# REPRODUCTION OF WHITE RHINOCEROS (CERATOTHERIUM SIMUM) AND BLACK RHINOCEROS (DICEROS BICORNIS) IN CAPTIVITY

IRENEUSZ DĄBROWSKI[1], TADEUSZ KALETA[2], JAN ŚMIEŁOWSKI[3]

[1]. Miejski Ogród Zoologiczny We Wrocławiu, ul. Wróblewskiego 1/5, 51-618 Wrocław
[2]. Animal Genetics, Warsaw Agricultural University, ul. Ciszewskiego 8, 02-786 Warsaw, Poland
[3]. Agricultural Academy, ul. Wojska Polskiego 28, 60-637 Poznań, Poland
Corresponding author: Ireneusz Dąbrowski irekdab@o2.pl

Abstract

Although populations are on a stable level (Foose, 2006), however, this is not only due to the reproduction of the animals kept in captivity, but in case of white rhinos the yearly animals imported from the wild are important factors influencing the growth rate. Between years 1976-1982, 1984-1988, 1998-2002 three peaks in the number of births.
In total 744 birth , the most successful year was 1979 when 43 white rhinoceroses (26 males, 17 females) were born.
Maximum numbers of offspring of white rhinoceros occurred between the 8th and 15th and in the 18th year of mother life. Generally the number of births decreased with age, The highest number of births among black rhinos occurred between the 7th and the 15th year of mother life
Among 202 females whose pregnancies were recorded in studbooks, 39.1% were pregnant only once, whereas 7.9% were pregnant at least 10 times till the beginning of 2005. Among 443 females imported from the wild, only 156 were pregnant until 2005. Seventeen females were pregnant already during transport, which means they had been conceived in the wild. Among 301 males imported from the wild, only 92 took part in reproduction successfully until 2005. ). The average amount of pregnancies per one female in captivity and in the wild was respectively 0.6 i 0.8. F= 3.861, p= 0.233.
In captivity females of both species had their first offspring 2-3 years later than those in the wild.

Keywords: reproduction, white rhinoceros, Ceratotherium simum, black rhinoceros, Diceros bicornis

## Introduction

Nowadays, the two species of African rhinoceros, black rhinoceros (Diceros bicornis) and white rhinoceros (Ceratotherium simum) are the most numerous representatives of their family: more than 3724 and around 14,542 living individuals, respectively (Internet 1). In comparison, Asian species are much less numerous: Indian rhinoceros (Rhinoceros unicornis) - 2,400 individuals, Sumatran rhinoceros (Dicerorhinus sumatrensis) - 300, Javan Rhinoceros (Rhinoceros sondaicus) - 70 (Internet 1). Despite a huge demand for their horns, mainly on the Asian market, there is an increasing tendency in the number of the animals. This is due to successful in situ conservation. Effective preservation of rhinos' natural habitats should be accompanied by their self-sufficient breeding in captivity, in zoos and safari parks. This form of preservation should aim to collect a diversified gene bank of both species, in case if the catastrophe like the slaughter of African rhinos that happened in second half of XX century was to repeat. The role of zoos can be fulfilled only

when breeding of rhinoceroses is coordinated not only at the country or continent level, but between all the institutions keeping black or white rhinoceroses.
In 1966 dr Heinz-Georg Klos, the manager of the zoo in West Berlin, started to collect the data to the studbooks of the both African species of rhinos. In 1970 the books were published for the first time, and since then updated consecutively. Since 1981 the data has been published as the "International Studbook of African Rhinoceroses". Since 1995 Andreas Ochs has become the new global studbook keeper (Rookmaaker, 1998). The last issue of studbooks for both African rhino species was published in 2005.

The aim of the study was to investigate some trends in breeding as well as the current condition of the animals kept in captivity, basing on the studbooks of the White and Black Rhinos (Ochs, 2005a, 2005b).

Material and methods

The material to this investigation were the newest studbooks of white and black rhinoceros (Ochs 2005a, 2005b). However, older issues were used in cases of mistakes or the lack of data. In the 2005 issues, the chronological lists of animals reported until 1st January 2005 were published. They were organized by the date of the report, and not by the year of appearing in the collection of a particular zoo or other institution cooperating with the studbooks coordinator (Ochs, 2005a, 2005b). Each animal in the studbook is described by its own number, sex, parents, the date and place of birth, the dates and places of all its transfers, the current status and, if the animal has died, the date and the reason for death. Also the names, the number of offspring and the information which generation the animal represents (accepting that all the rhinos captived in the wild are the zero generation) are gathered. Basing on this information, the following has been established:

- Countries and places from which the zero generation animals originate
- The number of the animals that started the population
- The number of the offspring born
- The schedule of births during the year
- The average age of a male/female when having the first/ last calf
- The age and sex structure of the existing population

In the last issues of the studbooks of both species data concerning 1475 southern white (Ceratotherium simum simum), 28 northern white (C.s.cottoni), 773 eastern ecotype of black (Diceros bicornis michaeli), and 151 south-central ecotype of black (D.b.minor) rhinoceros was published. In this publication there is information about all the abortions/miscarriages and stillbirths confirmed.

Specimens born and reported in the first months of 2005 are included in the studbooks. The data concerning them was useful to elaborate the schedule of births during the year, establish the level of mortality and to find out main reasons for deaths in the group of animals till the third year of life.
In order to compare the parameters of reproduction of white rhinoceros females born in the wild (P) and born in captivity (F1, F2, F3), one way ANOVA was applied. The criteria of choosing the females were: the number of pregnancies of each female and her age, the lower limit being 4th year of life (reaching the reproduction age). Before performing the calculation, it was checked if analysed samples satisfyed the assumptions of the analysis of variance (both samples should be approximately normally distributed with equal variances). The variances in both samples proved to be significantly different, therefore an additional analysis of the data was necessary.

Results

The first white rhinoceros (southern subspecies) was born in the Pretoria Zoological Garden on 8th June 1967. Between years 1976-1982, 1984-1988, 1998-2002 three peaks in the number of births were reported (Fig. 1). First of them was a result of a large import of white rhinoceroses in years 1970-74. The females which then arrived to the Pretoria Zoological Garden gave births to the first time in captivity. The two other peaks resulted from parturitions by the females imported in the years 1976-1978 and 1998-1999. Also the males that reached their sexual maturity and the parturitions of females imported before 1976 were important factors influencing the high number of births.

In total 744 calves (399 males, 339 females, 6 unknown) were born in all the institutions cooperating with the studbook coordinator. The most successful year was 1979 when 43 white rhinoceroses (26 males, 17 females) were born.

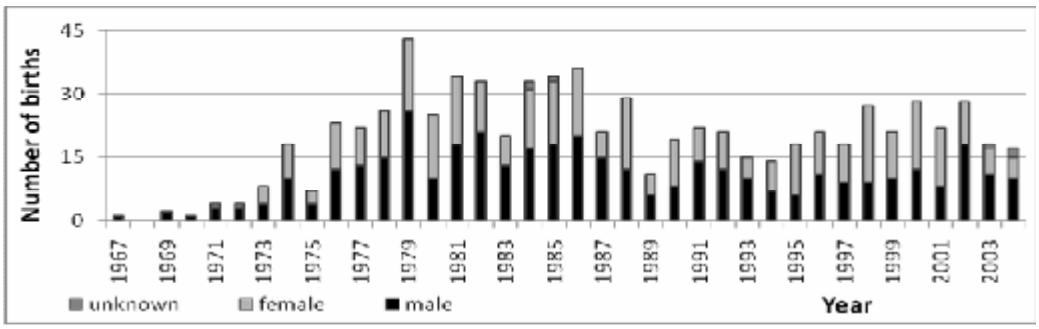


Figure 1. The number of white rhinoceroses born in captivity in successive years.

The first calf of black rhinoceros (eastern ecotype) was born in the Chicago Brookfield Zoo on 7th October 1941. Since 1960, almost every year the births were reported (Fig. 2). Increase in the number of births can be explained by the fact that the females from the respective generations reached their sexual maturity. In total, 504 black rhinoceroses (238 males, 251 females, 15 unknown) were born in all the institutions. The most successful year was 1997, when 24 calves (12 males, 10 females, 2 unknown) were born.

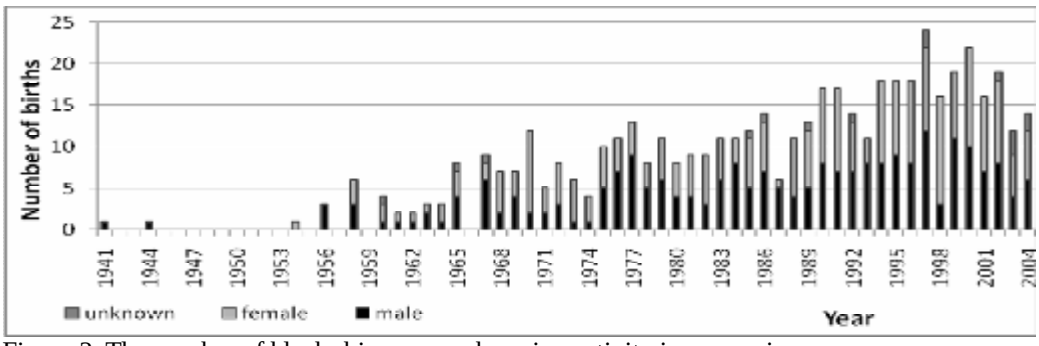


Figure 2. The number of black rhinoceroses born in captivity in successive years.

Parturitions among rhinoceroses kept in captivity took place all over the year, with a peak from September to January (Fig. 3). Average number of parturitions per month was 62,2 for white rhinos and 42,1 for black rhinoceros. For animals living in the wild a peak of calving was observed from March to July (Owen-Smith,1975).

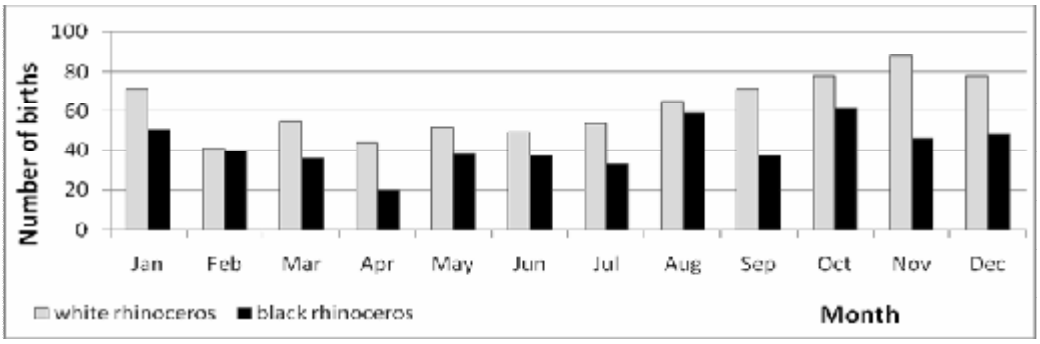


Figure 3. Distribution of white/black rhinoceroses' births during the year.

This is because, although rhinos reproduce un-seasonally, the geographical position of an institution and connected with this climate and seasons of the year influence the time of births. The animals exhibited in traditional zoos are often mated from spring till the late autumn, because the weather during winter could increase the risk of getting hurt during the courtship or copulation.

Maximum numbers of deliveries among white rhinoceros were recorded between the 8th and 15th and in the 18th year of mother life (Fig. 4). The high number of births in the 10th year of female life was a consequence of a large number of primiparae's deliveries at this age and successive childbirths of females that had given birth earlier (Fig. 4).

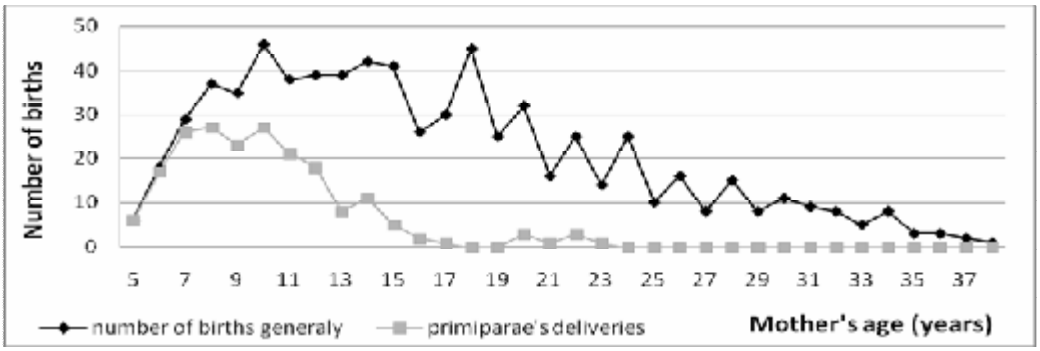


Figure. 4.Number of births of both northern and southern white rhinoceroses in relation to mother's age.

Although generally the number of births decreased with age, it was observed that between the 18th and 30th year of a female life, every two years the number of births increased. The highest level of primiparae's deliveries is observed between the 7th and the 11th year of life.

The highest number of births among black rhinos occurred between the 7th and the15th year of mother life (Fig. 5). In the 9th year of female life the maximum of deliveries was recorded

(analogously to white rhinoceroses). A peak of primiparae's deliveries took place between the 7th and the 9th year of mother life.

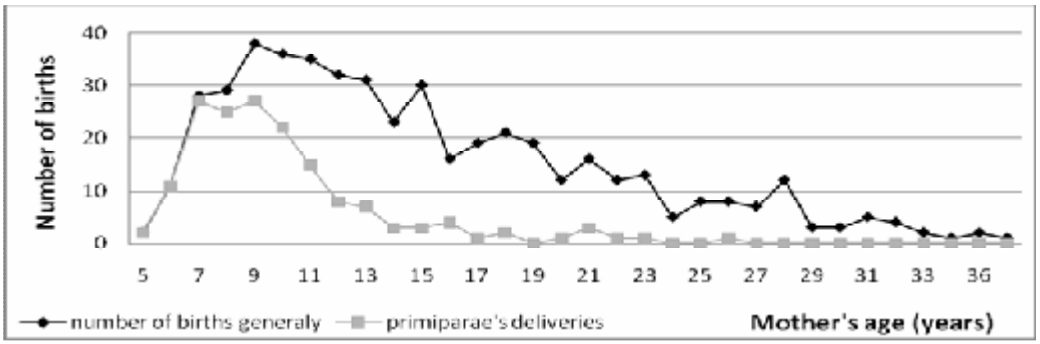


Figure 5. Number of births of black rhinoceroses (eastern and south-central ecotypes pooled) in relation to mother's age.

Among 202 females whose pregnancies were recorded in studbooks, 39.1% (79 specimens) were pregnant only once, whereas 7.9% (16 animals) were pregnant at least 10 times till the beginning of 2005 (Fig. 6). Among 443 females imported from the wild, only 156 were pregnant until 2005. Seventeen females were pregnant already during transport, which means they had been conceived in the wild.

Among 301 males imported from the wild, only 92 took part in reproduction successfully until 2005.

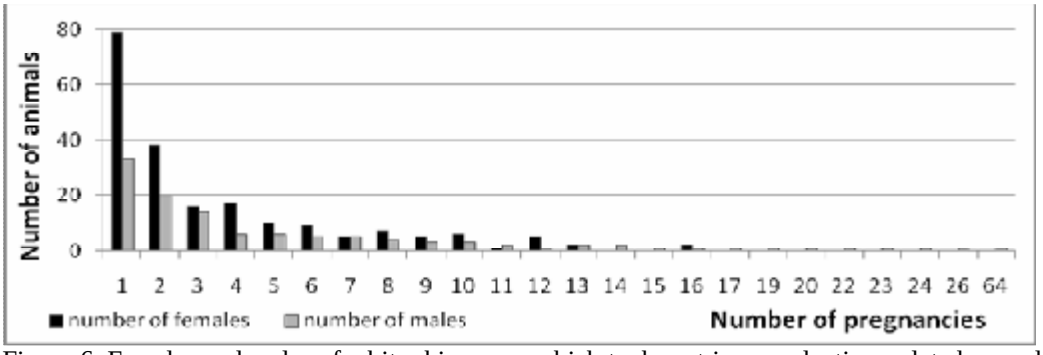


Figure 6. Females and males of white rhinoceros which took part in reproduction, related according to the number of pregnancies produced by them. The number of all pregnancies recorded in a studbook regardless to the result (life parturition, stillbirth, abortion) are included. For males "number of pregnancies" means the number of conceptions.

The ANOVA analysis showed that the assumption of the low limit of the females' age was insufficient, as the analysed sample of females born in the wild consisted of 165 females (almost 40% of the sample) at the age over 32, which combined with the lack of such animals in the sample consisting of specimens born in captivity could significantly distort the results of the test (overstate the amount of pregnancies per one female born in the wild). The average amount of pregnancies per

one female in captivity and in the wild was respectively 0.6 i 0.8. The one way analysis of variance gave the following results: F= 3.861, p= 0.233.

The p-value is significantly higher than the assumed level of significance ($p < 0.05$), which tells that there is no ground for rejecting the zero hypothesis (equality of average values in both groups).

Both the female record holders and the most successful male came from San Diego Wild Animals Park where the high number of pregnancies was a result of a male constant presence in the large female herd. There were 28,45% - 33 males that took part in reproduction successfully only once until 2005 of all 116 males that took part in reproduction. Twenty males (17,24%) conceived females at least 10 times (Fig. 6).

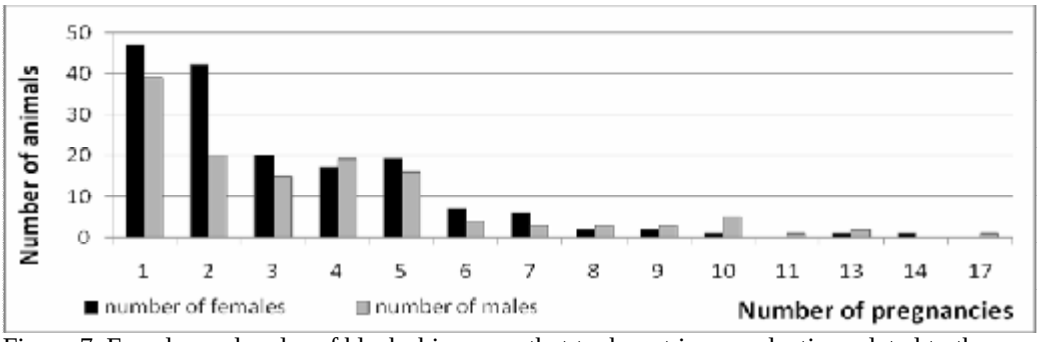


Figure 7. Females and males of black rhinoceros that took part in reproduction related to the number of pregnancies produced by them.

Fourty seven females (28.5%) whose pregnancy was recorded in a studbook until 2005 were pregnant only once (Fig. 7). Only 3 females (1.8%) were pregnant at least 10 times.

Fourty seven males (29.8%) which took part in reproduction successfully until 2005, conceived females only once. Nine males (6.9%) succeeded at least 10 times.

Among 202 females imported from the wild only 95 were pregnant until 2005. Among 184 males imported from the wild only 73 took part in reproduction successfully.

A female that reached the highest number of births (14) lived in the San Francisco Zoological Garden. Seventeen most successful males and a female having been pregnant 13 times lived in the Hiroshima Zoological Garden.

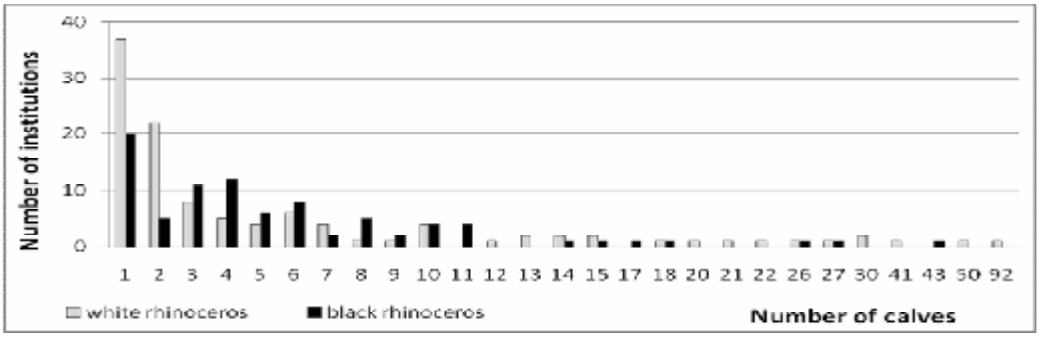


Figure 8. Institutions ordered according to the number of white or black rhinoceroses' births.

In total, 744 white rhinoceroses were born in 111 institutions between 1967 and 2004 (Fig. 8). An average number of calves in one institution, where at least one white rhinoceros was born, was 6.7 during 37 years (1967-2004). The institutions where the largest number of calves were born are: the San Diego Wild Animals Park (92 animals), The Safari Park London- Whipsawed (50) and the Pretoria-Lichtenberg Game Breeding Centre (41).

In 504 black rhinoceroses were born in 86 institutions between 1941 and 2004. The average number of calves born (only the institutions where at least one black rhinoceros was born) was 5.9 during 63 years. The highest amount of calves was born in the Lewa Wildlife Conservancy in Kenia (43), the Port Lympne Zoological Garden (27) and in the Dvur Kralove Zoological Garden (26).

Discusion

Rookmaaker, in his book about the history of breeding rhinoceroses in captivity, (Rookmaaker, 1998) questions whether proceeding on keeping south white rhino studbook is justifiable. He suggests reducing the number of those animals in zoos and safari parks. The money and space saved thanks to these solutions could be used to breed black and Asian rhinos. Rookmaaker (1998) supports his view with the fact that the southern white rhinos are not on the verge of extinction, contrary to the other species of rhinoceroses, even with hunting for them being allowed (South Africa, Namibia).

In our opinion Rookmaaker is right to some extend, however zoos should still keep a healthy, self-sufficient and genetically diverse population of the southern white rhinoceros.

The data is satisfactory because the populations are on a stable level (Foose, 2006), however unfortunately, this is not only due to the reproduction of the animals kept in captivity, but in case of white rhinos the yearly animals imported from the wild are important factors influencing the growth rate.

The low number of captive white rhinos population founders was due to inadequate method of exposition: young animals (male/-s and female/-s) were imported together and grew up also together, which had an evil influence on their breeding behaviour and female oestrus. Close investigation will find out other reasons for problems connected with breeding white rhinos.

What is more these results are not satisfactory comparing to the record of animals from the metapopulations of wild rhinoceroses living in Africa. In the years 2001 - 2003 the number of southern white rhinos increased by 13.5% every two years (Emslie, 2004). In Suazi yearly growth of population during 10 years was 9.4% and the number of animals increased from 27 to 61 (Reilly et al. 2004). The growth of black rhinos population was 5.2%, which lets us to believe that the number of these animals will be increasing, providing that the level of the population is stable (Emslie, 2004).

In captivity females of both species had their first offspring 2-3 years later than those in the wild (9.5 year old females in captivity versus 6-7 year old in the wild). What should be noticed is the connection between a big number of animals imported from the wild by one zoo and a big number of birth in the succeeding year (Whipsnade Zoo, San Diego WAP). Every significant increase in the number of births was a result of an increased import of rhinoceroses in preceeding years.

Unsatisfactory is still the fact that untill the beginning of 2005 many females of both African rhino species which have been bred in captivity were pregnant only once. History shows us that the situation in African countries is unstable and that it is easy to destroy even the most numerous populations of animals during short periods of time (Emslie and Brooks, 1999). Therefore, establishments dealing with breeding rhinoceroses in captivity should be able to have (if such a

need appears) a number of animals sufficient to the possible further reintroduction of the species in places where they would be killed.

As far as the idea of switching money and space in zoos and safari parks to breeding more endangered species (like black or Indian rhinos), this could be introduced by the substitution of southern white rhinos in the institutions that cannot afford keeping more than three animals. Also extended promoting the problem among the new institutions, stressing how important these species are for the nature preservation and how the institutions would be interesting for visitors, when breeding the rhinoceroses. It is still true that challenge for the institutions keeping rhinos in captivity is implying and developing biotechnological methods in reproduction not only of rhinoceroses but all the endangered species (Western, 1984).

The first successful insemination of a southern white rhino female was possible in 2004 (Internet 2). Before, the method of collecting sperm from both African species and from indian rhino had been applied (Internet 3). The newest achievement was collecting ovum cells from the black rhino female. This was done in Western Plains Zoo, Australia, in order to develop the method of in vitro fertilisation (Internet 4).

This actions are to give a chance to rare and endangered species (northern white, javan or sumatran rhino) to be saved from the fate of western black rhino subspecies.

In the case of white rhinos, a suitable structure of the stable herd, including the age and number of females, needs to be established as this factor may have a crucial influence on the reproduction. These aspects of white rhinoceros breeding need close investigation. In the case of black rhinos a big mortality rate not only of young but also adult specimens remains the unsolved problem.

References

**Emslie, R. 2004.** Rhino population sizes and trends. Pachyderm 37: 107-110.

**Emslie, R. & Brooks, M. 1999.** African rhino: status survey and conservation action plan. Gland and Cambridge, IUCN/ SSC African Rhino Specialist Group, Cambridge, UK.

**Foose, T. J. 2006.** Population management of rhinoceros in captivity. International Zoo Yearbook 40: 174-196.

**Ochs, A. 2005a.** International studbook for the African White Rhinoceros. Zoologischer Garden Berlin AG, Berlin, Germany.

**Ochs, A. 2005b.** International studbook for the African Black Rhinoceros. Zoologischer Garden Berlin AG, Berlin, Germany.

**Owen-Smith, R. N. 1975.** The social ethology of the white rhinoceros Ceratotherium simum (Burchell 1817). Zeitschrift fur Tierpsychologie 38: 337-384

**Reilly, T., Reilly M. & Emslie, R. H. 2004.** Transfer of Swaziland's southern white rhino from CITES Appendix I to Appendix II. Pachyderm 37: 99-105.

**Rookmaaker, L. C. 1998.** The rhinoceros in captivity; a list of 2439 rhinoceroses kept from Roman Time to 1994. SPB Academic Publishing, The Hague, The Netherlands 245-247.

**Western, D. 1984.** Humpty Dumpty and The Rhinos. African Elephant and Rhinoceros Group Newsletter 3: 4-5.

Internet 1: http://www.savetherhino.org/eTargetSRINM/site/848/default.aspx

Internet 2: http://www.sosrhino.org/news/rhinonews083005a.php

Internet 3: http://www.sosrhino.org/research/res_rrp_semencollection.php

Internet 4: http://www.sosrhino.org/news/rhinonews101106.php