

owing to the mean retention time of ingesta. Additionally, fecal samples of five males were collected over a period of one year. The samples were analyzed for dry matter, crude protein, crude fibre, nitrogen free extraction (Weender) and the cell wall constituents by Van Soest (ADF, ADL, NDF).

The mature grass in South Africa was higher in fibre and lower in protein content than the hay and grass feed in the zoo. The digestibility of nitrogen free extraction, crude fibre, organic matter and dry matter of the samples from South Africa was higher than expected, as in general a high fibre content is known to reduce digestibility. No differences were found in the quality of food and feces between territorial males during the rainy season. The fecal samples collected over the year showed a peak in the concentration of crude protein and cell constituents after seasonal rains.

Population Growth, Sex Ratio and Reproduction of a Natural Living Population of White Rhinoceros

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White rhinos are being intensively managed both in captivity and in their natural habitat, but only a few data are available about the demography of this species. Informations about how the populations are regulated or patterns of their dynamics are however necessary in order to base management practices on ecosystem principles. In this study the demography of a natural living population of white rhinos was studied and the influence of management practices on the growth of the population has been analyzed. The study was carried out on a game farm in South Africa which housed a well growing population of white rhinoceros since 1991. All animals were individually known and their age was established by comparative horn and body analysis. The date of birth was determined by observations with a ± 1 month accuracy. Occasionally hunting of adult males and translocation of subadult males took place for management reasons.

The annual growth rate over the last 10 years was 15%. The high rate of increase is believed to be a consequence of the low population density (0.23 animals/qkm). The white rhinos reproduced seasonally with an increase in birth rates between December and June and a peak in March. The median interval between successive birth was 2 years and 3 months, however the length of the interval varied in dependence on the sex of the previous calf. Hunting of males has disarranged the adult sex ratio (15% males: 85% females), which is believed to have caused a skewed proportion of juveniles. More than twice as many males than females were borne during the last years. The high proportion of receptive females per male could possibly explain the shortened courtship period which was observed during the study. Whether the change in mating behavior has had an influence on the reproduction rate has still to be analyzed.

An Overview of Diseases of Black Rhinoceroses in North America 1980 - 2000

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This report summarizes a number of diseases of unusual nature and uncertain etiology that have affected captive black rhinoceroses (*Diceros bicornis michaeli* and *D. b. minor*) in North America. Included are hemolytic anemia, fungal pneumonia, leukoencephalomalacia, several skin disorders including superficial necrolytic dermatopathy, idiopathic hemorrhagic vasculopathy, and hemosiderosis. The diseases have played a significant role in limiting the growth of that population. Hemolytic anemia is one example, in the past, it accounted for 40% of all adult deaths of captive black rhinoceroses (although its current incidence appears to be reduced). In contrast, a syndrome of mucocutaneous ulcers has had an even higher morbidity, but fortunately, a lower mortality.

Other conditions of note in captive black rhinoceroses also include an apparently high level of severe dental disease due to the presence of significant accumulations of dental tartar. In several black rhinoceroses ill from other causes, significant hypophosphatemia have developed. Liver failure from suspected creosote toxicosis has also been reported in both captive and recently imported black rhinoceroses. Several diseases, that are more commonly seen in domestic animals, such as tuberculosis, have also been reported.

In contrast to the black rhinoceros, the diseases of white rhinoceroses (*Ceratotherium simum simum*) in North America are of a more routine nature and apparently lower incidence. Efforts have been made to identify „common denominators“ that may cause increased susceptibility of black rhinoceroses to some or all of these syndromes. A holistic approach is necessary as unusual patterns of cellular metabolism, hemosiderosis associated with time in captivity, various aspects of nutrition, and other factors are being evaluated to determine their relationship with these diseases. Additionally, a PhD candidate in veterinary epidemiology is surveying the health, nutrition and management of the North American population in attempt to identify further correlates with these syndromes.

Microsatellite Analysis of African Black Rhinoceros (*Diceros bicornis*) to Determine Genetic Diversity and Population Structure

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The application of DNA markers coupled with the advent of the polymerase chain reaction has revolutionised the fields of evolutionary biology, population genetics and conservation biology. Molecular markers allow questions in biology to be addressed that could not be

resolved by the more traditional means of morphology and behavioural studies. Microsatellite DNA consists of repeated units of short sequences and these hypervariable repeat loci are used extensively to quantify variation in populations. This study measures genetic variation and population structure in 107 black rhinoceros from three different populations or evolutionary lineages: 47 *D. b. minor*, 19 *D. b. michaeli* and 51 *D. b. bicornis*. Levels of heterozygosity, allelic diversity and genetic differentiation among populations were quantified using eight polymorphic microsatellite markers. There were high levels of genetic diversity in all three evolutionary lineages. Heterozygosity values ranged from 0.411 in *D. b. minor* to 0.718 in *D. b. michaeli*. Significant differentiation was detected among all pairwise comparisons done with an average R_{st} of 0.226. These results are discussed in the light of conservation management of fragmented black rhinoceros populations that are currently under threat from both increasing habitat destruction and poaching.

Pathological Iron Overloads Acquired in Captivity by Browsing (but not by Naturally Grazing) Rhinoceroses

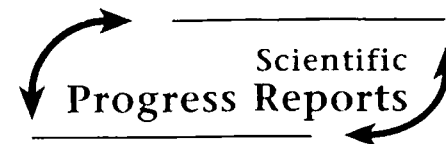
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African black rhinoceroses (*Dicerosbicornis*) in captivity are affected by a number of disorders of high morbidity and mortality, including acute episodic hemolytic anemia. Hemosiderosis, the deposition of iron pigments in multiple organs, has been the most consistent necropsy finding in this population and has most commonly been interpreted as evidence of previous hemolytic events. Direct participation in necropsies of black rhinoceroses dying in captivity, and review of histopathology of previous necropsies, revealed magnitudes and patterns of tissue iron deposition that were incompatible with hemolytic disease alone, but instead were indicative of a true iron overload syndrome that progressed in severity with time in captivity. This interpretation was supported by quantitative analyses of necropsy tissues and serum iron analytes, including sera from four of the five extant species of rhinoceroses and from both captive and free-ranging black and white (*Ceratotherium sinum*) rhinoceroses. Significant, often extreme, elevations in serum and tissue iron and ferritin concentrations and transferrin saturations were observed in captive adult black rhinoceroses compared to all control groups. Similar elevations were observed in the few Sumatran (*Dicerorhinus sumatrensis*) rhinoceroses available for study, but not in the two species of natural grazers (African white and Asian greater one-horned [*Rhinocerosuicornis*]). These findings suggest that iron homeostasis in browsing rhinoceroses may be dependent on natural iron chelators, such as tannins, phytate, mimosine, etc., that may not be included as components of formulated captive diets. Excessive iron stores may contribute directly and/or indirectly to several of the other serious disorders threatening this species in captivity, such as susceptibility to infections in general, to tuberculous and exotic fungal pneumonias specifically, and to acute and chronic anemia, toxic hepatopathies, and stress intolerance.

Successful Electroejaculation and Other Semen Procurement Methods from four Species of Rhinoceros (*Ceratotherium sinum*, *Diceros bicornis*, *Rhinoceros unicornus*, *Dicerorhinus sumatrensis*)

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Several semen procurement techniques, including penile massage, rectal massage, artificial vagina, and rectal probe electroejaculation were applied to four rhinoceros species. Penile massage, rectal massage, and artificial vaginas were applied to cognizant animals; rectal probe electroejaculation was applied to anesthetized animals. In some instances, multiple procedures were applied to individual animals. Success of these procedures was based on whether or not sperm was acquired. Penile massage was the direct manual massage of the penis. Rectal massage was manual manipulation of the accessory glands through the rectal wall. Artificial vaginas were applied to the erect penis during penile massage. Rectal probe electroejaculation utilized an ultrasound probe incorporated into a custom engineered electrical probe, designed by the authors. These procurement techniques were applied to a total of 21 animals. Penile massage was successful for all 5 black, all 5 white, 2 of 4 Greater One-horned Asian and 3 of 5 Sumatran rhinoceroses. However, only two animals, one black and one Indian, became trained to reliably produce samples with sperm. Rectal massage facilitated other methods, but was unsuccessful when used alone on 2 black, 1 white, 2 Greater One-horned Asian and 2 Sumatran rhinoceroses. An artificial vagina was applied to 2 black, 1 white, 2 Greater One-horned Asian and 1 Sumatran rhinoceroses, but was effective in only the black rhino that had been successfully trained for penile massage. Rectal probe electroejaculation was applied successfully to 2 black, 2 white and 1 Greater One-horned Asian. Seminal fluid was successfully collected in all 12 attempts to electroejaculate these 5 animals. Sperm was not present, however, in the fluids of one attempt in the Greater One-horned Asian. Rectal probe electroejaculation proved the most repeatable and reliable technique in producing seminal fluid with sperm.



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Recent Research on Elephants and Rhinos

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