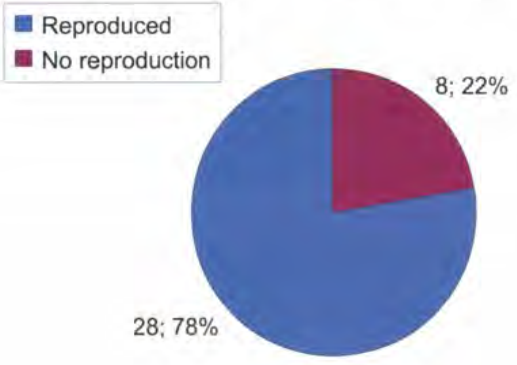
EEP

The European conservation breeding programme for the species was established in 1992, with RNDr Kristina Tomasova of Dvur Kralove Zoo as coordinator. In 1994, the EEP associated 54 zoos with a total of 169 (73.96) white rhinos and a single birth recorded throughout the year (TOMASOVA 1996). By comparison, the 2006 EEP population consisted of 223 (93.130) white rhinos held in 71 collections as per 31 December 2006 (VERSTEEGE 2007), with 5 (3.2) calves born during the year, which represents 2.3% of the stock reported as per 1 January 2006, i.e. 220 (93.127). The total number above included 8 (3.5) northern white rhinos with one hybrid held at Dvur Kralove Zoo.
On 1 January 2008, the EEP contained 236 (99.137) white rhinos in 69 zoos, when 5 (2.3) calves were born and 6 (2.4) rhinos died prior to 28 August 2008. As 2 (0.2) females were imported from Africa, the stock comprised 237 (99.138) animals on 28 Aug 2008 (VERSTEEGE pers. comm. 2008, HOLECKOVA 2008), i.e. 3.43 animals per collection. Despite some breeding successes, the EEP population has been stagnating. If a population increase was 6.5-10% as in the wild, then the EEP should see 15 to 23 calves born per year.
The most recent studbook (FRESE 2009) shows that on 30 November 2009 there were a total of 286 (113.173) white rhinos in 85 institutions throughout Europe, including EEP non-members, when 43 (22.21) calves born and 42 (18.24) deaths were recorded in the period from 2005 to 2009, confirming insufficient reproduction of the species in captivity.

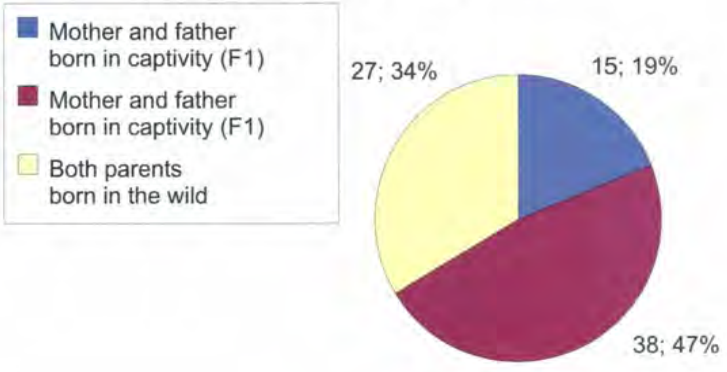
It results from the following diagrams that a major part of wild-born white rhinos kept within the EEP does not breed, and, at the same time, there is still a large part of the animals born with both or at least one parent from the wild.

Information on white rhino breeding within the EEP, 1995-2007 (VERSTEEGE 2008)

Involvement of wild-born individuals in breeding



Origin of the animals born



Assisted insemination

IZW Berlin has been experimenting in the field of assisted insemination in rhinos a number of years, with a total of 57 insemination sessions carried out in 35 different females (33 white rhinos, including 2 northern whites, and 2 black rhinos) until summer 2008 (HILDEBRANDT 2008). Hormonal induction of oestrous was performed 49 times and the natural cycle was underway in 8 cases. Pregnancy was achieved in five cases, of which one involved the use of frozen semen and two cases involved a successful birth of a mature calf. In total, 4 calves were born to 2 females as a result of artificial insemination (Budapest and Madrid), all of the young were males. To impregnate a female, male sperm is employed, collected immediately prior insemination or frozen (HERMES *et al.* 2005, HERMES *et al.* 2007, HILDEBRANDT *et al.* 2007, HILDEBRANDT 2008a) and b), SILINSKI 2003).

Poor reproduction of the white rhino in captive conditions

Although white rhinos reproduce very well in the wild, with an annual increase somewhere between 6 and 10%, provided the population is not threatened by poaching (EMSLIE and BROOKS 1999, HOLECKOVA 2008), breeding in captivity has been rather rare; according to the most recent release of ISB (2005), there was only a single rhino bred in the captive generation 3 (F3).

The latest international studbook for the white rhino (LANGE and OCHS 2005) shows that from 1 January 2001 to 31 December 2004, a total of 82 (33.44.5) individuals were born and 77 (35.40.2) died in captivity, while 46 (17.29) rhinos were imported from African nature reserves, meaning that being there no imports, the captive stock would have increased only by 5 animals (i.e. 0.7%) over those 4 years, which indicates that the population would be stagnating or coming to extinction without the wild-caught rhinos. On 1 January 2005, 758 (338.417.3) white rhinos were held in captive breeding institutions, when only 14 (9.3.2) calves were born throughout 2004 (LANGE and OCHS 2005), i.e. 1.85% of the captive population. At the same time, only a single generation 3 captive white rhino (F3) lived in the zoos worldwide. Given that the wild stock grows by 6.5-10% annually, that year should have seen 49 to 75 calves born in captivity (HOLECKOVA 2008).

By contrast, the black rhino (*Diceros bicornis*) reproduces in captivity already in generation 5 (LANGE and OCHS 2005, HOLECKOVA 2008).

According to ISIS, a global record-keeping system, which is however not used by every zoo, thus does not contain data of all holders worldwide, there were 114 institutions holding white rhinos registered in the system prior to 30 Jun 2007, with a total of 429 (187.241.1) individuals held, when 15 calves, i.e. 3.5% of the registered stock, were born over the period of preceding 12 months. As reported by the most recent international studbook (FRESE 2009), 102 (52.48.2) calves were born and 91 (50.41) individuals died from 2005 to 2009, which supports a stagnating population as a result of poor normal reproduction.

As results from ARKS (ISIS), the international record-keeping system, the UK-based Whipsnade Animal Park - importers of 25 (10.15) wild-caught southern white rhinos in 1962-1972, with subsequent import of a female from Blackpool Zoo in 1974, a male from Knowsley Zoo in 1988 and a male from the wild in 1991 - is the Europe's major white rhino breeder. Until March 2008, Whipsnade recorded 55 (31.24)

calves born, from which 11 (6.5) individuals, i.e. 20.4%, died within two days after the birth and additional 7 (3.4) calves within 7 years, so this park successfully reared 66.7% of the calves born, i.e. 37 (22.15) rhinos. A total number of females that became involved in breeding included 8 wild-caught animals, of which three gave a single birth, one gave two births, one gave four births, two gave six births and one female delivered eight times, and four captive-born females (F1), of which one gave ten births, two gave four births and one animal gave three births. The young were fathered by a total of four males, all of which were wild-caught animals (born in 1960, 1964, 1968 and 1988), from which one male became father two times, the second 15 times, the third 18 times and the last male fathered 19 calves.

The Beekse Bergen Safari Park is another important breeder, with 6 (2.4) southern white rhinos imported from the wild in 1970, of which 3 (1.2) animals participated in breeding. Later on, 3 unrelated males were imported (born in Pretoria, Paris and Cabarceno), from which two became breeding animals. For females, only 2 animals from the wild became breeding animals, where the first gave 9 births and the other gave 13 births. Until 2006, 22 (13.8.1) calves were born in Beekse Bergen, from which 17 (12.5), i.e. 77.3% were reared. At the same time, all the young were a mere captive-born generation 1 (F1) and all efforts to involve any of the young females that remained in the stock failed (females born in 1985, 1988, 1990 and 1998).

The first southern white rhino in generation 3 in captivity (F3) was born in Knowsley Safari Park, the UK, which imported 10 (4.6) wild-caught animals from 1972 to 1995 and subsequently in 1996 a female born in Edinburgh (Meru, stdbk #1026). In Knowsley, a total of 14 (9.5) (31.24) calves were born, from which 7 (3.4) individuals, i.e. exactly 50%, died within two years after the birth and 7 (6.1) southern white rhinos were successfully reared. A number of breeding females was four, including three wild-caught animals (one of them gave 3 births, the second also three births and the third animals gave two births) and a single female born in captivity (Meru), who gave five births. Knowsley had two breeding males, although there was a case where identification of the sire was impossible, as a female got pregnant in a group of multiple males. The first breeding male named Arthur (Stdbk #355, born 1966 in Umfolozi NP, SA) became a father to 4 (4.0) calves; an interesting fact is that the same male fathered a subspecific hybrid - female Nasi DK 2 born in Dvur Kralove, as he had mated Nasima, the northern white rhino female (Stdbk #351, born 1965 in Uganda), when both rhinos were kept together back in Knowsley. The other stud male was alone born in Knowsley (F1, dam Maggie, stdbk #352, and sire Arthur, stdbk #355, both animals born in 1966 in Umfolozi NP) and mated three females , including Meru born in Edinburgh (F2), which is why Meru's descendant became the first ever white rhino born in generation 3 in captivity (F3) according to the 2005 release of the studbook. All the data above were compiled based on the ARKS (ISIS) international record-keeping system and the 2005 release of the international studbook (LANGE and OCHS 2005).

Once a female rhino fails to get pregnant in time, which normally takes place before year 10-12, they very often begin to suffer serious health problems preventing them to reproduce; this in particular involves ovarial cysts and uterine tumours (HERMES *et al.* 2001, HERMES *et al.* 2004, HERMES *et al.* 2006, HERMES 2008).

The fact that healthy females held in captivity very frequently do not cycle, more specifically, their hormonal curve is flat (Schwarzenberger 2008), which may be due to the management methods that fail to take necessary social and territorial behaviour into account, is the major reproduction issue in captive white rhinos. Nevertheless, clear management technique still has not been determined. Even animal parks located in very warm areas, where animals can access spacious enclosures, have not been successful in breeding rhinos in multiple generations. In many cases, only a limited number of individuals within a larger group will breed, though repeatedly. Therefore, emphasis needs to be put on finding a method of unblocking this effect preventing successful reproduction.

Breeding in Czech and Slovak zoological parks

With the exception of Prague and Bratislava Zoo, breeding the white rhino in the former Czechoslovakia was always associated with activities of Dvur Kralove Zoo, who was a supplier of 9 (4.5) southern white rhinos to additional four animal parks from 1974 to 1980.

Prague Zoo obtained their 3 (1.2) animals by importing them from Umfolozi, SA, in 1971. This trio was reduced upon departure of female Paturi (Stdbk #162) to the French zoo in Port Saint Pere in 1993, while the remainder (male Patrys, stdbk #160 and female Pongola, stdbk #161) left to Opole, Poland, following the high-water in 2002, when their house was fully flooded.

Ostrava Zoo obtained a pair native to Umfolozi (male Natal, stdbk #371 and female Dinah, stdbk #208) from Dvur Kralove Zoo in 1974. While Dinah died in 2008, when she was 36, Natal (39) is still alive.

Liberec Zoo acquired their first southern white rhino from Dvur Kralove in 1976 (female Edita, stdbk #113), with subsequent import of a male born in Whipsnade in October the same year (Stdbk #279, born 15 Oct 1974, named Rushden in its native park). Sadly, this male, who had spent two months in Dvur Kralove Zoo's quarantine facility before arriving in Liberec, died in May 1977. The left-over female Edita was sold to Cairo Zoo, Egypt, in 1983. In 1984, Liberec imported a male Niko (Stdbk #669) born and reared in

Munster, Germany, and a female of Umfolozi origin (Tombi, stdbk #847). Niko left to Bratislava Zoo in 2002, while Tombi was sent to Peaugres in 2005.
Lesna Zoo obtained a southern white rhino pair native to Umfolozi (male Joe - stdbk #110 and female Zuzi - stdbk #112) from Dvur Kralove in 1979. As Joe died in 2003 when he was 38 and the female died in 2005 being 39 years old, two young females born in SA were imported to this zoo in 2006, to which however no male could be found until the end of 2009.
Usti n/L Zoo held a male (Dan, stdbk #111) with two females (Sasha, stdbk #114 and Zamba, stdbk #209); these rhinos originated from the wild and came together to Dvur Kralove. The first birth took place only in 1986, when female Sash delivered for the first time when she was 20. This female reared her calf successfully, giving another birth in 1991 and then in 1993, when she was approximately 26 years old. Both Sasha and Dan died in 2008, leaving a single female Zamba at Usti nad Labem Zoo.
Bratislava Zoo imported three (1.2) subadults (Tobi, stdbk #1153, Ada, stdbk #1154 and Sena, stdbk #1155) from Namibia (Oiwa Reserve) in 1986, which following a death of Tobi (2000) was completed in 2002 by a male from Liberec Zoo (Niko, stdbk #669, born 1981 in Munster, Germany). Sena died in 2006, so Bratislava has since kept a pair.

White rhinos held in Czech and Slovak zoos prior to 31 December 2009: overview

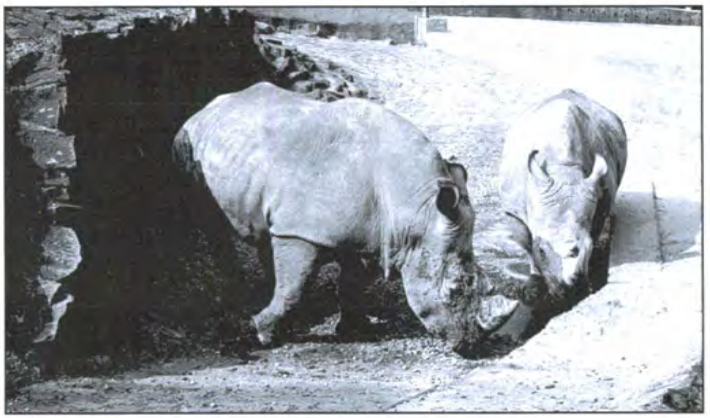
Zoo	Holding period	Import	1st birth	Last birth	Total born	Total reared	Status as per 31 Dec 2009
Dvur Kralove	1970-2009	26 (10.16)	1976	2000	9 (3.6)	7 (2.5)	2 (0.2)
Prague	1971-2002	3 (1.2)	-	-	0	-	0
Ostrava	1974-2009	2 (1.1)	-	-	0	-	1 (1.0)
Liberec	1979-2005	4 (2.2)	-	-	0	-	0
Lesna	1979-2009	4 (1.3)	-	-	0	-	2 (0.2)
Usti n/L	1980-2009	5 (1.4)	1986	1993	3 (3.0)	3 (3.0)	1 (0.1)
Bratislava	1986-2009	4 (2.2)	-	-	0	-	2 (1.1)
TOTAL	**1970-2009**	48 (18.30)	1976	2000	12 (6.6)	10 (5.5)	8 (2.6)

Male Natal at Ostrava Zoo, 2009 (dh)

Male Niko - previously held at Liberec Zoo, the male has been kept in Bratislava since 2009. (dh)

Lesna Zoo - 1995 (left) and 1999 (right) (lh)

Liberec Zoo - 1993 (lh)



Ostrava Zoo - 1986 (lh)

Prague Zoo, 2000 and 2003 (lh)

Prague Zoo, 1977 (lh)

Usti n/L Zoo, 2007 (lh)

Usti n/L Zoo, 2007 and 1997 (lh)

Bratislava Zoo, 2009 (dh)

THE HISTORY OF THE DVUR KRALOVE ZOO RHINO STOCK

Southern form

The southern white rhino subspecies was acquired through capture in the wild in Africa, imported in three shipments from Umfolozi National Park, South Africa. In 1970, 1972 and 1973, a total of 13 (4.9) animals were imported, of which two animals died still in the quarantine period. This first involved one of the females (Stdbk #1158), who probably died of pneumonia a mere 2 weeks after the arrival in 1970; in 1972, a male Faru (Stdbk #890) died of injuries that had probably occurred during the transportation. The remainder adapted well to the captive situation without any troubles. A pair (mother and son) from the latest - 1973 - transport (Natal and Uzima) was sold a year after, with the male shipped to Ostrava Zoo, while the female was purchased by Demmer (private). In 1977, female Smudla was imported, who was initially loaned to the zoo by Demmer, and later exchanged for the zoo's first raised white rhino - female Fatty (HOLECKOVA *et al.* 1994). In 1976, a two-month-old male lived in the zoo's quarantine facility (Rushden, Stdbk #277); imported by Liberec Zoo from England where bred at Whipsnade Animal Park, this animal never got in contacts with other local rhinos and was not a Dvur Kralove property. Once the animal's quarantine period was over, the rhino left for Liberec.

Following the import in 1970, the southern white rhinos were placed in the quarantine facility over several months, spending the summer in the enclosures of an exhibit called the African camp that had been constructed for them. Throughout the winter, the animals stayed inside the wintering facility; later on, this structure was used as a central store and from 2000, it served as a giraffe house. The summer months of 1971 and 1972 the rhinos again spent in the exhibit imitating an African wildlife capture camp. From 1973, the group was kept in the rhino house 1, split into two boxes, 6 m per 6 m each, where one box was designated for a group of 6 (2.4) older animals, males Joe and Dan and females Zuzi, Edita, Sasha and Vanda, while the other contained 4 younger rhinos (0.4), females Zamba, Faith, Tessa and Dinah. Outdoors, all the animals were kept together in a large enclosure, with additional young 8 (3.5) black rhinos. In 1973, this group comprised 18 rhinos, including 10 (2.8) southern whites, while in 1974 there were even 21 rhinos kept together outdoors, of which 12 (3.9) were those of the southern form.

After a pair was imported (Uzima and Natal, who were mother and son) in July 1973, the rhinos were distributed into three indoor stables, with Natal added to the four younger females, while Uzima, who had been dispelling her son Natal and attacking even older females, stayed on her own in a separate box. In the late 1974, 3 (1.2) rhinos left - a pair formed of male Natal and female Dinah left for Ostrava Zoo, and female Uzima who was shipped to abroad via Demmer (private), leaving two groups housed in two stalls - the original 6 rhinos (2.4) and the reduced group of three females (0.3), who had been staying together in the group of five (1.4). All those animals were still kept together with the black rhinos in the outdoor enclosure, meaning that two in fact mature white rhino males were permanently kept inside the group - Joe and Dan, born 1965 and 1966, respectively. As a result of the white rhino departures mentioned above, a social change occurred within the group, as three females (Faith, Tessa and Zamba) started being kept indoors without a male from 30 November 1974 in a single box, which they permanently shared with male Natal and female Dinah until that time. In additional 12 days, Uzima was housed in a separate box, accompanying the other rhinos only outdoors, left as well. Subsequently, all females were introduced outdoors only to a single male - Dan from January 1975, meaning that seven females of two groups, namely the older females, 8 to 9 years old Zuzi, Edita, Sasha and Vanda, and the younger cows, about 5 years old Zamba, Tessa and Faith, were released outdoors daily together with a single male Dan, at that time a nine-year-old rhino. Dan was kept indoors together with the four older females. Already from February 1975, Dan mated or at least attempted to mate all the three young females, i.e. only those who were not kept with the male indoors in a permanent situation, but whom he could join only outdoors. One of these (Faith) did conceive following a single mating that was recorded (6 April 1975). However, as the female was not showing any obvious signs of pregnancy of nearing birth, and the keepers were still lacking experience of how pregnant females should be handled, Faith continued being kept in the indoor box together with females Tessa and Zamba. Then Faith gave unexpected birth on **15 August 1976** in the night, and a newborn male **Fali DK 1** was found dead inside the box in the morning. The post mortem examination proved that the male was alive when born, but then died of lung rupture as a result of being trampled. Since that time, every rhino female suspected pregnant was timely separated prior any expected or assumed birth based on that lesson learned.

In summer 1977, northern white rhinos were moved to the neighbouring stalls in the same house; however, both subspecies were kept separately from each other at all times inside the house and outdoors. In the same year, a southern white female Smudla arrived, who was initially loaned to the zoo as Demmer's property, but later exchanged for the zoo's first raised white rhino - female Fatty (HOLECKOVA *et al.* 1994). In 1980, this female left for Poland.

In the meantime, Faith became obviously pregnant again. This time the rhino was isolated for the birth into a separate box. On **4 April 1978**, Faith delivered her second calf - **female Fatty DK 3,** and raised the calf without problems. Tessa got pregnant as well, giving birth to male **Teny DK 4** on **16 December 1978**; the calf was reared completely without troubles. Dan even routinely mated Zamba, the last of the tree young females, but Zamba never got pregnant.

Unfortunately, Dvur Kralove Zoo had been criticised by that time by certain zoos and conservationists, without any support and justification, to be intentionally crossing the northern and southern form of the white rhino, which was not truth. This criticism was one of the reasons why the southern white rhino stock was discontinued, despite the promising development, to provide breeding capacities for the rare northern form imported in 1975. Therefore, all southern white rhinos including the breeding trio were sold or given away to other zoos in 1979 and 1980 (HOLECKOVA *et al.* 1994).

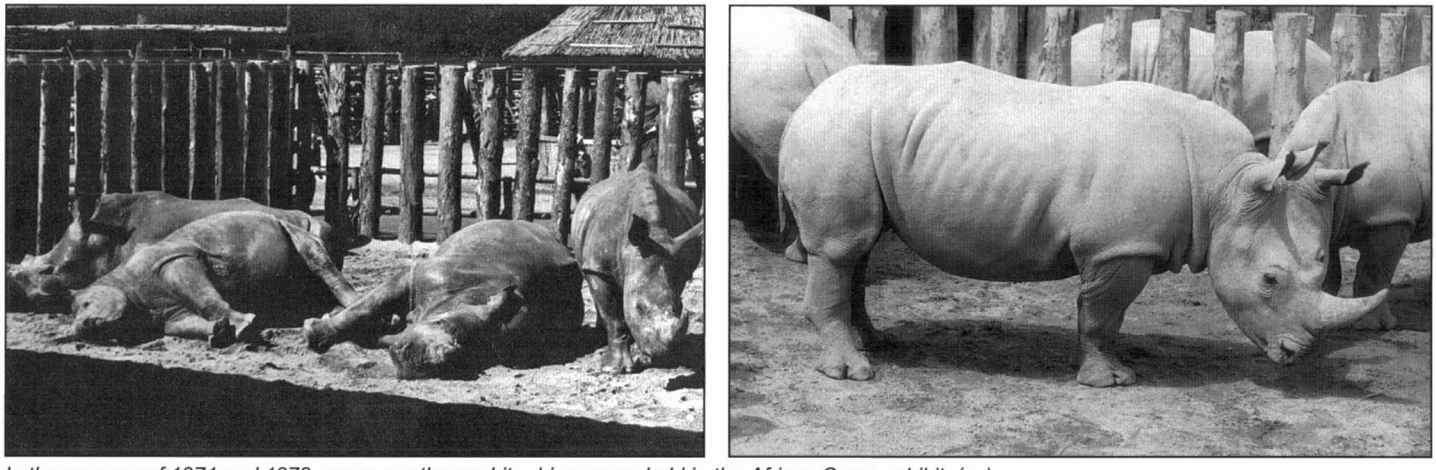
The breeding male Dan accompanied by Zamba and Sasha departed to Usti nad Labem Zoo; however, Zamba who had been mated by Dan in Dvur Kralove since 1975 (on 6 February for the first time), never got pregnant. On the other hand, Sasha was not mated by the male in Dvur Kralove at that time; this female only bore her first young (male Sagan - Stdbk. #865) several years after in Usti nad Labem in 1986. The Sasha's mating earlier in 1985 was preceded by her intentional separation from both the group and the male. Later on, when the first Sasha's offspring was weaned, this female became pregnant even two times, giving birth to two additional males - Doran, Stdbk #970 in 1991, and Dino, Stdbk. #1029 in 1993. Due to space issues, Doran was loaned to Dvur Kralove Zoo, while Dino left for Poznan Zoo, Poland, where he fruitfully mated their female soon after arrival, thus becoming one of the youngest sires amongst captive white rhinos, being 4 years and 7.5 months old at that time (FRESE 2009). Regrettably, none of the rest of southern white rhinos that were originally imported to Dvur Kralove has ever bred after the stock was terminated. Even more unfortunate was the fact that the extension of space failed to result in reproducing the other northern white rhino females kept in Dvur Kralove, when at the same time the departure of the southern breeding females was a great issue for the keepers, as the zoo sent out the only breeding females and the first offspring produced, while the black rhino stock was at that time undergoing a crisis, which was to culminate in deaths of several animals.

New southern white rhinos were imported only in 1990 - this involved a loan of male Frankie, 21, and female Sanni, 24, from Cologne Zoo. These animals however arrived to stimulate potential sexual activities of the northern form animals that still had not reproduced rather than for breeding purposes.

The most recent imported animal was male Doran produced by male Dan and Sasha at Usti nad Labem Zoo, who had been supplied to Usti Zoo from Dvur Kralove in 1980. This male was sent on temporary loan to Dvur Kralove in 1990 due to a lack of space at the zoo of his origin (HOLECKOVA *et al.* 1994).

Doran as well as Frankie & Sanni left Dvur Kralove in 1996 on the basis of loan terminating.

Details of all southern white rhinos imported, loaned and born are summarised in the tables below.



In the summer of 1971 and 1972, young southern white rhinos were held in the African Camp exhibit. (az)

A list of southern white rhinos imported to Dvur Kralove Zoo prior to 31 December 2009

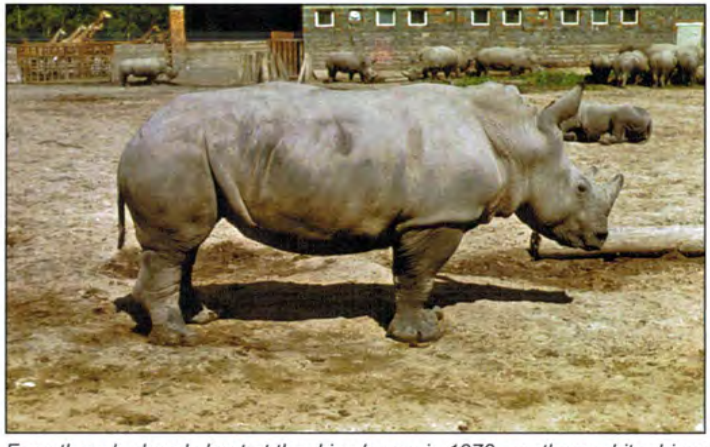
Key: Stdbk # - the international studbook number of the animal, M - male, F - female

No.	Sex	Name	Stdbk #	Arrival	Born	Departure / Death in DK	Comments
1	M	**Joe**	110	2 Jun 1970 Umfolozi, SA	1965, Umfolozi, SA	12 Jul 1979, Lesna	† Lesna
2	F	**Zuzi**	112	2 Jun 1970 Umfolozi, SA	1966, Umfolozi, SA	16 Jul 1979, Lesna	† Lesna
3	F	**Edita**	113	28 Jun 1970 Umfolozi, SA	1966, Umfolozi, SA	3 Jun 1976, Liberec 12 Mar 1983, Cairo, Egypt	
4	F	**Sasha**	114	28 Jun 1970 Umfolozi, SA	1966, Umfolozi, SA	19 Nov 1980, Usti n/L	Proven breeder in Usti n/L † 2008 Usti n/L
5	F	—	1158	7 Sep 1970, v.d. Bring, Soest	1967, SA	1 Sep 1970, Dvur Kralove	† Pneumonia
6	M	**Dan**	111	15 Oct 1970 Umfolozi, SA	1966, Umfolozi, SA	4 Dec 1980, Usti n/L	1st breeding male † 2008 Usti n/L
7	F	**Vanda**	118	15 Oct 1970 Umfolozi, SA	1967, Umfolozi, SA	27 Apr 1979, Gelsenkirchen, Germany	
8	F	**Dinah**	208	31 May 1972 Umfolozi, SA	1970, Umfolozi, SA	30 Oct 1994, Ostrava	† Ostrava
9	F	**Zamba**	209	31 May 1972 Umfolozi, SA	1970, Umfolozi, SA	19 Nov 1980, Usti n/L	Still alive
10	F	**Tessa**	110	31 May 1972 Umfolozi, SA	1970, Umfolozi, SA	1 Oct 1980 Wroclaw, Poland	2nd breeding female
11	F	**Faith**	110	9 Jul 1973 Umfolozi, SA	1970, Umfolozi, SA	29 Oct 1980 Katowice, Poland	1st breeding female
12	M	**Faru**	892	31 May 1972 Umfolozi, SA	1971, Umfolozi, SA	12 Jun 1989 Dvur Kralove	† Trauma
13	M	**Natal**	371	9 Jul 1973 Umfolozi, SA	1971, Umfolozi, SA	30 Oct 1994, Ostrava	Still alive
14	F	**Uzima**	910	9 Jul 1973 Umfolozi, SA	1966, Umfolozi, SA	12 Nov 1974, Demmer	
15	M	**Rushden**	277	7 Sep 1976, Gelsenkirchen, Germany	15 Oct 1974, Whipsnade, England	19 Oct 1976, Liberec	Quarantined for Liberec Zoo
16	F	**Smudla**	307	5 Oct 1977 Demmer, Langato	1973, SA	3 Oct 1980 Wroclaw, Poland	† 1985, Wroclaw
17	F	**Frankie**	127	24 Aug 1990 Cologne, Germany	14 Jul 1968, Looskopdam, SA	9 Jul 1996 Aywaille, Belgium	
18	F	**Sanni**	199	24 Aug 1990 Cologne, Germany	18 May 1966 Umfolozi, SA	9 Jul 1996 Aywaille, Belgium	
19	F	**Doran**	970	21 Apr 1980, Usti n/L	13 Jan 1980 Usti n/L	25 Jun 1996 Belo Horizonte, Brazil	Son of Dan and Sasha
A total of 19 (7.12) animals were imported, including 1 (1.0) for Liberec Zoo kept only over a quarantine period.							

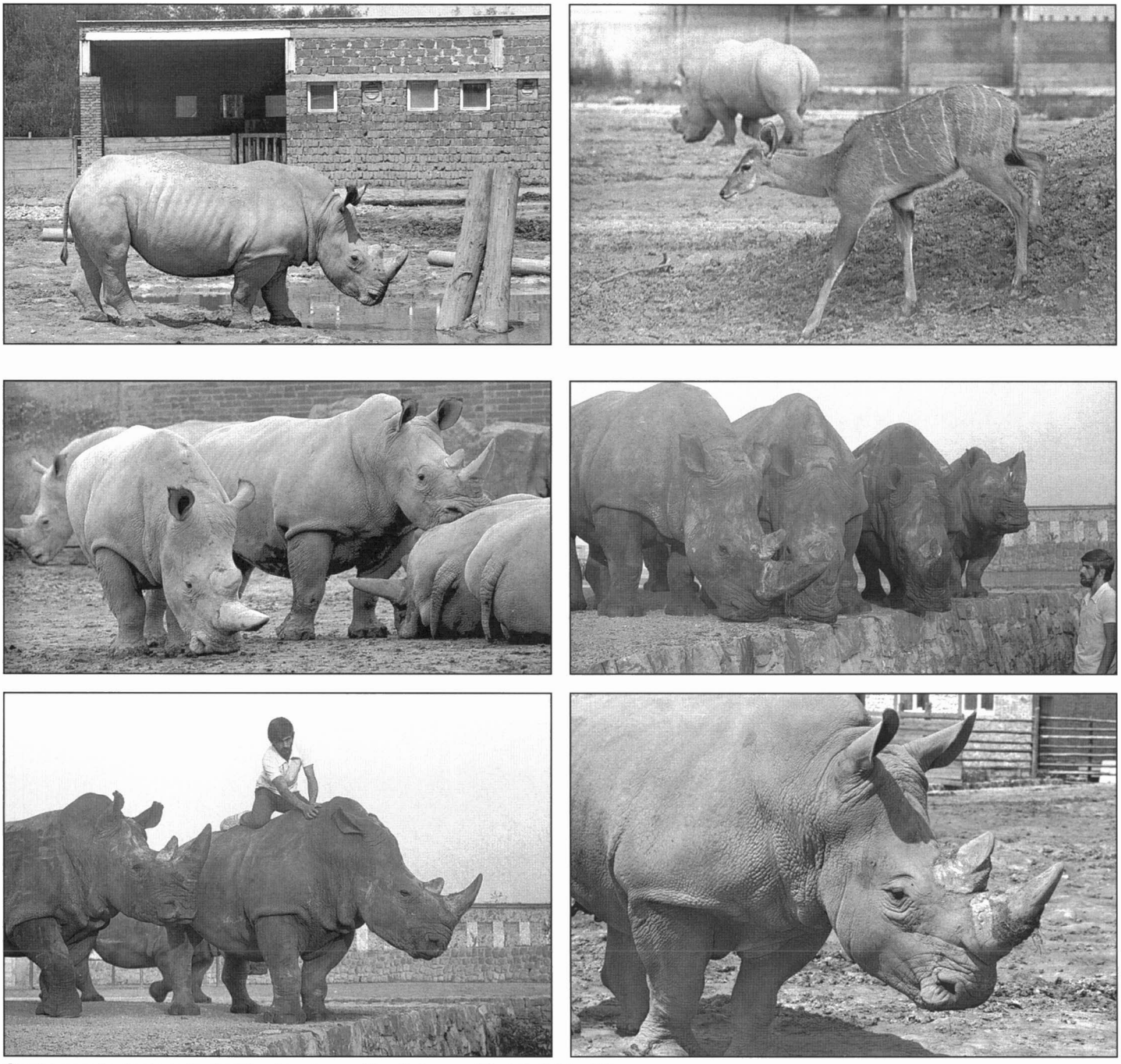
Southern white rhinos born at Dvur Kralove Zoo prior to 31 December 2009

No.	Sex	Name	Stdbk #	Dam	Sire	Born	Comments
1	M	Fali DK 1	??	Faith	Dan	15 Aug 1976	Died of trauma after the birth
2	F	Fatty DK 3	530	Faith	Dan	4 Apr 1978	
3	M	Teny DK 4	531	Tessa	Dan	16 Dec 1978	

Southern white rhinos from the first transport in the African Camp exhibit, 1970 (jov/az)



Even though already kept at the rhino house in 1973, southern white rhinos still used a mixed outdoor enclosure together with black rhinos. (vd/jh)



Southern white rhinos in front of the rhino house #1 with keeper Mirek Svitalsky (lh)

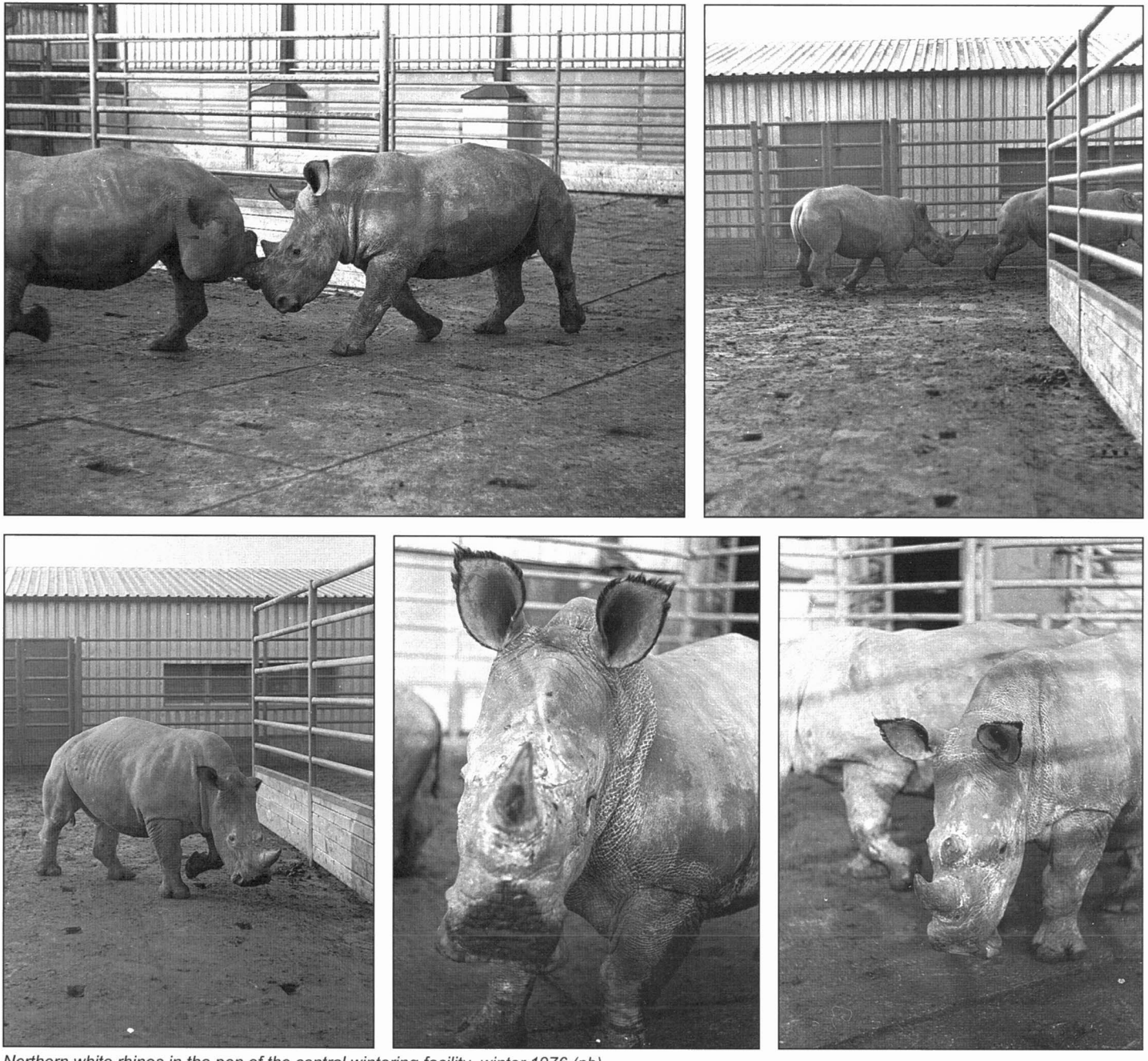
Northern form

In 1975, 6 (2.4) northern white rhinos were imported from southern Sudan; the animals had been caught for Dvur Kralove Zoo in the swamp Upper Nile area near Shambe in April by Chipperfield, England. The young rhinos - about 1.5 years old - were first shipped up the River Nile to Juba and then carried by trucks to Nabiswa, Uganda, where kept four months in a quarantine facility. Transported by railroad to Kenyan Mombasa via Tororo, the animals continued to Hamburg, Germany, by an ocean cargo ship. where they were transferred to a Czechoslovak river boat that sailed down the Elbe River as far as the port in Decin, Czechoslovakia, and then by trucks to the city of Frantiskovy Lazne, where they were kept in a state-owned quarantine. Having stayed there for a month, the rhinos finally reached Dvur Kralove Zoo on 20 September 1975 (VAGNER unpublished). Concerning the transport, Dvur Kralove was subject to critics suggesting that protecting the remainder of rhinos in Sudan would have been a better option; it was believed there were about 780 individuals ranging in the country at that time (VAGNER unpublished). However, within ten subsequent years, northern white rhinos became almost extinct in the wild.

Capture of northern white rhinos in Sudan, 1975 (az)

Following arrival, the entire group was located in the central wintering facility where all animals were staying together day and night. In May 1977, all individuals were relocated into the rhino house 1 next to the southern white rhinos. Each of the white rhino forms walked separately into the adjoining outdoor enclosures (see page 49). The rhino house 1 became a final destination for a northern white female Nasima imported from England in late August 1977. At that time, the northern white rhinos continued to be kept permanently together not only outdoors, but also inside the house, when all six individuals (males Saut and Sudan, females Nesari, Nadi, Nola and Nuri) inhabited two interconnected stalls. Nasima was introduced to the herd outdoors on 29 September 1977, that is one month after arrival, but was attacked by Saut and subsequently Nasima attacked the male; over the next days, the situation became more relaxed and the rhinos were respecting each other when held outdoors. From 3 October on, Nasima who was kept in a stall next to the herd was refusing to walk outdoors with the remainder of the northern whites, and thus putting the female together with other animals discontinued.

Northern white rhinos at the central wintering facility over the first winter (1975/1976)



Northern white rhinos in the pen of the central wintering facility, winter 1976 (pb)

Nasima, who had been caught in the wild (Uganda) in 1965, was imported from Knowsley Safari Park, Prescot, England and arrived in the high period of pregnancy, as was found later on, with however no-one being aware of that. As the female prevented any attempts of making a company to any other northern female or rhino as such, she was isolated in a separate box where she gave surprising and unexpected birth to female **Nasi DK 2** on **11 November 1977** as early as 2.5 months upon her arrival at the zoo. Nasi's father was Arthur (Stdbk #355), a southern white rhino male, with whom Nasima had been kept in Knowsley for several years. Mating probably occurred anywhere between 15 and 20 July 1976. Nasi was historically the first and only crossbred offspring of the two white rhino forms that was ever born around the world.

Nasima was kept with Nasi DK 2 in a separate part of the house, without any contact with the northern form group. When reached 11 months of age, Nasi was separated from her mother on 16 October 1978 and on the next day relocated to the rhino house 2 inhabited by black rhinos, and thus weaned. Nasima was on 9 November 1978 put together with the northern white rhino herd consisting of two males and four females that were still being kept together permanently, not only outdoors, but also indoors, housed in interconnected stalls. As early as 20 and 22 November, Nasima mated with Saut outdoors and got pregnant. At the same time, the female again refused staying in the group, so was still kept in a separate box inside the house next door to the northern white rhino herd. During the spring, Nasima was repeatedly united with the group, but still isolated at night as she was fighting with every rhino. Additionally, Sudan was retained in the herd as of February 1979 as a single male due to escalating aggression between both male rhinos aged at that time 6 and 7 years; this male was permanently staying together with the females both outdoors and indoors. In April 1980, the 2.5-year-old Nasi joined the northern white rhino group, i.e. male Sudan and females Nesari, Nadi, Nuri and Nola. On 10 May 1980, Nasima was showing behaviour as if in oestrus, so was put together outdoors with Sudan; both rhinos treated each other as if ready for mating. In the days to follow, Nasima went out with male Saut, but was attacked by the male on 13 May and thus separated and any reuniting discontinued. Less than a month later, on **8 June 1980** early in the morning, Nasima bore her second calf - male **Suni DK 5,** the first pure northern white rhino born in captivity. At that time, enlarged udder and milk secretion was the only known indication of coming birth as other methods of determining if a female was pregnant were unknown. However, the signs above often could not be seen earlier than a month prior delivery or even later.
As of November 1981, Sudan was separated from the rest of herd indoors into a self-contained box; since that time, only females were kept together indoors (at night), joining the male only outdoors.
In January 1982, attempts to reunite Nasima and her calf with the group of five females (Nesari, Nola, Nadi, Nuri and Nasi DK 2) failed, thus this female rhino was continued being kept separately with her son Suni DK 5.
At the same time - early January 1982, Nuri died of shock as a result of trauma following slipping on glazed ice, when her pubic symphysis ruptured.
The young Suni DK 5 was weaned from Nasima on 11 May 1982 when he was 1 year and 11 months old. On 22 May, Nasima was paired with Sudan as she seemed to have entered oestrus; the animals mated immediately. Mating took place again on 23 and 24 June, and then on 18 July, when Nasima became pregnant. At the same time, Nasima and the rest of females were kept together indoors in three interconnected stalls as of 29 May. Nasima was isolated on 27 April 1983 into a separate box as she appeared to have been pregnant, being attacked by male Sudan in the outdoor enclosure. On **15 November 1983** in the night, this female gave birth for a third time, to **Nabire DK 6**, her second daughter, whom Nasima reared without problems as well as she did in the case of her previous calves. When Nabire was 6 months old, she was put together with the rest of herd as well as her mother, but attacked by Sudan. Therefore, Nasima and the calf still continued being housed separately both indoors and outdoors. Nabire was weaned when 12.5 months old (09-12-1985) and Nasima subsequently paired with male Saut; nonetheless, this female was still lactating at that time. As early as 25 December 1985, Nasima was successfully reunited with the group of females and kept since indoors in the group situation, which involved a total of five females (Nasima, Nesari, Nadi, Nola and Nasi), despite showing unrest and aggression towards the remainder in early January. Ever since Nasima was kept permanently in the female group, this female did mate with Sudan, even repeatedly, but each time failed to be pregnant (mating occurred on 12 August, 18 September, 17 October and 18 November 1986). Mating attempts continued in 1987 as well, when Nasima was noted by the keepers to show periods of some kind of false oestrus, similarly as the remainder of the females within the herd. Mating also occurred on 12 May and 10 June 1987.
In the meantime, male Ben who had already reached 36 years was imported from London in late August 1986 with the aim to involve the rhino being the last Europe's remaining member of the northern form in the breeding scheme. Ben was united with the group in June 1987, with an attempt to mate Nasima registered on 14 July 1987. However, as this male rhino was unable to copulate, the females were split, with Nasima staying indoors with Nasi and Nesari only and paired with Sudan. Mating of Nasima and Sudan oc-

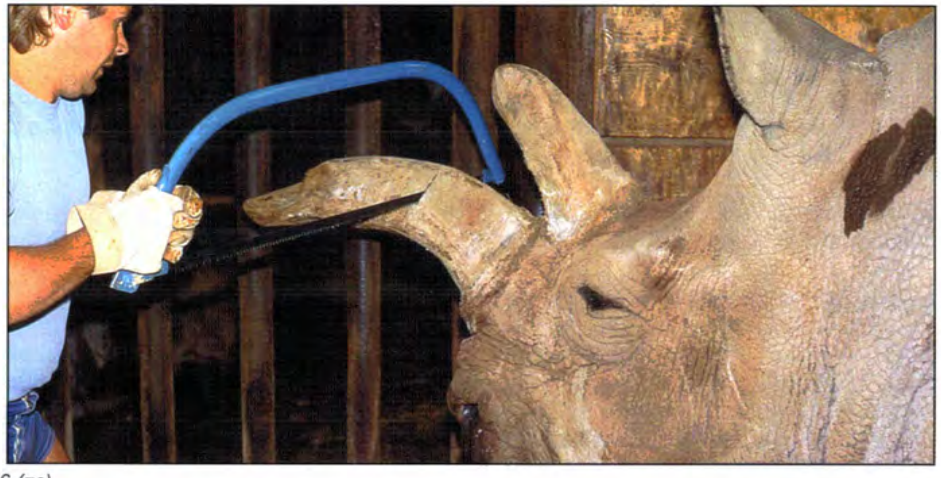
curred on 12 August and 13 September 1987, with subsequent replacement of the male, when Saut was put together with Nasima and other females, trying repeatedly breed Nasima in October 1987. In November, Sudan was being united with the female group again, trying to breed Nasima on 15 December 1987. Mating took place outdoors within the female group on 14 January, 13 February and 17 March 1988, when Nasima finally became pregnant. This female began attacking the other rhinos as early as 24 May, thus held separately in a special box. Any subsequent introductions of the male were full of aggression, so Nasima stayed alone. On **11 July 1989** in the afternoon, this female bore her third daughter - **Najin DK 7**, who was reared by the mother without complications.
Today it appears that it was the permanent keeping within the group of other female rhinos with whom Nasima stayed night and day both indoors and outdoors, for many months (total 1.5 years) what had the negative impact on the female's oestrus in 1986 and 1987, as a result of which this rhino failed to get pregnant, yet still mating. Afterwards, social changes occurred within the group, induced by uniting with the male imported from London and splitting the group into two parts. The return of Nasima's full oestrus resulting in the female's pregnancy could probably be invoked by the division of the female group, particularly the separation of Nasima and Nabire - her 3.5-year-old daughter, with additional factors being the arrival of and the uniting with the new male Ben.

By that time, however, intense efforts were underway to make the remainder of the females reproduce; the first international meeting concerning the northern white rhino took place in Dvur Kralove on 5-7 February 1986, with participating representatives of CBSG/IUCN, where the critical status in the wild was reviewed and a necessity declared of involvement of additional individuals in breeding, including the aged male Ben (Stdbk #19) held since 1955 at London Zoo, where following the death of Bebe, a northern form female (Stdbk #290), the male was kept totally alone since 1964, i.e. 22 years. Alike Bebe, male Ben was born in Uganda in 1950, from where this pair travelled in 1955 to London Zoo.
Based on the February 1986 meeting, it was decided to build a new house just for the northern white rhino and design work was launched. At the same time, a new department involved in the rhino propagation was set up within the zoo's research institute, with staff starting to explore a method of female cycle detection and seeking to collect and examine sperm of the males. The adult females Nasi, Nadi and Nesari, so far non-breeders, and males Suni and Sudan were anaesthetised on 4 August 1986 to undergo examination of their reproductive tracts under the attendance of experts from London and the USA. During the session, the non-breeding females were found to have probably been not cycling due to hypertrophic hymen (VAHALA 2008) and it was suggested that their hymens had become hypertrophied because the females were not mated; as a result, their hymen could act as contraception, so the females failed to enter oestrus. Therefore, the females were anaesthetised and their hymen perforated by veterinarians. The same treatment was carried out in the southern form females Sasha and Zamba (formerly kept in Dvur Kralove) at Usti nad Labem Zoo in 1986 in cooperation with Dvur Kralove vets, where Sasha became successfully pregnant not very long after. It should be however noted from today's perspective that both Sasha and Zamba were actually mated in Dvur Kralove when they were still young, so hypertrophic hymen might have been related to the fact that these females had not been mated for a long time and namely never gave birth rather than being never mated.
In 1987, hormonal stimulation of the females was underway.
In the same period, research in hormonal cycles was underway in Dvur Kralove from 1986. with females sampled for vaginal swabs and morning urine, with samples being subsequently investigated for suitable metabolites of sexual hormones. Early in the morning, keepers, veterinary assistants and vets were waiting inside the house for the rhinos to wake up, collecting personally urine into beakers to avoid contamination of urine on the box floor, which was not very easy, but essential for the research of cycles in females.
The next meeting with the representatives of the Captive Breeding Specialist Group (CBSG) to the IUCN was held at Dvur Kralove Zoo on 24-26 February 1988, with participants including Drs Ulysses Seal, CBSG Chairman, and David Jones, a CBSG member and Director of the Zoological Society London. It was stated during the meeting that there were 18 free-ranging northern white rhinos in Garamba NP, Zaire, 5 animals in Sudan and possibly 1-2 individuals in the Central African Republic, while in captivity there were 4 males, 5 females and 1 crossbred animal at Dvur Kralove Zoo, a single old male in San Diego and male at Khartoum Zoo, about 10 years old. Further, results achieved within the research as agreed in 1986 were summarised as follows:

- Research activities were underway in Dvur Kralove, London and San Diego, when the most success concerning oestrus detection was achieved by Dvur Kralove personnel through using hormonal metabolites in female's urine, while other partners had come only to particular and non-applicable results. It was agreed that Dr Hodges, London's veterinarian, would come to Dvur Kralove to study the local methods used, while transferring his own experience from London.
- Dr Seal initiated the efforts to establish a second group of northern white rhinos.
- In addition, visits were paid to the construction site of the new rhino house and labs of the Institute for Genetic Pool Conservation at Dvur Kralove Zoo.

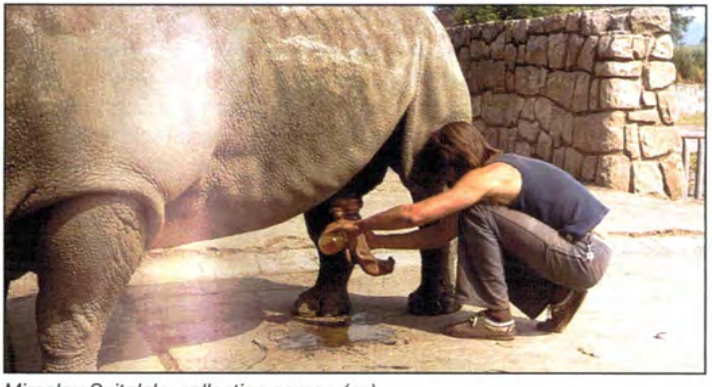
Research in the northern white rhino at Dvur Kralove Zoo, 1986-1990

Anaesthetising a female (zc)



Examining and dehorning northern white rhinos, 1986 (zc)

An anaesthetised female (zc)



Miroslav Svitalsky collecting semen (zc)

It was proposed that the rhino herd be split and a part of the animals transferred into another zoo, where they had achieved success in reproduction of the southern subspecies to reduce the risk of possible decimation of the only captive animals held at a single location based on unexpected health problems. Subsequently, it was decided following several meetings upon recommendations of conservation organisations that 3 (1.2) individuals, namely male Saut and females Nadi and Nola, would be transferred to San Diego WAP, the USA; this institution was preferred to the safari park in England's Whipsnade, as it had more favourable climate being placed in sunny California, where the rhinos could be permanently kept outdoors, plus this safari park could boast the largest number of southern white rhino calves in the world and a large research institute. Everyone believed the climate would resolve the breeding issues in the females, who had been found to have almost no cycles. On 30 September 1988, a loan agreement was drawn up based on which 3 rhinos from Dvur Kralove were to be loaned to San Diego WAP, namely male Saut and females Nadi and Nola, then 14 and 16 years old, and a management committee was formed with representatives of Dvur Kralove, San Diego WAP, CBSG/IUCN and the Zoological Society London. The partners committed under the agreement to provide Dvur Kralove Zoo with Arabian oryxes and three young gorillas for breeding purposes - a male and two females. While the three northern white rhinos departed into the USA about one year after, Dvur Kralove obtained Arabian oryxes and a young gorilla male Assumbo, who however had been hand-reared and kept many years apart from the gorilla groups, which caused him being not able and willing to mate with the gorilla females kept in Dvur Kralove. The other two gorilla females were never supplied to Dvur Kralove as promised and the agreement failed to be observed and fulfilled in this regard, despite repeated negotiations that followed. On the other hand, visitors driving through the northern white rhino enclosures at San Diego WAP are informed of the fact that the animals had been loaned from the Czech Republic.
On 13 October 1989, the three northern white rhinos - 15 and 17 years old at that time - were loaded in Dvur Kralove into the crates made by the zoo personnel and carried away by trucks, at first to the Frankfurt a/M international airport. From there the rhinos were flown all the way to the USA- San Diego airport. with subsequent transport to the San Diego Zoo's Wild Animal Park 45 kilometres away, where the animals were kept within a 45-hectare area that they shared with other African ungulates and birds.

In the interim period, Dvur Kralove still continued to stimulate the females through modified diet (1988) and hormonal treatment (1988 and 1989). On 2 August 1989, mating of Nesari with Sudan occurred, giving the zoo a hope, which however was not fulfilled.

Subsequently, the most recent Nasima's daughter Najin DK 7 was weaned from her mother in Dvur Kralove on 21 June 1990 when the calf was less than a year old, and Nasima united on 23 June with a group of 3 females (Nesari, Nabire and Nasi); immediately after, Nasima was introduced to Sudan in the outdoor enclosure, and mated by the male as early as 5 July and subsequently on 1 August, 28 August and 24 September. Nasima became pregnant 3 months after first united with the herd and introduced to the male. Najin DK 7 lived from her birth in the former rhino house, where she was gradually grouped with two young black rhinos; at first, it was with a two-year-old male (Jos DK 7) on 2 July 1990, and then with a two-year-old female (Sany DK 8) on 1 August 1990; these three animals were kept together at the rhino house as well (see photo on page 1).
In the meantime, the aged male Ben had to be euthanised on 25 June 1990 for overall decrepitude and disability of standing up. This rhino was 40 and weighed less than 1,200 kg (1,460 kg earlier in August 1989).
The team of Dvur Kralove researchers was still in the process of looking for a method of inducing cycling in females. Until the time of completion of the new rhino house, the existing enclosure was modified as of 1986: the ditches were lined by stones to avoid the risk of throwing a female down into the ditch and enable the female group being put together with the male on a daily basis, as until that time, females used to be kept with males outdoors only for short periods during oestrus as a result of several cases of falling into the ditch. Following the modification described above, the male could stay out with the females all day long.

At the same time, it was suggested that oestrus could be stimulated by modifying the lighting schedule (applied from the horse breeding) and diet (by applying the varied quality of feeds in dry and rainy periods in the wild). In 1989, the new house designed above all for northern white rhinos was finished; the northern whites were chiefly housed in the western section of the building, with an adjoining outdoor enclosure assigned for keeping the northern white rhino herd of nearly 3,000 m^2 (for more details refer to page 56). The first rhino taken into the house was male Ben in August 1989.

Northern white rhinos in the outdoor enclosure #3 by the rhino house 2 (az)

A dry moat along the northern white rhino enclosure lined with stones preventing falls (zc)

From autumn 1990, i.e. at the new rhino house, the zoo implemented a controlled light regime including darkening windows and lighting inside the house with the aim of photostimulating the animals. This was preceded by relocation of the northern white rhino group into the new rhino house in October 1990. In addition, each of the females was kept in a separate stall at night and the group with the others only outdoors during the day. This was the first case of implementing separate housing of each female at that time - only female Nasima had been kept apart, until 1985 as mentioned above. To provide an additional breeding stimulus, a southern white rhino pair (Frankie and Sanni) was imported and housed in the neighbouring stalls inside the building; alternating the northern white rhinos in the outdoor enclosures, the pair was later incorporated into the group. Female Sanni, then 26 years old, was injured by Sudan; the male's horn injured the female's groin and torn her rectum. The wound was treated by the most experienced rhino keeper, Miroslav Svitalsky, who had been caring for the rhinos since they arrived from Africa. Sanni attacked the man, wounding him to death. Today it is apparent that providing too old and non-breeding animals to stimulate oestrus in the northern white rhino females was inadequate and fully useless, plus with such cruel consequences; it is hard to understand why young or cycling females could not be supplied from European collections, for instance from Whipsnade, when the meetings concerning the rhinos were also attended by a representative of the Zoological Society London that manages the safari park above.

On **17 July 1991,** prolapsed vagina and signs of abortion appeared in Nasima. The female was treated with big difficulties and the placenta with the calf inserted back into vagina. Despite every effort, Nasima aborted her fourth daughter **DK 8** on the next day - **the pregnancy day 296.** The foetus weighed 17.3 kg. Nasima was then subject to treatment, upon which the female recovered, but the chances of giving birth to a full-term calf were disappearing.

In the late 1992, stimulation of breeding through diet control was launched, when the quantity of concentrated feeds and quality of the diet was reduced. Four months later in the spring, the ration was significantly enriched in terms of both quantity and quality and supplemented by vitamins. The aim was to imitate the variations in diet in a similar manner as it takes place over the rainy periods in the wild. At the same time, the females were split into two groups, where females Nesari (17 years) and Sanni (southern white, 28 years) were being introduced to Suni (11), while Sudan (17) was put together with females Nasima (26) and Nasi (14).

The young Najin DK 7 was kept since weaning in the former rhino house (rhino house 1) with young black rhinos.

In the early 1990s, research in the northern form was still underway, with experts from abroad asking the zoo repeatedly to collect samples for analysis. This became fatal for Nasima, who blocked her horn in the restraint corridor while being sampled for skin tissue despite having been trained for the sampling procedure; the animal subsequently died of collapse. Training for sampling was underway from May 1991 using a restraint corridor constructed by the new rhino house. The procedure went smoothly until 28 June, when Nasima lied down in the chute, blocking her horn so unfortunately that she was unable to stand up. In the subsequent panic, the rhino was shocked and died as a result of heart collapse. The female was 26 years old and weighed 1,680 kg.

Needless to mention that skin samples for genetic analysis to be performed in the USA had been collected from all rhinos for primary research in the preceding years, and the results clearly confirmed the genetic difference of the northern form; in addition, analysis of the karyotype was undertaken by Dr Oliver Ryder in the USA (1984), who found a chromosomal abnormality with suspected Robertsonian translocation in Sudan and his descendants. This in fact means fusing of two chromosomes, so certain individuals have only 81 chromosomes instead of 82. This chromosomal translocation was found in Sudan and his daughters Nabire and Najin, while Nasima, Saut and their son Suni had 82 chromosomes. Many years later, a descendant of Najin (81 chromosomes) and Saut (82 chromosomes) was found to have 82 chromosomes (Fatu DK 9).
As mentioned above, within the efforts to make the rest of the animals breed, which was backed up by the international community, 3 (1.2) animals were sent on loan to San Diego Wild Animal Park, California, in October 1989. However, even this institution failed to make the rhinos reproduce despite recurrent efforts of the local team of researchers and scientists, import of male Angalifu from Sudanese Khartoum Zoo as early as 1990 and repeated mating of male Saut and female Nola in 1995, which was however preceded by hormonal stimulation of both females. Therefore, San Diego WAP was asked in 1997 to return male Saut who was fully unrelated to the young Najin DK 7, which took place in the summer 1998. Much later, in 2006, one ovary was removed in female Nola at San Diego WAP, without consent and awareness of Dvur Kralove Zoo. Examination found atrophy and complete loss of function of the ovary, and the females in San Diego were no longer able to reproduce. Male Angalifu was sampled for semen by the IZW Berlin team, who found that the male's sperm was not suitable for natural reproduction (reduced motility, sperm cells partly damaged). In late May 2007, female Nadi died in San Diego, and the 37-year-old female Nola is now kept alone in the park as evidenced by the picture taken in the autumn 2009.

Northern white rhinos in the outdoor enclosure by the rhino house 1 during the construction of a shelter with black rhinos in the back, 1986 (lh)

Transport of three northern white rhinos to San Diego WAP, the USA, in 1989

Saut, Nadi and Nola prior the transport into the USA

Zdenek Barta by the enclosure prior the transport (zc)

Loading the rhino triplet in 1989 (zc)

Loading a crate containing a rhino prior departure into the USA (az)

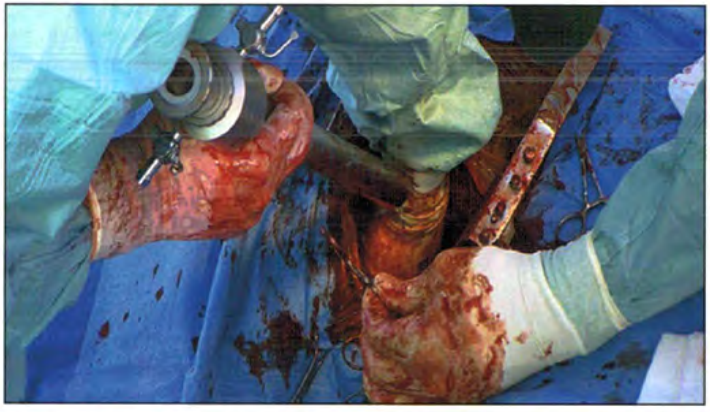
Dvur Kralove's northern white rhinos at San Diego WAP: 1989-2009

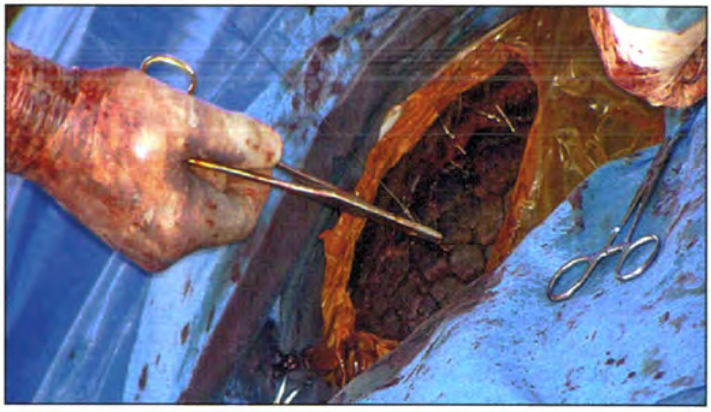
Saut, Nola and Nadi at San Diego WAP (az)

Nola at San Diego WAP (dh)

Nadi at San Diego WAP (dh)

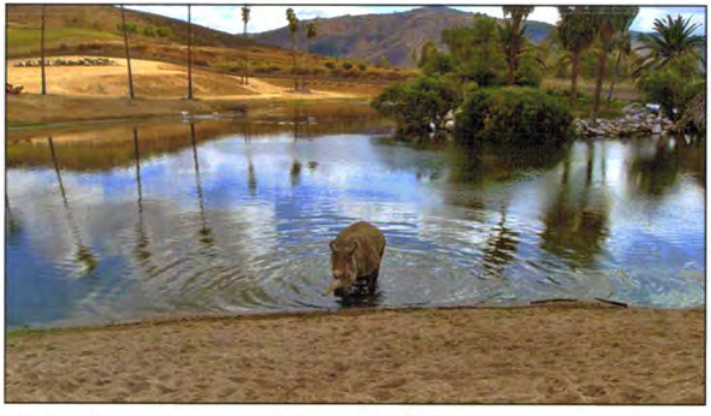
Saut and Nola mating at San Diego WAP in 1995 (az)





Collecting an ovary from the female northern white rhino, San Diego WAP, 2007 (az)

Removed ovary and healed wound after the removal, San Diego WAP (az)



Female Nola at San Diego WAP in 2009 (az)

Stock history in 1990-2000

In 1994, the rhinos began to be kept constantly together, with the outdoor enclosure modified by replacing the U-type moat by one with gradual slope. One of the reasons for separating the males at night until then was the risk of potential throwing a female by the male into the moat. At the same time, the way the animals were housed indoors was also modified to allow the females communicating with male Sudan on one side and Suni on the other. All females were held in several interconnected stalls. The monitoring of the hormonal activity continued in collaboration with the Vienna Veterinary University; it was found that in virtually every female, including the crossbred Nasi kept together with the female group, levels of sexual hormones increased each time in the latter half of summer and in autumn, supporting the beneficial effects of permanent holding of the male together with the females. In addition to that, none of the females was hormonally stimulated since 1993, with only vitamin E in form of TPGS administered in 1994. Females were mated repeatedly, with Nesari mated by Suni on 9 Jun 1993 and 24 Jan 1994 and Nabire mated by Sudan on 5 Sep 1994; even Najin became mate as well (29 Sep 1997 with Sudan), but no pregnancy ever occurred (HOLECKOVA 2008).

In parallel, the young and thus prospective females Nabire and Najin were put together with their brother (Suni) and father (Sudan) on a rotational basis and it became clear that importing an unrelated male would be necessary. As any opportunity of getting a young male from Garamba fully disappeared at the moment of outbreak of a civil war and establishing a new government in former Zaire, today the Democratic Republic Congo, RNDr Dana Holeckova, Director of Dvur Kralove Zoo, requested San Diego to return male Saut as early as 1996. Having spent a number of years in the USA, Saut was also expected to possibly introduce changes into the female group in terms of female behaviour and sexual attractiveness (HOLECKOVA 2008).

Following two years of discussions and administrative procedures, Saut was returned on 15 July 1998. Having undergone the quarantine period, the male was united with the group of all the four females (Nasi, Nesari, Nabire and Najin) on 19 August. As early as 14 September 1998, Saut mated with Najin some 20 minutes and attempted to mate Nesari on 20 September 1998. Najin was mated again on 28 September, 28 October and 28 November 1998 and then on 5 March 1999. Besides, Saut attempted to mate Nesari on 12 September 1999 and mated with Nabire on 28 September 1999. Testing the hormonal derivatives in the dung showed that all females started cycling and Najin became pregnant following the last March mating (HOLECKOVA 2008).

Reproductive activities within the female group following uniting with male Saut up to 31 December 2000 (HOLECKOVA 2008).

Najin (born 1989)	Nabire (born 1983)	Nesari (born 1975)
14 Sep 1998: mating, 20 minutes	28 Sep 1999: showing interest	19 Sep 1998: mating attempt
28 Sep 1998: mating, at least 14 minutes	26 Jun 2000: mating without getting pregnant	3-4 Sep 1998: male showing interest in the female
28 Oct 1998: mating, at least 15 minutes		12 Aug 1999: interest in the female
28 Nov 1998: mating attempt		12 Sep 1999: mating attempt
5 Mar 1999: mating, pregnancy confirmed in Dec 1999		28 Nov 2000: mating attempt
29 Jun 2000: birth, following 482 days		

Baby of the Millennium

The calf was born following 482 days of pregnancy on 29 Jun 2000, at 2.30 am. The birth as such proceeded quickly: Just a minute prior to delivery of the young, Najin lied. Then she got up and gave birth within another minute. Some 30-40 minutes following the birth, the calf was horned by the female several times. Luckily, Jan Zdarek - the experienced rhino keeper - was present, calming the female down and recording the entire birth by a camcorder. The calf - female - started searching for milk, but Najin was evading the attempts at the beginning. Fortunately, the female calmed down very soon and started milking. Saut became a father for the second time after a 20-year break (HOLECKOVA 2008).

The birth as well as the first weeks of the life of the newborn rhino could be watched by anyone interested online (http: www.rozhlas.cz/mlade), as the calf was tracked by 5 recorders placed both indoors and outdoors. The baby rhino was first released outdoors with its mother on 7 July when it was 9 days old. From that time on, it walked out on a routine basis. Dubbed the Baby of the Millennium, the young female was the fourth live-born northern white rhino in captivity and the first one born in generation 2 at the same time. Its first small steps around the outdoor enclosure as well as the naming party were shot by several television teams, covered by a number of radio stations, reported in the press by daily and weekly media throughout the country, and abroad. Simultaneously, a competition for the most attractive name was launched. Based on several hundred proposals received, the name FATU was selected, meaning a "Maasai goddess of eternal life" (HOLECKOVA 2008).

Breeding activities since 2000 and cooperation with IZW Berlin (HOLECKOVA 2008)
The birth of Fatu was a great promise for the future. As early as 2001, Najin was integrated into the herd together with her calf and put together with male Saut, who became mating the female, even in the presence of the young. Dung examinations were giving hope and everything indicated for the fact that Najin had become pregnant in the course of 2001. The female began cycling and mating again in the spring 2002, but pregnancy still did not come.
In 2001, Dvur Kralove Zoo started cooperating closely with IZW Berlin, whose veterinarian experts first specialised in artificial impregnation of elephants, with subsequent launching research into the field of assisted insemination in rhinos. In the partnership with Dr Ch Walzer of Salzburg Zoo, a new and safer method of anaesthetising rhinos was developed, when Immobilon posing risks was replaced by other products, making any deaths of rhinos during examinations rather unique.
All the non-breeding individuals were anaesthetised one by one and their reproductive organs examined using modified ultrasound of special intensity. Females Nesari, Nabire and Nasi were hormonally stimulated repeatedly in 2002 without success, even mating did not occur.
According to dung testing, the hormonal activities of the females decreased to very low levels similar to those shown before Saut's arrival in the group in 1998; by the way, reproductive organs were still functional in all females and nothing was preventing potential pregnancy. Later examinations showed that modifications did occur in Nasi, with tumour found in the female's uterus, due to which the rhino had to be euthanised. Nabire was found to have suffered ovarial cysts and Nesari had become unable to reproduce as well for tumour changes in her reproductive tract.
Saut and Suni were examined repeatedly as well; semen was collected from the males and is currently stored at IZW Berlin. Following the death of Saut in 2006, the male's reproductive organs were transferred to Berlin, where a part of the male's sperm was "saved".

As neither Najin nor her daughter could become pregnant, the zoo proceeded to attempt for artificial insemination. Although two animals were already born following assisted insemination (in the southern white rhino), the rate of success is very low, as the above was based on a total of some 50 inseminations. Najin was inseminated twice, on 11 November 2006 and 22 June 2007, while Fatu even three times - on 20 June and 11 November 2006 and then on 19 June 2007, with fresh semen of Suni used in four cases (for which the male had to be anaesthetised as well) and a single case of use of frozen sperm of this male. Unfortunately, none of the efforts above has led to making the females pregnant, plus 28 immobilisations of the northern white rhinos were carried out as part of IZW Berlin's research activities from 2001 to 2009, meaning a great load put on the animals in the absence of positive results.
The animal management techniques reducing the levels of hormonal activities in the females might have been the very reason for the failure of assisted reproduction in white rhinos despite using the most advanced techniques and technology and profound attitude of experts. Therefore, considering the advanced age of all the four potential breeders, a decision was taken to relocate them into wild conditions, where the rhinos could live on extensive areas in accordance with natural instincts in normal social and territorial relationships. At the same time, their behaviour will be monitored using radio transmitters placed in their horns, among others to find patterns essential for the white rhino to reproduce in a natural way.

From 2001 to 2007, IZW Berlin carried out a total of 27 anaesthetisations of the animals, including the following activities:
- Suni (male): 5 cases of sperm collection; a part of semen transferred to Berlin and stored, a part used for insemination.
- Saut (male): 2 cases of sperm collection; reproductive organs collected upon the male's death, sperm stored in Berlin.

- Nasi (female): 4 cases of anaesthetising, 4 cases of inserting a hormonal implant; prior euthanising, ovulation induced and ovaries collected and transferred to Berlin - never got pregnant, euthanised.
- Nesari (female): 3 cases of anaesthetising, 4 cases of inserting a hormonal implant - never got pregnant.
- Nabire (female): 4 cases of anaesthetising, 4 cases of inserting a hormonal implant - never got pregnant.
- Najin (female): 5 cases of anaesthetising, 2 cases of artificial insemination - never got pregnant.
- Fatu (female): 4 cases of anaesthetising, 3 cases of artificial insemination, 1 case of inserting a hormonal implant - never got pregnant.

University of Vienna
Dung collection was carried out on a routine basis, with samples examined at the University of Vienna, which involved hundreds of specimens. In addition, the institution was consulted regarding inserting implants and insemination.

All of the above-listed efforts undertaken from 2001 to 2007 failed to result in pregnancy of any female, plus females were kept separated from males a number of months both prior and following the artificial insemination as recommended by IZW, which in fact led to reduced hormonal activities in the females as confirmed by testing hormonal activities from faeces at the Veterinary University of Vienna.

Saut, who died in 2007, mated Najin repeatedly since 2001; however, the female failed to get pregnant, though it is believed she might have aborted in a single case, as shown by the hormonal activity diagram. In 2006 and 2007, the above-mentioned attempts to impregnate Najin and Fatu by assisted insemination were carried out, but without success.
Therefore, Dvur Kralove Zoo initiated in the late 2007 discussions concerning potential involvement of the last remaining individuals able to reproduce in breeding, which resulted in a meeting of specialists held in Dvur Kralove in September 2008, where the majority of experts recommended relocating the rhinos into a safe location in the wild. This was made in December 2009, when males Sudan and Suni, and females Najin DK 7 and Fatu DK 9 were transferred into the Ol Pejeta Conservancy, Kenya.

The following table provides summary of all cases of anaesthetisation in northern white rhinos and crossbred Nasi carried out in co-operation with IZW Berlin in the years 2001-2009. In 2009, Nabire was examined as mentioned earlier, and male Suni sampled for semen, which is now kept frozen in Berlin for potential artificial insemination in future. At the same time, biological samples were collected from all rhinos before the move to Kenya for potential use in future, such as in the case of improvement of "genetic engineering" techniques, etc.

Overview of cases of anaesthetising and examining in the northern white rhinos by IZW Berlin (HOLECKOVA 2008 - amended)

Individual	Nesari	Nabire	Nasi	Najin	Fatu	Suni	Saut
Checkup #1	30 Jul 2001	30 Jul 2001	21 May 2002	14 Apr 2004	20 Jun 2006	14 Apr 2004	14 Apr 2004
Checkup #2	21 May 2002	21 May 2002	4 Nov 2002	**11 Nov 2006**	**11 Nov 2006**	20 Jun 2006	19 Jun 2006
Checkup #3	4 Nov 2002	4 Nov 2002	21 May 2007	21 May 2007	**21 May 2007**	**11 Nov 2006**	
Checkup #4		14 Apr 2004	20 Jun 2007	19 Jun 2007	**19 Jun 2007**	**22 Jun 2007**	
Checkup #5		16 Jul 2009		**22 Jun 2007**		10 Sep 2009	

In bold: artificial insemination

Only four animals were moved into Kenya instead of five (i.e. males Sudan and Suni DK 5 and females Nabire DK 6, Najin DK 7 and Fatu DK 9) as originally intended, as examination of Nabire in July 2009 found that this female rhino would not be probably capable of natural reproduction any longer. The remainder animals were shipped to Kenya on 19 December 2009, where the animals arrived on 20 December - refer to Last chance to survive chapter, page 257.

For summary of all imports, births and historical data of northern white rhinos held at Dvur Kralove Zoo, refer to the tables on page 223 and 225.

Summary of northern white rhino imports to Dvur Kralove Zoo prior to 31 December 2009
(Stdbk # - animal number within the International Studbook; M - male, F - female)

No.	Sex	Name	Stdbk #	Arrival	Birth	Departure / † Death in DK	Comments
1	M	**Sudan**	372	19 Sep 1975 Sudan	1973 Sudan	19 December 2009 Ol Pejeta, Kenya	
2	M	**Saut**	373	19 Sep 1975 Sudan	1972 Sudan	14 Oct 1989, San Diego WAP, USA	Return - see #9
3	F	**Nola**	374	19 Sep 1975 Sudan	1974 Sudan	14 Oct 1989, San Diego WAP, USA	
4	F	**Nuri**	375	19 Sep 1975 Sudan	1973 Sudan	† 4 Jan 1982	Shock -trauma
5	F	**Nadi**	376	19 Sep 1975 Sudan	1972 Sudan	14 Oct 1989, San Diego WAP, USA	† 30 May 2007 San Diego WAP
6	F	**Nesari**	377	19 Sep 1975 Sudan	1972 Sudan		
7	F	**Nasima**	351	27 Aug 1977 Knowsley, UK	1965 Sudan	† 28 Jun 1992	Collapse
8	M	**Ben**	19	27 Aug 1986 London, UK	1950 Sudan	† 25 Jun 1990	Euthanised due to high age
9	M	**Saut**	373	15 Jul 1998, San Diego WAP, USA	1972 Sudan	† 14 Aug 2006	Heart failure
Total animals imported: 9 (4.5), of which 1 (1.0) were imported twice							

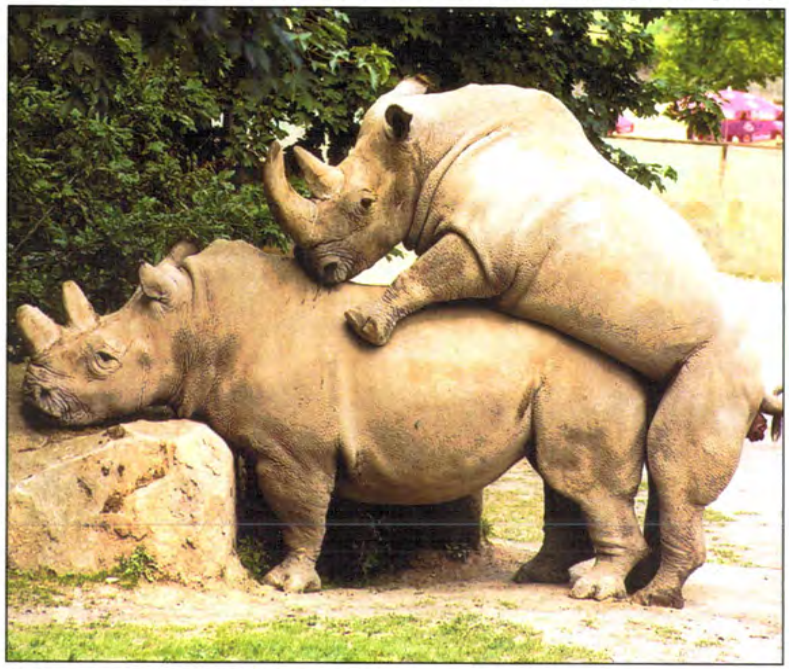
Northern white rhinos born at Dvur Kralove Zoo prior to 31 December 2009

No.	Sex	Name	Stdbk #	Dam	Sire	Birth	Comments
0	F	Nasi DK 1	476	Nasima	Arthur	11 Nov 1977	Crossbred animal, fathered by a southern form animal
1	**M**	**Suni DK 5**	**630**	**Nasima**	**Saut**	**8 Jun 1980**	**NWR #1 born in captivity**
2	**F**	**Nabire DK 6**	**789**	**Nasima**	**Sudan**	**15 Nov 1983**	
3	**F**	**Najin DK 7**	**943**	**Nasima**	**Sudan**	**11 Jul 1989**	
4	F	— DK 8	1122	Nasima	Sudan	18 Jul 1991	Abort on day 296
5	**F**	**Fatu DK 9**	**1305**	**Najin DK 7**	**Saut**	**29 Jun 2000**	**First individual born in generation 2**

In bold: still alive (M - male, F - female)

A total of six young were born to the northern white dams, from which the first one (female Nasi DK) was a crossbred animal produced by both subspecies - the only hybrid that was ever born. The remainder animals were descendants of two females and two males.

Nabire DK 5 being mated on 29 September 1997; Nasi DK 2 standing to the right (th)



Saut mating Najin DK 7, 23 June 2003 (th)

History of the northern white rhino breeding in Dvur Kralove prior to 31 December 2009 (M - male, F - female)

# Name	Sex	ISB/ESB # ARKS #	Birth	Arrival in DK Sire/Dam	Departure from DK	Died	Comments
15/15/DK/0 **Saut**	M	373 059002	1972 Sudan	19 Sep 1975 Sudan, wild-caught 15 Jul 1998 San Diego WAP, USA	14 Oct 1989, San Diego WAP, USA	14 Aug 2006 Dvur Kralove	1st breeding male Loaned to the USA in the years 1989-1998
16/16/DK/0 **Sudan**	M	372 059001	1973 Sudan	19 Sep 1975 Sudan, wild-caught	19 Dec 2009 Ol Pejeta, Kenya	-	2nd breeding male
17/17/DK/0 **Nadi**	F	376 059005	1972 Sudan	19 Sep 1975 Sudan, wild-caught	14 Oct 1989, San Diego WAP, USA	30 May 2007 WAP San Diego, USA	Breeding loan Returned from loan
18/18/DK/0 **Nesari**	F	377 059006	1972 Sudan	19 Sep 1975 Sudan, wild-caught	-	-	
19/19/DK/0 **Nuri**	F	375 059004	1973 Sudan	19 Sep 1975 Sudan, wild-caught	-	4 Jan 1982 Dvur Kralove	Trauma, collapse, shock - fell on ice
20/20/DK/0 **Nola**	F	307 059003	1974 Sudan	19 Sep 1975 Sudan, wild-caught	14 Oct 1989, San Diego WAP, USA	-	
22/21/DK/0 **Nasima**	F	351 059007	1965 Uganda	27 Aug 1977 Knowsley, UK	-	28 Jun 1992 Dvur Kralove	Named Twink in the UK Collapse - shock
24/0/DK/2 **Nasi DK 2**	F	476 059008	11 Nov 1977 Dvur Kralove	Born in DK Nasima/southern form	-	20 Jun 2007 Dvur Kralove	Tumour in uterus, euthanised
27/0/DK/5 **Suni DK 5**	M	630 059009	8 Jun 1980 Dvur Kralove	Born in DK Nasima/Saut	19 Dec 2009 Ol Pejeta, Kenya	-	
28/0/DK/6 **Nabire DK 6**	F	789 059010	15 Nov 1983 Dvur Kralove	Born in DK Nasima/Sudan	-	-	
29/23/DK/0 **Ben**	M	019 059011	1950 Sudan	27.8.1986 London Zoo, UK	-	25 Jun 1990 Dvur Kralove	Euthanised due to high age
30/0/DK/7 **Najin DK 7**	F	943 059012	11 Jul 1989 Dvur Kralove	Born in DK Nasima/Sudan	19 Dec 2009 Ol Pejeta, Kenya	-	2nd breeding female
33/0/DK/8 **-DK 8**	F	1122 059013	18 Jul 1991 Dvur Kralove	Born in DK Nasima/Sudan		18 Jul 1991 Dvur Kralove	Abort - placed in National Museum Prague
35/0/DK/9 **Fatu DK 9**	F	1305 059014	29 Jun 2000 Dvur Kralove	Born in DK Najin/Saut	19 Dec 2009 Ol Pejeta, Kenya	-	F2 - Baby of the Millennium

Explanatory note - numbers: 15/15/DK/0: 15 - Historical (time) serial number of individual at Dvur Kralove Zoo
15 - Historical serial number of import to Dvur Kralove Zoo
DK - Dvur Kralove Zoo symbol
0 - Historical serial number of birth at Dvur Kralove Zoo

Northern white rhinos in the outdoor enclosures by the new rhino house

Enclosure #3 by the new rhino house, 2009 (dh)

Enclosure #5 by the new rhino house in use by northern white rhinos, 2009 (dh)

BREEDING INDIVIDUALS

A total of 7 (3.4) white rhinos became involved in breeding, which included 4 (2.2) northern whites and 3 (1.2) southern white rhinos. More details follow in the tables below, implicating that the first young, Nasima, was fathered by male Arthur from Knowsley Zoo, Prescot, England. Out of all nine animals born, 2 (1,1) southern white rhinos, 1 (0,1) subspecific hybrid and 4 (1.3) northern whites were reared with success; the subspecific crossbreeding occurred at Knowsley Zoo, England, when the zoo kept Nasima, the northern white rhino female.

Offspring of individual white rhinos at Dvur Kralove Zoo prior to 31 December 2009
(N - northern subspecies, S - southern subspecies)

F/M	Dan (S)	Saut (N)	Sudan (N)	Arthur - Knowsley (S)
Faith (S)	Fali DK 1 Fatty DK 3			
Tessa (S)	Teny DK 4			
Nasima (N)	—	Suni DK 5	Nabire DK 6 Najin DK 7 — DK 8	Nasi DK 2
Najin DK 3 (N)		Fatu DK 9		

Southern white rhino breeders at Dvur Kralove Zoo prior to 31 December 2009

No.	Stdbk #	Sex	Name	Number of young born	Number of young reared
1	111	M	Dan	3 (2.0)	1 (1.1)
2	211	F	Faith	2 (1.1)	1 (0.1)
3	210	F	Tessa	1 (1.0)	1 (1.0)

Northern white rhino breeders at Dvur Kralove Zoo prior to 31 December 2009

No.	Stdbk #	Sex	Name	Number of young born	Number of young reared
1	373	M	Saut	2 (1.1)	2 (1.1)
2	272	M	Sudan	3 (0.3)	1 (0.2)
3	351	F	Nasima	4 (1.3)	3 (1.2)
4	943	F	Najin DK 8	1 (0.1)	1 (0.1)

Dan (S) - born 1966, Umfolozi, SA; Stdbk #111 († 28 Mar 2008, Usti n/L)
Dan became a father to three calves: a male Fali DK 1, who died of trauma immediately after the birth, female Fatty DK 3 and a male Teny DK 4. Once Dvur Kralove Zoo discontinued the southern white rhino stock, the male left for Czech Usti nad Labem Zoo to become a father to three more animals (3.0), whose mother was female Sasha, with whom Dan left for Usti Zoo from Dvur Kralove in 1980. Dan died in Usti n/L when he reached 42 years.

Dan mating Zamba, 16 July 1976 (lh)

Saut (N) - born 1972 Shambe, Sudan; Stdbk #373 († 14 Aug 2006, Dvur Kralove)
Wild-caught in southern Sudan, Saut fathered two young, the first (Suni DK 3) and the last (Fatu DK 9) northern white rhino born in captivity. In the interim, 1989-1998, the male was loaned to San Diego WAP together with several Dvur Kralove females within the efforts to make additional northern white individuals breed. After returning from San Diego, the male began mating the Dvur Kralove based females, from which Najin DK 8 got pregnant and gave birth in 2000, meaning that 20 years passed between Saut's first and last progeny. Saut died at Dvur Kralove Zoo when he was 36 years old.

Male Saut after his arrival back from San Diego; to the left, the male is shown with female Nasi, August 1998. (dh)

Sudan (N) - born 1973 Shambe, Sudan; Stdbk #372

Wild-caught Sudan's origin is southern Sudan; the male became father to three calves - females, of which the most recent was born prematurely and dead. Sudan's daughters comprise Nabire DK 6 (born 1983), Najin DK 7 (born 1989) and DK 8 (aborted in 1991). In December 2009, the male returned to Africa as the only one from all the wild-caught animals, moved to the Ol Pejeta Conservancy, Kenya, within the Last Chance to Survive project; for more details, see page 257.

Sudan mating Nasima (jv)

Sudan mating Nesari (dh)

Faith (S) - born 1970, Umfolozi, SA; Stdbk #211

No.	Sex	Name	Stdbk #	Dam	Sire	Conceived	Birth	Gestation period	House & comments
1	M	**Fali DK 1**	??	Faith	Dan	6 Apr 1975	15 Aug 1976	496 days	House #1
2	F	**Fatty DK 3**	530	Faith	Dan	18 Nov 1976	4 Apr 1978	502 days	House #1

Faith first conceived when kept in the company of other southern white rhinos, giving subsequently birth within the group of females, where her first calf (male Fali DK 1) died of trauma. The female became pregnant very soon after that, rearing her second young, female Fatty DK 3, without problems. Faith was sold in 1980 to Katowice, Poland, after the southern white rhino stock was stopped.

Fali DK 1 on 15 August 1976 (pb)

Faith and Fatty DK 3, 21 May 1978 (lh)

Tessa (S) - born 13 Sep 1979, Umfolozi, SA; Stdbk #93

No.	Sex	Name	Stdbk #	Dam	Sire	Conceived	Birth	Gestation period	House & comments
1	M	**Teny DK 4**	531	Tessa	Dan	30 Jun 1977	16 Dec 1978	534 days	House #1

Tessa got first pregnant when she was 8 years, when staying indoors in the company of other two females, mated by male Dan outdoors. Tessa reared her first and only calf without troubles and departure of this female as a result of discontinued holding of the subspecies to Polish Wroclaw Zoo in 1980, where Tessa spent the rest of her life only in the company of her son Teny DK 4, can be considered unfortunate.

Tessa and Teny DK 4, 13 June 1980 (lh)

Nasi DK 2 - a hybrid of the northern and southern white rhino form (lh)

Nasima (N) - born 1965, Uganda; Stdbk #351 († 28 Jun 1992, Dvur Kralove)

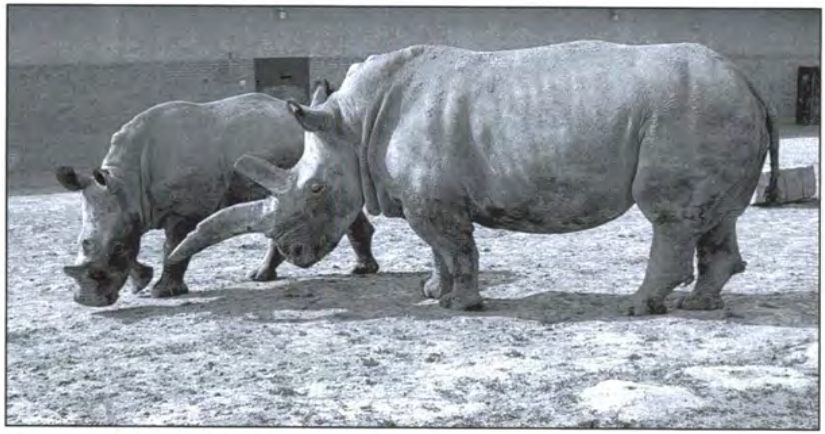
No.	Sex	Name	Stdbk #	Dam	Sire	Conceived	Birth	Gestation period	House & comments
1	F	**Nasi DK 1**	476	Nasima	Arthur	?	11 Nov 1977	?	House #1
2	M	**Suni DK 5**	630	Nasima	Saut	?	8 Jun 1980	?	House #1
3	F	**Nabire DK 6**	789	Nasima	Sudan	18 Jul 1982	15 Nov 1983	484 days	House #1
4	F	**Najin DK 7**	943	Nasima	Sudan	17 Mar 1988	11 Jul 1989	481 days	House #1
5	F	**—DK 8**	1122	Nasima	Sudan	24 Sep 1990	18 Jul 1991	Abort on day 296	New rhino house (#3)

Nasima came from Knowsley Zoo, England, where she was called Twink; when she arrived, she was already pregnant, of which no one was aware. Surprisingly, she gave birth to her first calf - female Nasi DK 2 - as early as 2.5 months after; the calf was an inter-specific hybrid, as her father was a southern white male Arthur, Stdbk #355. Consequently, Nasima was repeatedly united with northern white males and bore 4 (1.3) pure northern white rhinos fathered by Saut (1 animal) and Sudan (3 animals). Sadly, the last calf was born prematurely and dead. Nasima died of collapse when 27 years old. As soon as Nasima finished rearing of Nabire DK 6, she was introduced to male Ben, Stdbk #19, imported from London; however, Ben was unable to mate, so the following young were fathered by Sudan, as Saut had been located at San Diego WAP since 1989.

Nasima and Suni DK 5, 25 November 1980 (lh)

Nabire DK 6, 11 February 1984

Nasima and Nabire DK 6, 9 May 1984 (lh)



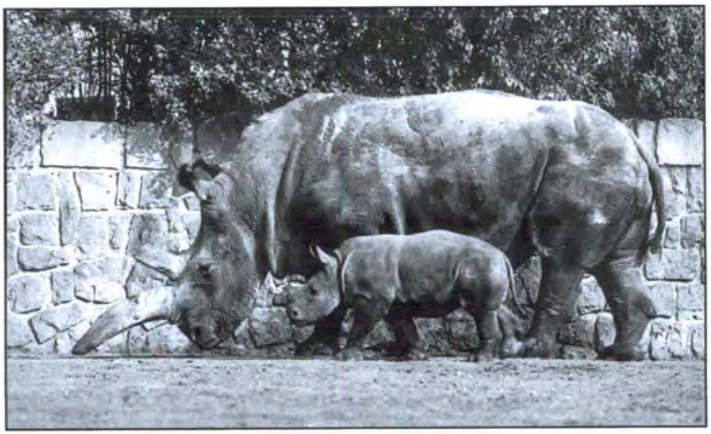
Nasima and Najin DK 7, 15 Apr 1991 (lh)

Najin DK 7 after the birth (zc)

Nasima and Najin DK 7, 15 Jul 1989 (lh)

Najin DK 7 (N) - born 11 Jun 1989, Dvur Kralove; Stdbk #943

No.	Sex	Name	Stdbk #	Dam	Sire	Conceived	Birth	Gestation period	House & comments
1	F	**Fatu DK 9**	167	Najin	Saut	5 Mar 1999	29 Jun 2000	482 days	New house (#3)



Nasima and Najin DK 7 (zc)

Saut and Najin DK 7 mating, September 1998 (ag)

Najin DK 7 and two-week-old Fatu DK 9, 2000 (dh)

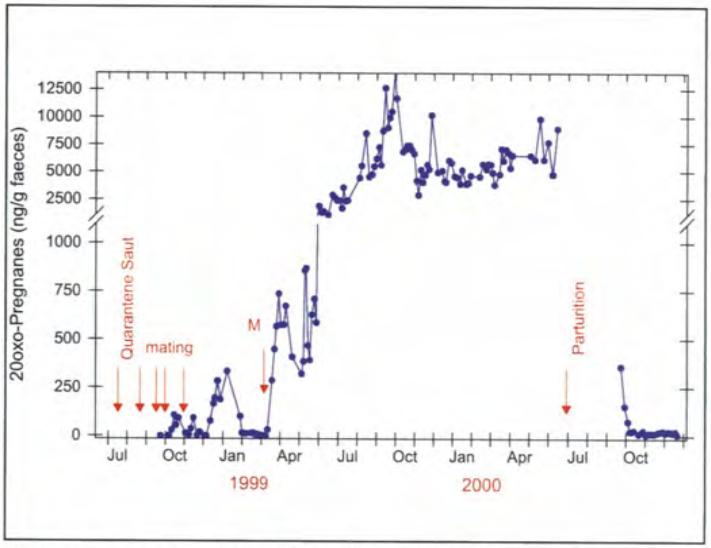
Fatu DK 9 when several weeks old (lh)

Najin first conceived only after the return of Saut from San Diego (August 1998); according to testing her hormonal activities, the female in fact never cycled before. First mated in September 1998, Najin became pregnant following mating in March 1999 and reared her only calf so far, female Fatu DK 9, called also the Baby of the Millennium, without any trouble.

Najin was reunited with the female group before her calf reached its first year; after a month, she was periodically introduced to male Saut within the group of females, which however did not result in pregnancy despite repeated mating. when the first mating occurred as early as two weeks after the animals were united (21 Jul 2001), with subsequent mating activities on 27 Aug, 10 Oct and 5 Nov 2001. On 7 Dec 2001, only an attempt to mate was recorded. Mating also occurred in 2002 (25 Jan, 19 Mar, 14 Apr, 22 Jun, 24 Sep and 19 Nov) and 2003 (25 Mar, 17 Apr, 23 Jun, 21 Jul and 14 Sep, with additional mating attempts observed on 11 and 12 Oct, 8 Nov and 4 Dec). As Najin still could not conceived, she was anaesthetised in 2004 and first examined by the team of vet experts from IZW Berlin, who found that

the female was fully sound with nothing that might have prevented her to get pregnant. Further, male Saut was anaesthetised and tested, sampled for semen that was found to be of good quality, with 86% motility, so even in this area, no reason was found for Najin failing to get pregnant. Finally, Suni was anaesthetised and examined as well, and found to have sperm with 88% motility. Over the year 2004, Najin and Saut mated on 19 Apr, 27 Jun - an attempt recorded, 25 Jul, 1 Oct and 30 Dec. In 2005, Saut was replaced by Suni in the female group, who attempted to mate Fatu on 24 and 25 July and Najin on 4 August. The hormonal activity testing found Najin to have had an irregular cycle (SCHWARZENBERGER). In 2006, Saut returned to the group of females and mated Najin on 16 June. In the same period, Fatu was anaesthetised and first examined by the IZW Berlin team, confirmed healthy and first inseminated by fresh semen of Suni using AI. As with Saut, Suni was anaesthetised to perform sampling. Subsequently, two northern white rhino groups were established, when Saut was kept with Najin, Nasi and Nabire, while Suni was held in the company of Fatu and Nesari. Suni tried to mate Nesari repeatedly during July, and Saut attempted for the same with Nabire and Najin during August. Sadly, Saut died quietly of heart failure on 14

Najin with Fatu three hours after the birth (am)



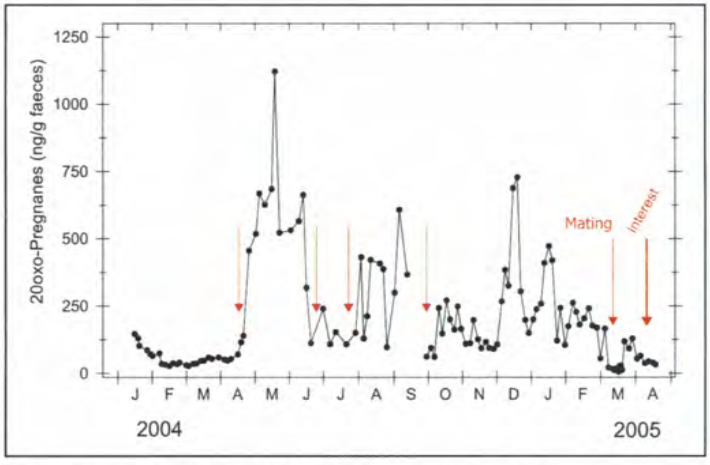
Najin's pregnancy confirmed through examining hormonal derivative from the dung (Schwarzenberger 2000)

Fatu DK 9, a month old, 2000 (dh)

One-year-old Fatu DK 9 with her mother Najin DK 7, 29 June 2001 (dh)

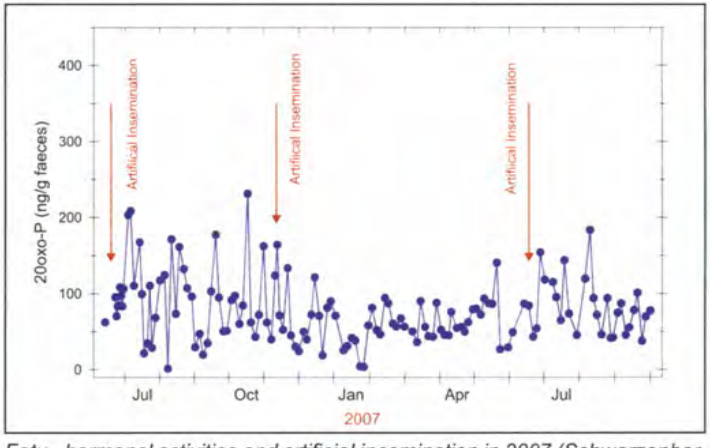
August 2006. In November 2006, artificial insemination was carried out by the IZW Berlin team in both Najin and Fatu, using Suni's sperm again. As recommended by IZW, all females were subsequently kept together, but without a male. In May and June 2007, attempts of artificial impregnation of both Fatu and Najin were carried out again by IZW Berlin; however, as with the previous cases, even repeated attempts of artificial impregnation failed to result in desired pregnancy in these females, sound and prospective in terms of reproduction organs. Following the artificial insemination above, the zoo continued to keep the females without a male as requested by IZW Berlin. Testing hormonal derivates in the dung then revealed that the hormonal activities of the females were on the decline. Any increase did not occur before the females were reunited with a male, which was Sudan as of May 2008, but neither additional mating nor two AI attempts made Najin pregnant again. The reason was the absence of hormonal cycle. In December 2009, Najin left for Kenya with her daughter Fatu DK 9 within the Last Chance to Survive project; more details are available on page 257.

In cooperation with the Veterinary University of Vienna, we monitored the female cycle and pregnancy by testing faeces. Dr Franz Schwarzenberger developed a methodology by which pregnancy can be diagnosed based on placental progesterone metabolites (SCHWARZENBERGER 1995a), which we used in all types of rhinoceros. The results of female Najin tests are shown in the following charts.



Najin - hormonal activities in 2007 (Schwarzenberger 2008)

Najin and Saut mating, 17 June 2006 (th)



Fatu - hormonal activities and artificial insemination in 2007 (Schwarzenberger 2008)

Fatu DK 9 watching mating her parents mating, 2004 (dh)

BIOLOGICAL DATA

Gestation and cycle length in females

As copulation in the white rhino typically lasts several tens of minutes, data regarding pregnancy, and even length of cycle in females could be successfully collected. The length of the cycles resulting in pregnancy in females was about 30 days (25-32); in a single case of the second pregnancy in Faith, it was 75 days, which could be due to failure to record one oestrus period, so the cycle could actually last only a half of the period in the event above; alternatively, this could be due to the fact that Faith had entered oestrus and was mated as early as 20 days following the preceding birth, when her calf died. The pregnancy period recorded ranged from 481 to 534 days, 496.5 days on average (n = 6). The cycle length in females ranged from 25 to 32 days. Maximum length of copulation was 45 minutes, while the minimum period was 15 minutes.

The regular and irregular cycle length in the white rhino provided by SCHWARZENBERGER (1995a) is 10 weeks and 20-45 days, respectively; in addition, this author reports that over 50% of females in captivity show neither cycle nor ovulation. HERMES *et al.* (2007) provide the length of cycle in the white rhino to be 30-35 or 65-70 days, where only the shorter of the two results in pregnancy; at the same time, they confirm the existence of long periods without cycling in many white rhino females, both young and older ones.

Mating, length of cycle and gestation period in white rhinos at Dvur Kralove Zoo prior to 31 December 2009

No.	Pair	Mating date / time	Cycle length	Birth	Name	Gestation period (days)
1	Faith x Dan	7 Mar , **6 Apr 1975**	30 days	15 Aug 1976	**Fali** DK 1	496 days
2	Nasima x Arthur	? Knowsley Safari Park, England	?	11 Nov 1977	**Nasi** DK 2	?
3	Faith x Dan	4 Sep, **18 Nov 1976**	75 days (about 32 days)	4 Apr 1978	**Fatty** DK 3	502 days
4	Tessa x Dan	15 Feb 1975, 18 Oct 1976, **30 Jun 1977**	?	16 Dec 1978	**Teny** DK 4	534 days
5	Nasima x Saut	20 Nov (20 min), 22 Nov 1978, ?	?	8 Jun 1980	**Suni** DK 5	?
6	Nasima x Sudan	23-24 Jun , **18 Jul 1982**	25 days	15 Nov 1983	**Nabire** DK 6	484 days
7	Nasima x Sudan	12 Aug, 18 Sep, 17 Oct, 18 Nov 1986 (15 + 25 min), 10 Jun, 12 Aug, 13 Sep (17 min) 1987, 14 Jan (45 min), 13 Feb (40 min), **17 Mar 1988** (30 min)	29-32 days	11 Jul 1989	**Najin** DK 7	481 days
8	Nasima x Sudan	5 Jul, 1 Aug, 28 Aug (40 min), **24 Sep 1990**	27 days	18 Jul 1991	— DK 8	Abort on day 296
9	Najin x Saut	14 Sep, 28 Sep, 28 Oct 1998, **5 Mar 1999**	30 days	29 Jun 2000	**Fatu** DK 9	482 days
Gestation time: 481-534 days (496.5 on average)			**25-32 days**			

Sex ratio

Out of the nine calves born at Dvur Kralove Zoo, 3 animals were males and 6 were females, with male to female ratio 1:2. Incorporating the Usti n/L Zoo data, where in fact animals originating from Dvur Kralove reproduced three times, produces the sex ratio 1:1, with a total of 12 young (6.6).

Comparing the data obtained from the safari parks in Whipsnade, Beekse Bergen and Knowsley, where 90 calves were born with the sex ratio 53 males and 37 females as determined (ISIS - ARKS), then these produce the sex ratio 1.43:1 for the benefit of males.

Birth distribution over the year

The following table shows the distribution of births at Dvur Kralove Zoo prior to 2009, as well as in captivity according to the International Studbook (FRESE 2009), summarising the data until 2009. The data collected at Dvur Kralove Zoo clearly indicate the low number of births, while confirming distribution of births throughout the year, which is additionally supported by the figures obtained from the International Studbook comprising 787 births distributed throughout the year, with 6 to 11% of births per year. Similarly, the data from Garamba National Park collected within the observation of local northern white rhinos (SMITH *et al.* 1995) are showing 22 births recorded throughout the year except for November, with three births per month in June, July and September, and one birth per month from March to May.

Distribution of births over the year in the white rhino at Dvur Kralove Zoo and in captivity prior to 31 December 2009 (FRESE 2009)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Number of births	0	0	0	1	0	2	1	1	0	0	2	1	8
% per month	0%	0%	0%	12.5%	0%	25%	12.5%	12.5%	0%	0%	25%	12.5%	100%
Of which southern form	0	0	0	1	0	0	0	1	0	0	0	1	3
% per month													
Births in captivity prior to 2009	77	47	55	51	53	44	57	71	75	80	90	87	787
% per month	10%	6%	7%	6%	7%	6%	7%	9%	10%	10%	11%	11%	100%

Birth intervals and reproductive age

As implied by the table below, birth interval related data were collected in three females, when the figures related to the southern female Sasha come from Usti n/L Zoo, where this animal had lived since 1980, giving births in the period from 1986 to 1993.

While Faith and Tessa became first pregnant when nearly 5 and 7 years old, respectively, Nasima and Najin first conceived when between year 9 and 10, and Sasha (Usti Zoo) only became pregnant after reaching her 18th year of age. The age when the females last conceived was 23.5 and 25.5 years in Nasima and Sasha, respectively. The remaining females are still found within their breeding age (Najin and Fatu), or have never lived in a potential breeding situation after the Dvur Kralove stock was stopped, when Faith left for Katowice and Tessa was kept only in the company of her son at Wroclaw Zoo until the end of her life. The oldest female giving birth was Sasha, who last delivered when 27 years old, and then never got pregnant again until her death, which occurred when she was 42 years old.

It results from the captive-based data prior to 2009 (FRESE 2009) involving 232 females and 791 calves that the age range of the youngest females giving birth was 4 to 5 years, the oldest primigravid females were 20-25 years old and the oldest females giving birth were 35 to 37 years old, while the maximum number of calves per female was 10 to 15 (Mfolozi, Stdbk #159, a female that has been living in San Diego WAP, USA, from 1971 to 2003 and lived to be 40 years old).

Birth intervals were related to the rearing method, as the females, except for Najin, used to be separated from the group prior birth and during the rearing period and not reunited with a male before the young was weaned. Najin was reunited with the female group before her calf reached its first year; after a month, she was periodically introduced to Saut within the group of females, which however did not result in pregnancy despite repeated mating. Other females used to be reunited with a male within the female group following weaning, which typically resulted in the females becoming pregnant very soon, which was the case of Nasima as well; however, this animal was permanently kept amongst a female group even indoors between her birth 3 and 4, and at that very time, the female started to show not very intense oestrus periods, mating very rarely and never getting pregnant. The fourth pregnancy in this female could probably relate to the import of male Ben from London, to whom Nasima was introduced as a single female, thus separated from the group. As Ben was unable to mate anymore due to the high age and health status, the female was introduced to Sudan, getting pregnant quite quickly.

The shortest birth interval was recorded in Faith - 21 months, with the female becoming pregnant 95 days following the preceding birth, when the calf died immediately after the birth and Faith was first mated as early as day 20 after the birth. Nasima usually displayed birth intervals 2 years to 2 years and 7 months. FRESE (2009) reports the shortest intervals between births (full-term calves only) to be 451 to 458 days, i.e. 15 months.

Males first fruitfully mated between year 7 (Saut) and 9 (Dan and Sudan), and last copulated when 26 (Dan) and 27 (Saut) years old.

It results from the captive-based data up to the end of 2009 (FRESE 2009) involving 141 males and 779 descendants that the youngest mating males were 3 to 5 years old - there was even a case of mating when the male was only two years (Stdbk #536), the highest age in first fruitful mating was 22 to 38 years and the oldest mating breeding males were 39 to 47 years; there was a even case of a male with 64 descendants (Stdbk #52 - Mandhla, who lived in WAP Sand Diego and other locations around the USA from 1962 to 1984 and reached the age of 26 years).

Age at time of birth and birth interval in white rhino females at Dvur Kralove Zoo prior to 31 December 2009

Females * Born	Birth No.	Birth	Female's age at delivery	Female's age at mating (about 16 months prior birth)	Interval between births	Reared
Faith, Stdbk #211 - S *1970, Umfolozi	1	15 Aug 1976	6 years	4-5 years	—	No
	2	4 Apr 1978	8 years	6.5 years	1 year and 9 months	Yes
Tessa, Stdbk #210 - S *1970, Umfolozi	1	16 Dec 1978	8-9 years	7 years	—	Yes
Nasima, Stdbk #351 - N *1966 Uganda	1	11 Nov 1977	11 years	9.5 years	—	Yes
	2	8 Jun 1980	14 years	12.5 years	2 years and 7 months	Yes
	3	15 Nov 1983	17 years	15.5 years	2 years and 5 months	Yes
	4	11 Jul 1989	23 years	21.5 years	5 years and 8 months	Yes
	5	18 Jul 1991	25 years	23.5 years	2 years	No
Najin, Stdbk #943 - N *11 Jul 1989, Dvur Kralove	1	29 Jun 2000	11 years	9 years and 8 months	—	Yes
Sasha, Stdbk #114 - S *1966, Umfolozi At Usti n/L Zoo	1	18 Nov 1986	20 years	18.5 years	—	Yes
	2	13 Jan 1991	25 years	23.5 years	4 years and 2 months	Yes
	3	10 Dec 1993	27 years	25.5 years	2 years and 11 months	Yes

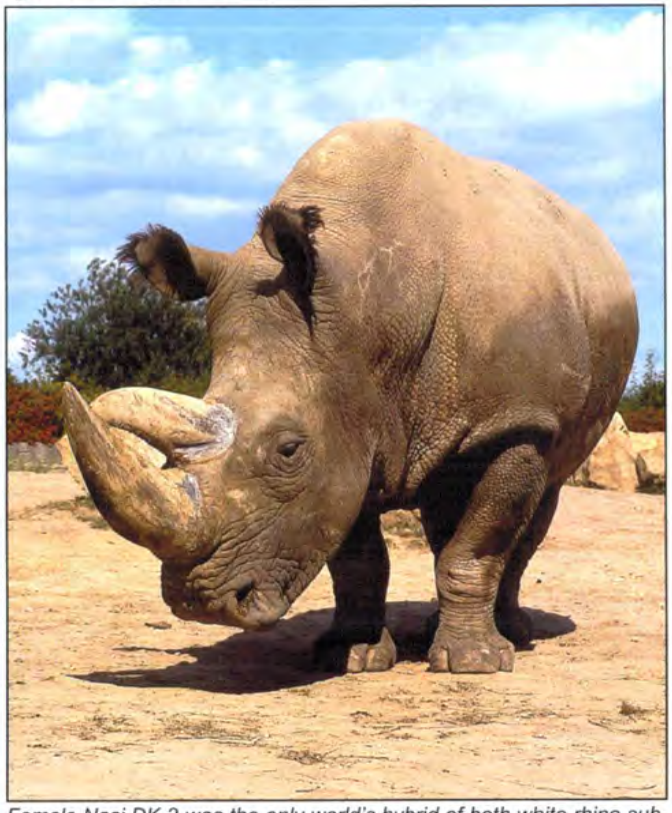
The age of the first fruitful mating in male white rhinos at Dvur Kralove Zoo prior to 31 December 2009

Male * Born	No.	Mating	Male's age at mating
Dan, Stdbk #111 - S *1966, Umfolozi	1	6 Apr 1975	8-9 years
	2	18 Nov 1976	10 years
	3	30 Jun 1977	11 years
	4	June 1985	21 years at Usti n/L Zoo
	5	October 1989	23 years at Usti n/L Zoo
	6	September 1992	26 years at Usti n/L Zoo
Saut, Stdbk #373 - N * 1972, Sudan	1	February 1979	7 years
	2	5 Mar 1999	27 years
Sudan, Stdbk #372 - N * 1973, Sudan	1	18 Jul 1982	9 years
	2	17 Mar 1988	15 years
	3	24 Sep 1990	17 years

In Garamba National Park, birth interval recorded usually ranged from 21 to 28 (32) months. There were two cases of about double birth interval (53 and 69 months); however, there might be births in the meantime that stayed unrecorded (SMITH et al. 1995). Data from the study above are summarised in the table below.

Birth intervals in northern white rhino females, Garamba NP (according to SMITH et al. 1995)

Females * Born	Birth No.	Birth	Interval between births
Mama Giningamba	1	February 1985	—
	2	October 1987	2 years and 8 months
	3	August 1989	1 year and 10 month
	4	July 1991	1 year and 11 months
Boletina	1	August 1983	—
	2	May 1985	1 year and 9 months
	3	September 1987	1 year and 9 months
	4	August 1989	1 year and 11 months
	5	January 1992	2 years and 5 months
	6	January 1994	2 years
Kunalina	1	September 1983	—
	2	July 1985	1 year and 10 months
	3	December 1989	4 years and 5 months
	4	September 1991	1 year and 9 months
	5	July 1993	1 year and 10 months
Mama Moke	1	June 1983	—
	2	March 1989	5 years and 9 months
	3	February 1991	1 year and 11 months
	4	June 1993	2 years and 4 months
Pacque	1	March 1986	—
	2	June 1988	2 years and 3 months



Female Nasi DK 2 was the only world's hybrid of both white rhino subspecies, 2002. (lh)

Weight in white rhinoceroses

Over the years, a number of weight-related data were obtained, which initially was at random, usually in connection with the transport of the animal; after 1986, this activity became scheduled, which in particular started once a scale had been installed in the new rhino house in 1993, allowing for weighing of adult animals (HOLECKOVA 1995). Even though white rhinos walked to the scale placed in the outer corridor without troubles thanks to the calm nature of these creatures, this action demanded considerable handling as the scale was located at the other section of the house, which was not the one in which the animals were residing; therefore, weighing was usually not performed more often than once per year. What's more, white rhinos never suffered loss of condition, meaning that weight was not so important source of information as with black rhinos. A total of 69 weight-related figures were obtained, including 11 in males and 58 in females.

In addition, adults of the southern subspecies were measured with the following findings: Frankie, weighing 2,095 kg, measured 171 cm at withers (1995), Sanni's weight was 1,990 kg, while measuring 150 cm at withers (1995), and the weight and withers height of Doran, a four years and four months old male, was 1,552 kg and 149 cm, respectively (1995).

The height at withers in the white rhino is 171-183 cm as reported by ESTES (1990), 150-185 cm according to PENNY (1988), and 160 to 190 cm as mentioned by TRENSE (1989).

Weight of adult animals

In total, 62 weight figures related to live adult animals were obtained; more specifically these were 5 males and 9 females, indicating that the weight of adult males varied from 1,460 to 2,345 kg, with the mean individual weight ranging from 1,460 to 2,212 kilograms. Similarly, the weight of adult females varied from 1,530 to 2,320 kg, while the mean weight of individual animals ranged from 1,624 to 2,203 kg, when the largest female was Nasi - the subspecific hybrid. Further details are summed up in the following tables, indicating the average weight of about 1,832 kg in males and 1,878 kg in females. An interesting fact is that visually some males are obviously larger than females, while in terms of weight there are no greater differences between the sexes (HOLECKOVA 1995).

The collected data can be compared with that from other zoos, using the ISIS figures (ARKS), which together with the Dvur Kralove data are shown in the following tables. The ARKS figures are comparable with those obtained at Dvur Kralove Zoo, with the mean male and female weight 1,986 kg and 2,012 kg, respectively. The lower weight figures observed in Dvur Kralove namely relate to the fact that the Dvur Kralove animals came mostly from the wild and the weight-related data were in part obtained in aged animals with rather worse condition. This in particular is the case of male Ben, who was weighed at the time of dying, when the male had extremely lost weight and was aged so that he could not stand up alone (HOLECKOVA 1995). The great variance is also determined by the fact that white rhinos held in captivity are much larger and heavier than those in the wild, even though the wild-born rhinos in question were in fact held in captivity from the young age, thus their size was under influence of the captive diet. ESTES (1990) reports the weight in males to range from 2,040 to 2,260 kg, and the mean weight in females 1,600 kg.

Three-month-old Fatu DK 9 with her mother Najin DK 7 (th)

Weights of adult male white rhinos at Dvur Kralove Zoo prior to 31 December 2009

Male	Stdbk #	Weight (kg; min-max)	Average (kg)	Numbers	Comments
Frankie S	127	1,860-2,095	1,975	3	21-27 years old
Saut N	373	1,572-1,850	1,711	2	17-30 years old
Sudan N	372	1,712-1,845	1,800	14	22-36 years old
Ben S	19	1,460	1,460	1	Year 39
Suni N	630	2,104-2,345	2,212	13	15-28 years old
Total	**5 animals**	**1,460-2,345**	**1,832**	**33**	
Kruger S	139	1,900	1,900	1	ARKS - Edinburgh, following death (35 years)
Ferdinand S	93	1,700-1,894	1,825	3	ARKS - Copenhagen, about 45 years old
Zulu S	90	1,950	1,950	1	ARKS - Coulange, year 25
Arthur S	355	2,000-2,190	2,117	8	ARKS - Woburn, 40-42 years old
Lee S	600	1,940-2,310	2,138	10	ARKS - Werribee, 13-23 years old
Total ARKS	**5 animals**	**1,700-2,310**	**1,986**	**23**	

Weights of adult female white rhinos at Dvur Kralove Zoo prior to 31 December 2009

Female	Stdbk #	Weight (kg; min-max)	Average (kg)	Numbers	Comments
Edita S	113	1,750	1,750	1	Year 10
Sanni S	199	1,870-1,990	1,930	3	24-30 years old
Nesari N	377	1,530-2,066	1,718	8	23-37 years old
Nasima N	351	1,680	1,680	1	Year 27
Nola N	374	2,000	2,000	1	Year 15
Nasi NxS	476	2,028-2,320	2,203	3	17-30 years old
Nabire N	789	1,965-2,130	2,016	6	12-26 years old
Najin N	943	1,954-2,036	1,983	3	7-20 years old
Fatu N	1,305	1,615-1,628	1,624	3	9-10 years old
Total	**9 animals**	**1,530-2,320**	**1,878**	**29**	

Birth weight

The weight at birth was obtained from the first young that died immediately after the birth (Fali DK 1) - this male weighed 58.5 kg. HALTENORTH et al. 1984 report the birth weight 80-90 kg, while PUSCHMANN (1989) provides a mean weight of a mere 30-40 kg. Beekse Bergen Safari Park recorded the birth weight of 68 kg in female Dounia (Stdbk #1203). In Whipsnade, the birth weight of 66, 65 and 72 kg was recorded in three males (Stdbk #869 and 810, plus a male born on 25 March 2008), while in a male Green (born 7 March 2008) they found the weight of 64 kg on day 5.

Growth and weight gain

Weighing of young rhinos produced only partial data on weight gain during the growth period; these are presented in the tables below, indicating that the daily gain was 1.17 kg/day up to the age of 2 years and 3 months and subsequently kept on decreasing, even though in three animals, the daily gain from the birth up to reaching 4.5 to 5.5 years was about 0.75 kg, more specifically, it ranged from 0.73 (Fatu) through 0.82 (Doran) to 0.85 (Najin) kg per day.

Growth was recorded in an infant rhino male Stan (born on 2 November 2006) at Beekse Bergen Safari Park, where this animal weighed 62.5 kg on reaching month 1 and 118 kg when nearing to month 3, meaning that this rhino gained weight 55.5 kg in 110 days, which is mean daily gain 0.5 kg; this calf had apparent health problems at that time, as initially its weight was on the decrease.

The same safari park recorded growth in a young female Imke (Stdbk #1350, born on 17 December 2000); this rhino weighed 58 kg on day 6, reaching 66 kg as early as day 11, which makes weight gain of 1.6 kg/day.

According to ISIS data (ARKS), a 1 year and 5 months old female Zimba (Stdbk #803) at Marwell Zoo weighed 1,219 kg, with approximate daily gain of 2.25 kg/day.

Najin DK 7 and Fatu DK 9, 2000 (dh)

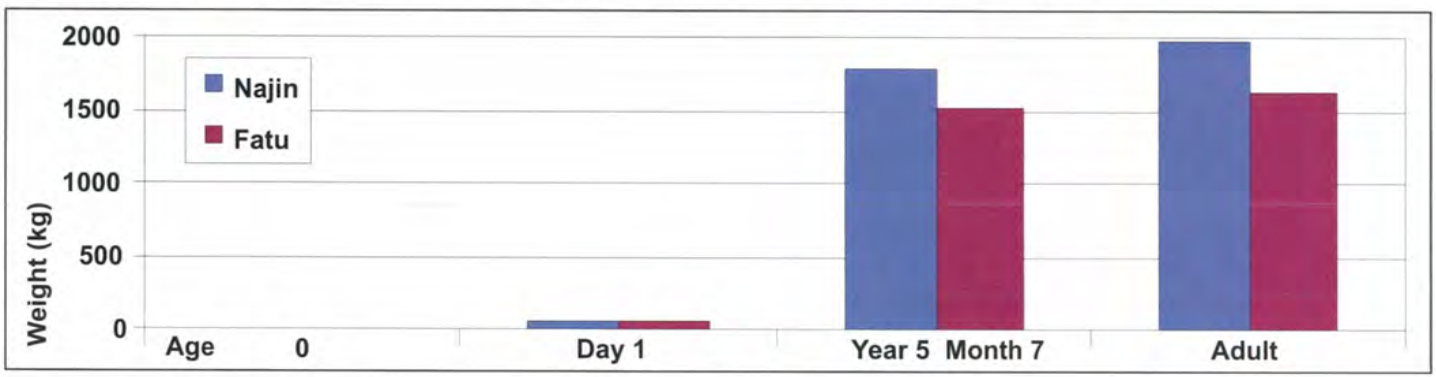
Growth of male white rhinos at Dvur Kralove Zoo prior to 31 December 2009

Age	Weight span	Mean	Comments
Birth weight	58.5	**58.5**	Fali
2 years and 3 months	1,020 kg		Doran
4 years and 4 months	1,552 kg		Doran
5 years and 4 months	1,656 kg		Doran
Adult	**1,460-2,345 kg**	**1,832 kg**	**5 males, N = 14**

Weight gain in growing male white rhinos at Dvur Kralove Zoo prior to 31 December 2009

Date	Age	Weight	Weight gain	Daily weight gain
Fali DK 1 - M * 15 Aug 1976, Dvur Kralove				
Birth weight	Day 1	58.5 kg		
Doran - M * 13 Jan 1991, Usti n/L				
Birth weight	Estimation	60 kg		
17 Apr 1993	2 years and 3 months	1,020 kg	+ 960 kg in 824 days	1.17 kg/day
10 May 1995	4 years and 4 months	1,552 kg	+ 532 kg in 753 days	0.71 kg/day
13 May 1996	5 years and 4 months	1,656 kg	+ 272 kg in 368 days	0.28 kg/day
Najin DK 7 - F - * 11 Jun 1989, Dvur Kralove				
Birth weight	Estimation	50 kg		
1 Mar 1995	5 years and 7 months	1,790 kg	+ 1,740 kg in 2058 days	0.85 kg/day
Adult	17-20 years	1,983 kg		
Fatu DK 9 - F - * 29 Jun 2000, Dvur Kralove				
Birth weight	Estimation	50 kg		
13 Jan 2006	5 years and 6.5 months	1,530 kg	+ 1,480 kg in 2023 days	0.73 kg/day
Adult	9-9.5 years	1,624 kg		

Comparison of growth of northern white rhino females Najin and Fatu at Dvur Kralove Zoo



Maximum longevity

In Dvur Kralove, the highest age was achieved by the northern form of the white rhino male Ben (Stdbk #19, born 1950, Sudan), who was euthanised due to high age in 1990, when he was believed to be about 40 years. Saut (Stdbk #373, born 1972, Sudan) died at 34. The eldest female is Nesari (Stdbk #377, born 1972, Sudan), a female, who still lives and is 38, while the oldest living male is Sudan, 37 years old (Stdbk #372, born 1973 in Sudan).

From the originally Dvur Kralove's animals, Dan and Sasha held at Usti nad Labem Zoo survived about 42 years; another male Natal still lives at Ostrava Zoo, in 2009, this rhino was about 38 years old.

The ISIS data indicate that male Arthur (Stdbk #355, the father of Nasi DK 2) born in the wild around 1966 still lived at Woburn Zoo, England, in September 2008, when he was about 42 years old. A male Lumpy (Stdbk #353) reached the age about 26 years at Knowsley Safari Park, while female Maggie (Stdbk #352) lived about 41 years at the same location; both rhinos were born in the wild around 1966.

A male Balthazar/Seventy (Stdbk #76), who was born at Pretoria Zoo on 23 October 1969, survived 33 years and 9 months at Beekse Bergen Safari Park, while female Mira (Stdbk #223) born in the wild in 1969 lived 36 years at the park above.

From Copenhagen Zoo, they report a male Ferdinand (Stdbk #93), who achieved the age of over 45 years, provided the expected date of birth was correct (around 1962, Umfolozi NP). Other wild-caught individuals (male Kruger - Stdbk #139, male Gus - Stdbk #91 and female Mashobeni - Stdbk #20) lived about 36 years, while a male Zulu Stdbk #90 and female Ukhukho/Paddy Stdbk #71 reached 37.5 and near to 42 years, respectively. In Whipsnade, 31 and 32 years was the age achieved by other animals from the wild, a male Jonny (Stdbk #92) and female Karibu (Stdbk #226).

According to the International Studbook (GOLTENBOTH and OCHS 1997), there was a single female living in captivity within the range 56-58 years, three males within the 38-40 category and five males within the range from 36 to 38 years in 1996.

The first animal held in captivity, which was a southern female Zuluana (born 1946, Stdbk #56), who survived 41 years in Pretoria, SA, which was the same age that was reached by the northern male Ben (born 1950, Stdbk #19) (BLASZKIEWITZ 1991).

Nutrition and feeding

Feeding in white rhinos is not problematic, although it appears that this species, unlike the black rhinoceros, can sometimes suffer from obesity and overfeeding (CLAUSS *et al.* 2005).

Throughout the history of the white rhino stock in Dvur Kralove, the rations underwent several changes that are presented in the table, which is documenting the efforts to stimulate breeding through changes in diet in the late 1980s, where it was rather concentrated in winter, while in April the percentage of pellets was reduced and a considerable portion of fresh green grass served.

Grass and hay form the basis of the diet. (dh)

A birthday 'cake' of Najin DK 7, Fatu DK 9 and Nabire DK 5 (th)

Comparison of white rhino diets at Dvur Kralove Zoo

1986 diet (SPALA 1986)	1990 diet	Diet since 2001
Hay October to February: 19 kg March to May: 13 kg June to September: 9 kg Meadow stand June to September: 40 kg	Hay - *ad libitum* Summers: added grass and hay	Hay - *ad libitum* Summers: added grass and hay
ZOO I pellets October to February: 2 kg/animal March to May: 6 kg/animal	ZOO C pellets: 3 kg	ZOO C pellets: 3.5 kg
Crushed oats October to February: 3 kg/animal March to May: 0	Carrots - in winter: 5 kg / twice a week	Carrots: 2 kg in winter Fruits and vegetables: 4 kg
Carrots October to February: 3 kg March to May: 6 kg		Bread - 1 kg 1 bread roll
Dried alfalfa March to May: 4 kg		Oat germs - 1 kg
Skimmed milk March to May: 0.5 kg		Mineral licks (Aminovitan): 1 table spoon
Biosan (vitamins): 60 g/animal/day		Vitamix standard + H: 2 + 2 table spoons
		Fodder limestone: 1 table spoon
		Combisol 4: 1(4) ml/day Combisol A: 1 ml/month

The basis for the diet is high-quality grass hay supplemented with straw, and meadow grass in summer. This bulk feed as well as water is available to the animals *ad libitum*. In the winter, carrots are fed instead of fresh grass. In nursing females and growing calves, limestone and skimmed milk powder is added to the diet (PTACKOVA 2009). The current basic diet is shown in the following table. ZOO C pellets (manufacturer De Heus, Bucovice, CR) is produced according to the recipe developed directly in Dvur Kralove (SPALA 1986), with the nutritional levels as given in the following table.

Basic diet of the white rhinoceros at Dvur Kralove Zoo in 2009 (PTACKOVA 2009)

Hay Grass	ZOO C pellets	Wheat bran	Bread	Aminovitan (Mineral licks)	NutriHorse Chondro
Ad libitum	2.8 kg	0.4 kg	0.3 kg	0.04 kg	0.07 kg

The diet includes the following supplements: C - Compositum 50 g/animal 3 times per week and vitamins A, B and E once per month.

Nutritional values of the pelleted feeds for white rhinos at Dvur Kralove Zoo (PTACKOVA 2009)

Pellets/contents	ZOO C pellets
Nitrogen substances (N)	115.84 g/kg
Fat	29.49 g/kg
Fibre	111.71 g/kg
Vitamin A	40,849 IU/kg
Vitamin E	117.30 IU/kg
Calcium (Ca)	16.39 g/kg
Sodium (Na)	2.70 g/kg
Phosphorus (P)	12.07 g/kg

Health issues

Throughout the years, internal and external parasites were not an issue in the rhinos, except for the period immediately after the arrival from the wild, when the *Anoplocephala* genus of tapeworms was found at an occasional basis (VAHALA pers. comm.). Additionally, parasite borne ulcer-like skin lesions (filaria) were recorded shortly after arrival, but disappeared with time (VAHALA pers. comm.).

In the northern form, two cases of death as a result of shock occurred, the first of which followed upon painful rupture of pubic symphysis (Nuri), while the second was the death of female Nasima that had blocked in a restraint chute during a process of sampling. Nasima spontaneously aborted her last calf less than a year prior her death, when she had reached day 296 of pregnancy. This was preceded by prolapsed uterine, which unfortunately repeated despite the veterinary treatment. Generally, white rhinos did not almost suffer any health problems, except for overgrown hooves in females and mucus discharged from nostrils. On the other hand, the absent breeding in most of the females, who in fact lacked the cycle, was an issue. Therefore, the veterinary management focused in particular on efforts to make the non-breeding females reproduce, which comprised gynaecological examinations including hymen perforation, hormonal stimulation and several assisted insemination attempts. In the non-breeding females, namely Nasi, Nesari and Nabire, ovarial (cysts) and uterine (tumours) disorders appeared as a result of failed function of reproduction organs.

In the southern form, there were two cases of death of young rhinos not long after their import from Africa as a result of transport (imported female #5 and male #8). In addition, a newborn calf died in a single event, again as a result of trauma, as female Faith gave birth without being expected to do so in the company of other two females.

The reasons for death are outlined in the table below (VAHALA - post mortem reports).

Hoof trimming carried out by Dr J Vahala (dh)

Young Najin DK 7, 3 May 1994 (lh)

Causes of deaths in the white rhinoceros at Dvur Kralove Zoo prior to 31 December 2009
(N = northern form, S = southern form)

No.	Name	Sex	Total died	Age	Cause of death
5/5/DK/0	- S	F	28 Sep 1970	3 years	Died on day 21 following the transport - possibly pneumonia
8/8/DK/0	Faru S	M	12 Jun 1972	1.5 years	Died on day 12 following the transport
21/0/DK/1	Fali S	M	15 Aug 1976	At birth	Trauma - ruptured lung when born in the group of three females, weighed 58.5 kg
19/19/DK/0	Nuri N	F	4 Jan 1982	9 years	Collapsed when slipped on ice, shocked following a painful pelvis injury
29/23/DK/0	Ben N	M	25 Jun 1990	40 years	Euthanised for age, unable to stand up; weight 1,460 kg
33/0/DK/8	- N	F	18 Jul 1991	Abortion	Spontaneous abortion of Nasima on pregnancy day 296, weight 17.2 kg
22/21/DK/0	Nasima N	F	28 Jun 1992	27 years	Collapsed when fell in the chute after her horn has blocked, weight 1,680 kg
15/15/DK/0	Saut N	M	25 Feb 2006	34 years	Heart failure
24/0/DK/2	Nasi NxS	F	20 Jun 2007	30 years	Euthanised for tumour-like disease of uterus

Exports of white rhinoceroses

Throughout the white rhino collection history, all individuals of the southern form kept in Dvur Kralove were exported, as the southern white stock was discontinued. In a single case, a male left after having passed the quarantine period provided by Dvur Kralove for Liberec Zoo. Any later departures related to the efforts of making the northern form reproduce, when first 3 (1.2) animals left for San Diego WAP, California, in 1989. A southern white rhino pair was imported to Dvur Kralove and added to the remaining northern animals to stimulate the breeding behaviour; however, as these rhinos were too old for stimulating, which especially applied to the female, they left in 1996. In the same year, Doran, a southern white male placed in Dvur Kralove only as part of cooperation between two Czech zoos breeding the white rhino, left as well.
Within the Last Chance to Survive project, through which Dvur Kralove Zoo has attempted to save the northern form, the last remaining 4 (2.2) northern white rhinos with breeding potential held in captivity were moved to the Ol Pejeta Conservancy, Kenya. In total, 25 (9.16) white rhinos left Dvur Kralove, including 7 (3.4) animals of the northern form.

Overview of white rhinos exported from Dvur Kralove Zoo prior to 31 December 2009 (M - male, F - female)

No.	Sex	Name	Stdbk #	Departure	Born	Arrival	Comments
1	F	Dinah S	208	30 Oct 1994, Ostrava	1970, Umfolozi, SA	31 May 1972, Umfolozi, SA	† Ostrava
2	M	Natal S	371	30 Oct 1994, Ostrava	1971, Umfolozi, SA	9 Jul 1973, Umfolozi, SA	Still alive
3	F	Uzima S	910	12 Nov 1974, Demmer	19??, Umfolozi, SA	9 Jul 1973, Umfolozi, SA	
4	F	Edita S	113	3 Jun 1976 Liberec	1966, Umfolozi, SA	23 Jun 1970, Umfolozi, SA	† Liberec
5	M	Rushden S	279	19 Oct 1976, Liberec	15 Oct 1974, Whipsnade, England	7 Sep 1976, Gelsenkirchen, Germany	† Liberec
6	F	Vanda S	115	27 Apr 1979, Gelsenkirchen, Germany	1967, Umfolozi, SA	15 Oct 1970, Umfolozi, SA	Southern form stock discontinued
7	M	Joe S	110	12 Jul 1979, Lesna	1965, Umfolozi, SA	2 Jun 1970, Umfolozi, SA	Southern form stock discontinued
8	F	Zuzi S	112	12 Jul 1979 Lesna	1966, Umfolozi, SA	2 Jun 1970, Umfolozi, SA	Southern form stock discontinued

No.	Sex	Name	Stdbk #	Departure	Born	Arrival	Comments
9	F	Fatty DK 2 S	530	26 Jul 1979 Veszprem, Hungary	4 Apr 1978 Dvur Kralove	Reared	Southern form stock discontinued
10	F	Tessa S	210	1 Oct 1980 Wroclaw, Poland	1970, Umfolozi, SA	31 May 1970, Umfolozi, SA	Southern form stock discontinued
11	F	Faith S	211	4 Nov 1980 Katowice, Poland	1970, Umfolozi, SA	31 May 1970, Umfolozi, SA	Southern form stock discontinued
12	F	Smudla S	307	3 Oct 1980 Wroclaw, Poland	1973, SA	5 Oct 1977 Demmer, Langato	Southern form stock discontinued
13	M	Teny DK 4 S	531	29 Oct 1980 Wroclaw, Poland	16 Dec 1978, Dvur Kralove	Reared	Southern form stock discontinued
14	F	Sasha S	114	19 Nov 1980, Usti n/L	1966, Umfolozi, SA	23 Jun 1970, Umfolozi, SA	Southern form stock discontinued
15	F	Zamba S	209	19 Nov 1980, Usti n/L	1970, Umfolozi, SA	31 May 1970, Umfolozi, SA	Southern form stock discontinued
16	M	Dan S	111	4 Dec 1980, Usti n/L	1966, Umfolozi, SA	15 Oct 1970, Umfolozi, SA	Southern form stock discontinued
17	M	Saut N	373	14 Oct 1989 San Diego WAP USA	1972, Sudan	19 Sep 1975, Sudan	Loaned to the USA as part of efforts to make the northern subspecies reproduce
18	F	Nola N	374	14 Oct 1989 San Diego WAP USA	1974, Sudan	19 Sep 1975, Sudan	Loaned to the USA as part of efforts to make the northern subspecies reproduce
19	F	Nadi N	376	14 Oct 1989 San Diego WAP USA	1972, Sudan	19 Sep 1975, Sudan	Loaned to the USA as part of efforts to make the northern subspecies reproduce
20	M	Doran S	970	25 Jun 1996 Belo Horizonte, Brazil	13 Jan 1980 Usti n/L	21 Apr 1980, Usti n/L	Loaned due to space issues in Usti n/L
21	M	Frankie S	127	9 Jul 1996 Aywaille, Belgium	14 Jan 1969 Pretoria, SA	24 Aug 1990 Cologne, Germany	Loaned as part of efforts to make the northern subspecies reproduce
22	F	Sanni S	199	9 Jul 1996 Aywaille, Belgium	1966 Looskopdam, SA	24 Aug 1990 Cologne, Germany	Loaned as part of efforts to make the northern subspecies reproduce
23	M	Sudan N	372	19 Dec 2009, Ol Pejeta Conservancy, Kenya	1973, Sudan	19 Sep 1975, Sudan	Last Chance to Survive Project
24	M	Suni N	630	19 Dec 2009, Ol Pejeta Conservancy, Kenya	8 Jun 1989 Dvur Kralove	Reared	Last Chance to Survive Project
25	F	Najin N	943	19 Dec 2009, Ol Pejeta Conservancy, Kenya	11 Jul 1989 Dvur Kralove	Reared	Last Chance to Survive Project
26	F	Fatu N	1305	19 Dec 2009, Ol Pejeta Conservancy, Kenya	29 Jun 2000 Dvur Kralove	Reared	Last Chance to Survive Project
In total, 26 (10.16) individuals were exported, of which 4 (2.2) were returned to the wild in Africa.							

N = northern form, S = southern form

Summary

Dvur Kralove Zoo has held both forms of the white rhinoceros, with 14 (3.11) southern whites and 6 (2.4) northern white rhinos imported from the wild from 1970 to 1973 and 1977, respectively. From 1976 to 1978, 3 (2.1) calves of the southern form were born; however, the southern stock was discontinued in 1980 to provide more space for the northern subspecies. Throughout the history of the stock, 6 (1.5) northern white rhinos were born, of which the first calf was a subspecific hybrid, as its mother was mated by a southern white male at Knowsley Zoo, England. Out of all 9 (3.6) white rhino infants, 7 (1.5) were successfully reared. Dvur Kralove Zoo, in an attempt to make the northern subspecies reproduce, sent first their 3 (1.2) rhinos only 14-15 years old on the basis of international discussions to the Wild Animal Park San Diego, USA, where they however were not successful in making the animals breed. As the most recent northern white rhino was born in 2000, though that animal was an F2 generation in captivity, and females held in zoological parks are known to fail cycling very frequently, the 4 (2.2) last remaining fertile captive animals were sent to the Ol Pejeta Conservancy, Kenya within the Last Chance to Survive project in December 2009; that is why Dvur Kralove Zoo currently holds only 2 non-breeding females of the northern subspecies. More details about the white rhino stock throughout almost 40 years are compiled in the following table.

Numbers of white rhinos at Dvur Kralove Zoo in the period from 1970 to 2009 (1.0 - male, 0.1 - female)

YEAR	Status as per 1 Jan	Arrival	Departure	Total born	Death	Status as per 31 Dec
1970	0	6 (2.4) S	-	-	-	6 (2.4)
1971	6 (2.4)	-	-	-	-	6 (2.4)
1972	6 (2.4)	5 (1.4) S	-	-	1 (1.0) S	10 (2.8)
1973	10 (2.8)	2 (1.1) S	-	-	-	12 (3.9)
1974	12 (3.9)	-	3 (1.2) S	-	-	9 (2.7)
1975	9 (2.7)	6 (2.4) N	-	-	-	15 (4.11)
1976	15 (4.11)	-	1 (0.1) S	1 (1.0) S	1 (1.0) S	14 (4.10)
1977	14 (4.10)	2 (0.2) N+S		1 (0.1) N x S	-	17 (4.13)
1978	17 (4.13)	-	-	2 (1.1) S	-	19 (5.14)
1979	19 (5.14)	-	4 (1.3) S	-	-	15 (4.11)
1980	15 (4.11)	-	7 (2.5) S	1 (1.0) N		9 (3.6)
1981	9 (3.6)			-		9 (3.6)
1982	9 (3.6)			-	1 (0.1) N	8 (3.5)
1983	8 (3.5)			1 (0.1) N	-	9 (3.6)
1984	9 (3.6)			-	-	9 (3.6)
1985	9 (3.6)			-	-	9 (3.6)
1986	9 (3.6)	1 (1.0) N	-	-	-	10 (4.6)
1987	10 (4.6)	-	-	-	-	10 (4.6)
1988	10 (4.6)	-	-	-	-	10 (4.6)

YEAR	Status as per 1 Jan	Arrival	Departure	Total born	Death	Status as per 31 Dec
1989	10 (4.6)	-	3 (1.2) N	1 (0.1) N	-	8 (3.5)
1990	8 (3.5)	2 (1.1) S			1 (1.0) N	9 (3.6)
1991	9 (3.6)	-		1 (0.1) N	1 (0.1) N	9 (3.6)
1992	9 (3.6)	-		-	1 (0.1) N	8 (3.5)
1993	8 (3.5)	1 (1.0) S		-	-	9 (4.5)
1994	9 (4.5)	-		-	-	9 (4.5)
1995	9 (4.5)	-		-	-	9 (4.5)
1996	9 (4.5)	-	3 (2.1) S		-	6 (2.4)
1997	6 (2.4)	-			-	6 (2.4)
1998	6 (2.4)	1 (1.0) N			-	7 (3.4)
1999	7 (3.4)	-			-	7 (3.4)
2000	7 (3.4)	-		1 (0.1) N	-	8 (3.5)
2001	8 (3.5)	-		-	-	8 (3.5)
2002	8 (3.5)	-		-	-	8 (3.5)
2003	8 (3.5)	-		-	-	8 (3.5)
2004	8 (3.5)	-		-	-	8 (3.5)
2005	8 (3.5)	-		-	-	8 (3.5)
2006	8 (3.5)	-		-	1 (1.0) N	7 (2.5)
2007	7 (2.5)	-		-	1 (0.1) NxS	6 (2.4)
2008	6 (2.4)	-		-	-	6 (2.4)
2009	6 (2.4)	-	4 (2.2) N	-	-	2 (0.2)
Total	-	**26 (10.16)**	**25 (9.16)**	**9 (3.6)**	**8 (4.4)**	-
Total southern form	-	**17 (6.11)**	**18 (6.12)**	**3 (2.1)**	**2 (2.0)**	-
Total northern form	-	**9 (4.5)**	**7 (3.4)**	**5 (1.4) + 1 (0.1) N x S**	**5 (2.3) + 1 (0.1) N x S**	-
Total hybrids	-	-	-	**1 (0.1)**	**1 (0.1)**	-

N = northern form, S = southern form

The overview on page 250 - 252 contains basic historical information about the individual white rhinos that were a Dvur Kralove Zoo property.

BASIC GUIDELINES FOR REARING THE WHITE RHINOCEROS

On the basis of almost 40 years of experience, principles of breeding and managing in Dvur Kralove to create optimal conditions for the white rhinos can be summarised as follows:

1. **Nutrition is not very complicated**; the diet consists of high-quality hay, grass, fruits, vegetables and pellets. Animals should be weighed on a periodical basis to ensure inspection.
2. **If kept in a group situation, sufficient space is required, even though introducing to males is usually nothing dramatic.** A group of rhinos can be released into the outside enclosure daily except for extreme outdoor temperatures with potential inclusion of a male over unlimited periods of time.
3. **Monitoring the females' cycling and pregnancy using faeces is very important,** as it will allow for early separation of the female prior birth.
4. **When the female is about to give birth, timely isolation into a separate box** is necessary, where a temporary barrier between the fence openings above the ground is required to prevent the calf to escape from the box. **Monitoring the process of birth and the behaviour of the female after the birth using CCTV with a recording feature is the best choice;** this will allow for evaluation of the behaviour of mother and calf, as well as monitoring of the nursing process. For a better stability of the calf when trying to stand up after the birth, sprinkling little sand around the box is advisable, which depends on the slipperiness of the wet floor.
5. Breeding is the biggest issue, as females tend to fail cycling. Keeping in a pair situation will not result in breeding, and even holding the animals in groups is not sufficient to make the females cycling. Inducing oestrus seems to need changes in social links, for instance by exchanging the male or separating the female with the calf following the birth and subsequent return of the female into the group. Permanent keeping the mother with her subadult daughter has appeared to prevent the mother cycling.
6. **Having good keepers is fundamental.**

History of white rhino keeping at Dvur Kralove Zoo prior to 31 December 2009

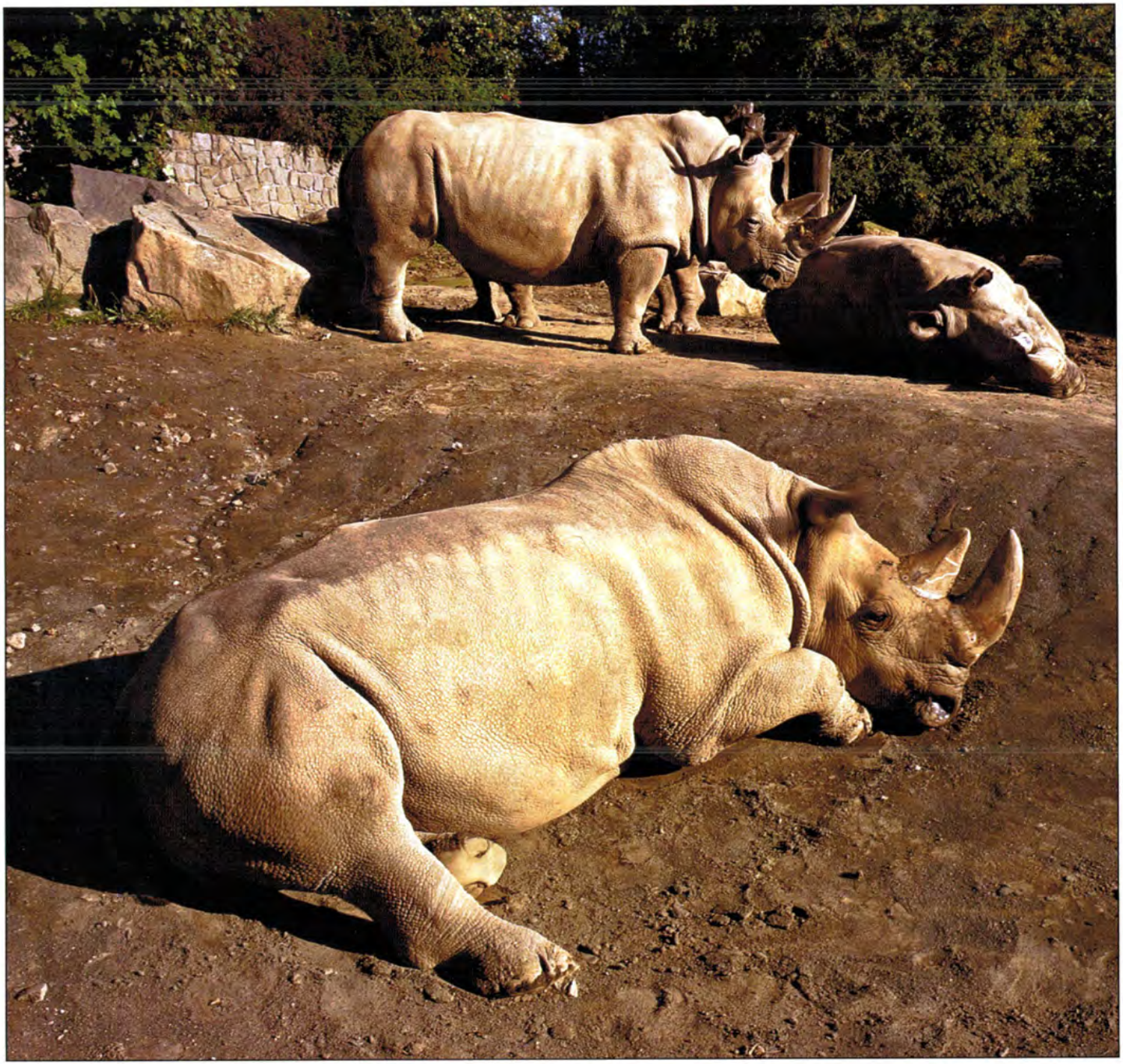
(M - male, F - female; blue: northern form animals)

No. Name	Sex	Stdbk # ARKS	Born	Arrival in DK Parents	Departure from DK	Died	Comments
1/1/DK/0 **Joe**	M	110 117004	1965 Umfolozi NP	2 Jun 1970 Wild-caught, SA	12 Jul 1979 Lesna		
2/2/DK/0 **Zuzi**	F	112 117006	1966 Umfolozi NP	2 Jun 1970 Wild-caught, SA	16 Jul 1979 Lesna		
3/3/DK/0 **Edita**	F	113 117007	1966 Umfolozi NP	23 Jun 1970 Wild-caught, SA	3 Jun 1976 Liberec		
4/4/DK/0 **Sasha**	F	114 117008	1967 Umfolozi NP	23 Jun 1970 Wild-caught, SA	19 Nov 1980 Usti n/L	† 21 Mar 2008 Usti n/L	Euthanised
5/5/DK/0 —	F	1158 117021	15 Oct 1967 Umfolozi NP	7 Sep 1970 Soest, Brink	-	† 28 Sep 1970 Dvur Kralove	Died in the quarantine period Probably pneumonia
6/6/DK/0 **Dan**	M	111 117005	1970 Umfolozi NP	15 Oct 1970 Wild-caught, SA	4 Dec 1980 Usti n/L	†28 Mar 2008 Usti n/L	1st breeding male High age
7/7/DK/0 **Vanda**	F	115 117009	1967 Umfolozi NP	15 Oct 1970 Wild-caught, SA	27 Apr 1979 Ruhe		

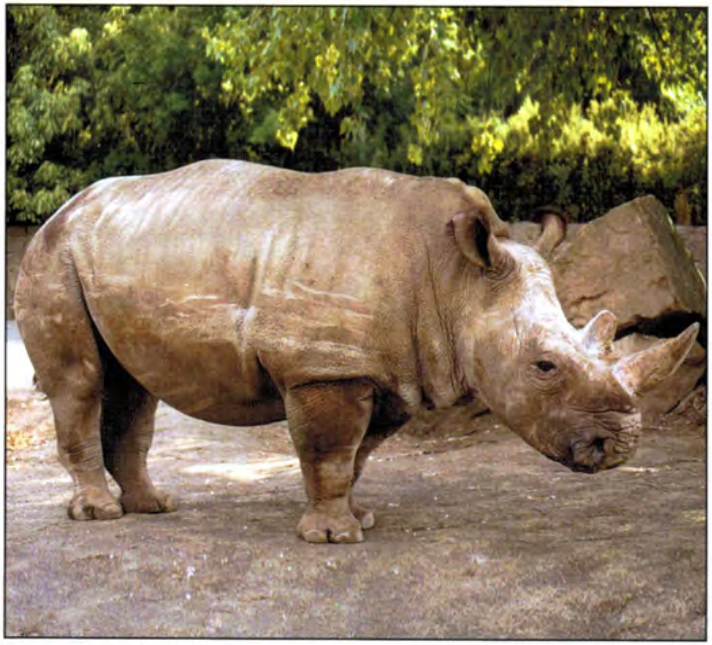
No. Name	Sex	Stdbk # ARKS	Born	Arrival in DK Parents	Departure from DK	Died	Comments
8/8/DK/0 **Faru**	M	892 117020	1971 Umfolozi NP	31 May 1972 Wild-caught, SA	-	12 Jun 1972 Dvur Kralove	Died in the quarantine period, trauma
9/9/DK/0 **Dinah**	F	208 117010	1970 Umfolozi NP	31 May 1972 Wild-caught, SA	30 Oct 1994 Ostrava	† 7 Mar 2008 Ostrava	
10/10/DK/0 **Zamba**	F	209 117011	1970 Umfolozi NP	31 May 1972 Wild-caught, SA	19 Nov 1980 Usti n/L		Still alive
11/11/DK/0 **Tessa**	F	210 117012	1970 Umfolozi NP	31 May 1972 Wild-caught, SA	1 Oct 1980 Wroclaw, Poland		3rd breeding female
12/12/DK/0 **Faith**	F	211 117013	1970 Umfolozi NP	31 May 1972 Wild-caught, SA	29 Oct 1980 Katowice, Poland		1st breeding female
13/13/DK/0 **Natal**	M	371 117016	1971 Umfolozi NP	9 Jul 1973 Wild-caught, SA	30 Oct 1994 Ostrava		Son of Uzima Still alive
14/14/DK/0 **Uzima**	F	910 117019	1965 Umfolozi NP	9 Jul 1973 Wild-caught, SA	12 Nov 1974 Demmer		Mother of Natal
15/15/DK/0 **Saut**	M	373 059002	9.1972 Sudan	19 Sep 1975 Wild-caught, Sudan 15 Jul 1998 San Diego WAP (USA)	14 Oct 1989 San Diego WAP (USA)	14 Aug 2006 Dvur Kralove	2. 2nd breeding male Loaned to the USA - returned
16/16/DK/0 **Sudan**	M	372 059001	1973 Sudan	19 Sep 1975 Wild-caught, Sudan	19 Dec 2009 Ol Pejeta, Kenya		3rd breeding male Loaned to Kenya
17/17/DK/0 **Nadi**	F	376 059005	1972 Sudan	19 Sep 1975 Wild-caught, Sudan	14 Oct 1989 San Diego WAP (USA)		Breeding loan Returned from loan
18/18/DK/0 **Nesari**	F	377 059006	1972 Sudan	19 Sep 1975 Wild-caught, Sudan	-		
19/19/DK/0 **Nuri**	F	375 059004	1973 Sudan	19 Sep 1975 Wild-caught, Sudan	-	4 Jan 1982 Dvur Kralove	Trauma, collapsed, shock - fell on ice
20/20/DK/0 **Nola**	F	307 059003	1974 Sudan	19 Sep 1975 Wild-caught, Sudan	14 Oct 1989 San Diego WAP (USA)		
21/0/DK/1 **Fali DK 1**	M	??? 117014	15 Aug 1976 Dvur Kralove	Reared Faith/Dan	-	15 Aug 1976 Dvur Kralove	Trauma - ruptured lung, born inside a group
22/21/DK/0 **Nasima**	F	351 059007	1965 Uganda	27 Aug 1977 Knowsley, UK	-	28 Jun 1992 Dvur Kralove	Name in the UK: Twink 3rd breeding female Collapse - shock

No. Name	Sex	Stdbk # ARKS	Born	Arrival in DK Parents	Departure from DK	Died	Comments
23/22/DK/0 **Smudla**	F	307 117015	1973 Umfolozi NP	5 Oct 1977 Langato	3 Oct 1980 Wroclaw, Poland		
24/0/DK/2 **Nasi DK 2**	F	476 059008	11 Nov 1977 Dvur Kralove	Reared Nasima/southern form	-	20 Jun 2007 Dvur Kralove	Tumour in uterus
25/0/DK/3 **Fatty DK 3**	F	530 117017	4 Apr 1978 Dvur Kralove	Reared Faith/Dan	26 Jul 1979 Veszprem, Hungary		
26/0/DK/4 **Teny DK 4**	M	531 117018	16 Dec 1978 Dvur Kralove	Reared Tessa/Dan	1 Oct 1980 Wroclaw, Poland		
27/0/DK/5 **Suni DK 5**	M	630 059009	8 Jun 1980 Dvur Kralove	Reared Nasima/Saut	19 Dec 2009 Ol Pejeta, Kenya		Loaned to Kenya
28/0/DK/6 **Nabire DK 6**	F	789 059010	15 Nov 1983 Dvur Kralove	Reared Nasima/Sudan	-		
29/23/DK/0 **Ben**	M	019 059011	1950 Sudan	27 Aug 1986 London Zoo, UK	-	25 Jun 1990 Dvur Kralove	Euthanized due to high age
30/0/DK/7 **Najin DK 7**	F	943 059012	11 Jul 1989 Dvur Kralove	Reared Nasima/Sudan	19 Dec 2009 Ol Pejeta, Kenya		4th breeding female Loaned to Kenya
31/24/DK/0 **Frankie**	M	127 117001	14 Jul 1968 Looskopdam, SA	24 Aug 1990 Cologne, Germany	9 Jul 1996 Aywaille, Belgium		Loan as part of efforts to make the NWR breed
32/25/DK/0 **Sanni**	F	199 117002	18 May 1966 Umfolozi, SA	24 Aug 1990 Cologne, Germany	9 Jul 1996 Aywaille, Belgium		Loan as part of efforts to make the NWR breed
33/0/DK/8 —	F	1122 059013	18 Jul 1991 Dvur Kralove	Reared Nasima/Sudan		18 Jul 1991 Dvur Kralove	Abort - placed in National Museum Prague
34/26/DK/0 **Doran**	M	970 117003	13 Jan 1991 Usti n/L	16 Apr 1993 Usti n/L	25 Jun 1996 Belo Horizonte, Brazil		Loaned as part of assistance
35/0/DK/9 **Fatu DK 9**	F	1305 059014	29 Jun 2000 Dvur Kralove	Reared Najin/Saut	19 Dec 2009 Ol Pejeta, Kenya	-	F2 - the Baby of the Millennium Loaned to Kenya

Explanation for figures: 13/13/DK/0: 13 - Historical (time) serial number of individual at Dvur Kralove Zoo
13 - Historical serial number of import to Dvur Kralove Zoo
DK - Dvur Kralove Zoo symbol
0 - Historical serial number of birth at Dvur Kralove Zoo



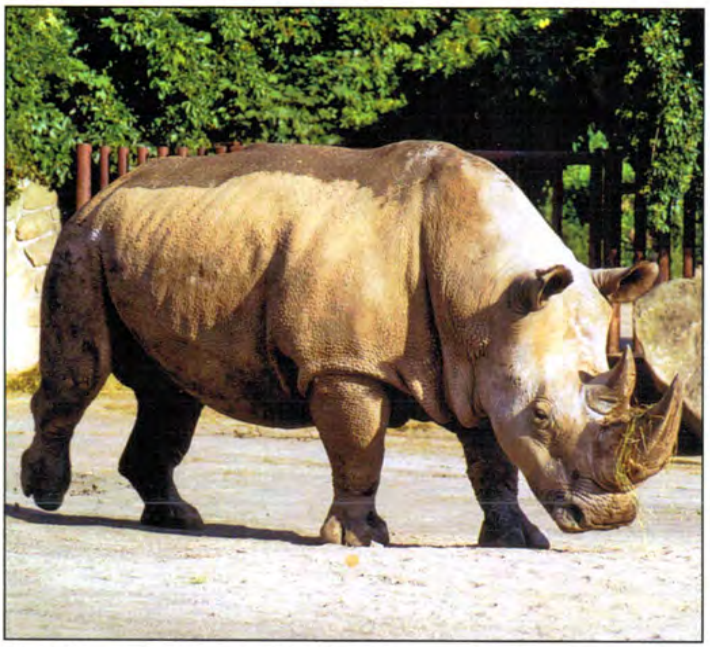
Northern white rhinos in the outdoor enclosure, 2002 (mp)



Young Najin DK 7 (dh)

The modified horn in adult Najin DK 7 (dh)

Sudan (left), Nasi DK 2 and Nabire DK 6 (far right) being united (dh)

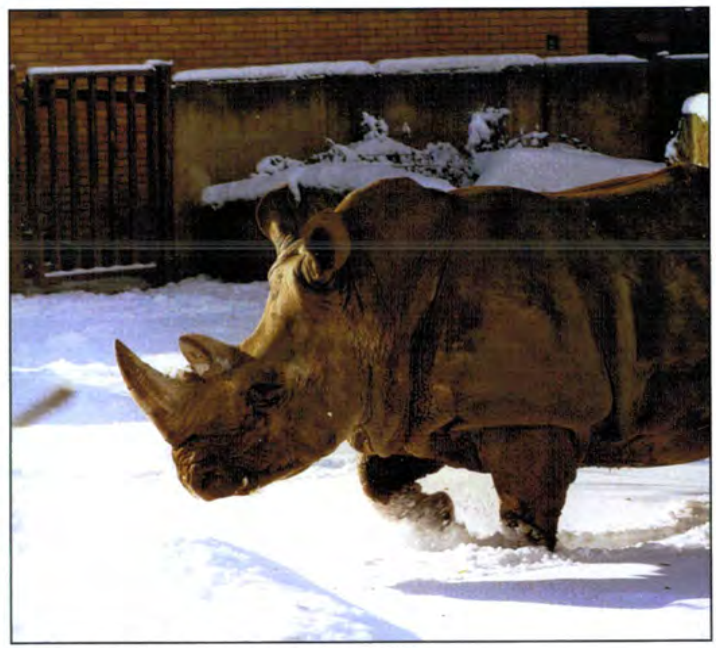


Suni DK 5 was the heaviest white rhino, with as much as 2.4 t measured. (dh)

Northern white rhinos in winter

Najin DK 7 and Fatu DK 9 outdoors, 2001 (dh)

Suni DK 5 in the snow (th)



Young Najin DK 7 ranging in the snow (dh)

Sudan savouring Kenyan vegetation for the first time, 21 December 2009 (dh)