

An Overview of Diseases of Black Rhinoceroses in North America 1980-2001

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This report summarizes 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. 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 seems reduced).¹⁰ A syndrome of mucocutaneous ulcers has had an even higher morbidity, but fortunately, a lower mortality.^{12,13} Other conditions of an unusual nature include fungal pneumonia,¹⁹ encephalomalacia,^{7,11} idiopathic hemorrhagic vasculopathy,¹⁴ and hemosiderosis.^{5,15,16} Efforts have been made to identify „common denominators“ that may cause increased susceptibility to some or all of these syndromes. 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.

Hemolytic Anemia

A fatal case of hemolytic anemia at the Saint Louis Zoo led to a survey that identified 47 episodes of hemolysis in 39 individual black rhinoceroses. Cases can be classified as „primary, i.e., those hemolytic events occur without other evident underlying disease, and „secondary,“ i.e., those cases that often occur in agonal events in black rhinoceroses dying of other causes.¹⁰ Although several familial groups of affected black rhinoceroses exist, no relationship between the affected groups, nor sex, age or captive-bred vs. wild-caught patterns were evident.¹⁰ Early reports suggested that many of the acute cases of hemolysis were associated with leptospirosis.^{6,10} and indeed the advent of the fluorescent antibody test for *Leptospira interrogans* proved that many cases with negative titers were indeed positive (in reality, they had probably died peracutely before an antibody response could be mounted).⁶ At the present, time we are recommending annual vaccination of black rhinoceroses with a leptospiral bacterin that contains the serovars *Leptospira interrogans icterohemorrhagica* and *L. int. grippotyphosa* (serovars that have elicited reports of elevated titers in surviving rhinoceroses). Although it is speculative at this time, the incidence of acute, primary hemolytic anemia has decreased dramatically with the advent of leptospiral vaccination. However, it is important to note that there has been a significant incidence (approx. 5%) of allergic-like reactions after vaccination, so care should be taken to observe.

However, it also important to note that not all of the cases of hemolysis could be accounted for by leptospiral infection, and a series of investigations was initiated to examine other etiologies that would predispose the black rhinoceros red blood cell (RBC) to lysis. Various studies determine that the anemia is unlikely to result from autoimmune disease.²

uncomplicated vitamin E deficiency,³ nor an unstable hemoglobin.⁴ Perhaps the most significant findings were uncovered in investigations of the metabolism of the black rhinoceros RBC. Black rhinoceros RBCs were found to be markedly deficient in energy (ATP) compared to other mammalian species, and although the levels of glucose-6-phosphatase dehydrogenase (G-6-PD) were normal, the effect of a several enzyme variations produced a metabolic effect not unlike that produced by G-6-PD deficiency.¹⁷ White rhinoceroses were also low in RBC energy, however several other enzymes, most notably catalase, were higher in that species.¹⁷

Skin Diseases

In the United States, nearly 50% of all adult black rhinoceroses have had at least one episode of skin or oral/nasal mucosal lesions that resulted in significant morbidity and less often, significant mortality.^{12,13} As with the hemolytic anemia, the skin lesions can appear as „primary,“ or secondary to other significant health problems. Many episodes have been associated with stressful events. The most commonly occurring skin disease in captive black rhinoceroses in North America has been named superficial necrolytic dermatopathy (SND).¹³ Clinically, the lesions first appear as epidermal plaques, vesicles or pustules that subsequently erode and ulcerate. Often, they first occur over points of wear and are mistaken for abrasions. The lesions are usually bilateral and symmetric. Oral or mucosal lesions can occur alone or with the skin lesions. Histologically, early lesions exhibit epidermal hyperplasia, intraepithelial edema, hydropic degeneration of keratocytes, and parakeratosis, followed by the formation of vesicles or pustules that result in superficial epidermal necrosis. The disease is most similar to rare degenerative skin conditions in man (necrolytic migratory erythema) and dogs (superficial necrolytic dermatitis), conditions that are caused by hyperglucagonemia or other metabolic disturbances that lead to hypoaminoacidemia.¹² Other skin conditions in captive black rhinoceroses include a series of collagenolytic and eosinophilic granuloma-like diseases.¹⁸ Although eosinophils are a common minor component of the dermal inflammatory response in black rhinoceroses, in some cases they predominate and are often associated with changes that lead to collagenolysis and mineralization. As noted under hemolytic anemia, some black rhinoceros have acute skin lesions after vaccination (or in some cases systemic antibiotics). One rhinoceros appeared to exude blood from the entire skin, however, pathological basis for this response has not been determined. Although poxvirus has been isolated from a rhinoceros with vesicles and pustules in a European zoo (3, 12, 13 - ZWAM), no pox virus-induced lesions have been identified in North American black rhinoceroses. Finally, in contrast to the captive population, reports of skin disease from wild black rhinoceroses have been almost exclusively associated with the filarial parasite, *Stephanofilaria dinniki*.

Fungal Pneumonia

At least nine cases of fungal pneumonia have been identified in black rhinoceros in North America. Seven were due to infection with *Aspergillus* sp. and three with *Phycomyces* sp. (there was one dual infection).¹⁹ Four of the fungal infections occurred after corticosteroid therapy, three were associated with other chronic illnesses, and two cases were „primary, i.e., no other illness or immunosuppressive factors were evident. Cases in rhinoceroses on concurrent corticosteroid therapy occurred after even apparently low dose therapy (e.g., 1mg/kg for several days, so caution is advised when using this class of drugs in black

rhinoceroses. Fungal pneumonias are uncommon in most mammalian species, and their occurrence is most commonly associated with immunosuppression

Encephalomalacia

A marked leukoencephalomalacia has been reported in three black rhinoceros calves and one two year old animal. All were female. Clinical signs ranged from somnolence to hyperthermia and hyperexcitability.⁷⁻¹¹ Three of the cases died during their episodes and one was subsequently euthanized due to being a „dummy“ calf. Histologically, there was massive necrosis of white matter (leukoencephalomalacia), and in some areas adjacent grey matter was also affected. Evidence of inflammation was only present in older lesions, were it was presumed secondary to the necrosis. Various diagnostic tests did not indicate vitamin-E deficiency induced malacia, polioencephalomalacia, or viral infection. Current research is centering on a possible relationship to hereditary encephalomalacias in man. Additionally, a correlation association with high maternal iron levels has also been noted.¹⁶

Idiopathic Intravascular Vasculopathy

A syndrome of characterized by extensive swelling of the limbs and neck in conjunction with severe, nonhemolytic anemia has been described in seven black rhinoceroses in North America.¹⁴ An *ad hoc* committee named the condition idiopathic hemorrhagic vasculopathy syndrome (IHVS). Six of the seven animals were of the southern subspecies (*Diceros bicornis minor*), but that may simply reflect the black rhinoceros population in Texas at that time.¹⁴

Five of the seven animals survived their initial episode and two of those five survived a recurrent episode of IHVS. All except one were from Texas (the other was in Colorado)(Murray). The drop in hematocrit was thought to be caused by small vessel vasculopathy observed on histology and that resulted in hemorrhagic extravasation into the soft tissues. Despite extensive research that evaluated infectious agents, autoimmune disease, potential coagulation disorders, the cause of the vasculopathy remains unknown.¹⁴ An complex disease, such as equine purpura hemorrhagica in horses, immune complex disease, remains a possibility.¹⁴

Hemosiderosis

As noted above, tissue iron levels in captive black rhinoceroses are significantly higher than those in the wild (often 2-fold or more) and increase with time in captivity.^{8, 16} Various factors now indicate that these iron levels are dietary in origin and not the result of chronic, low-grade, hemolytic anemia. Interestingly, comparative data indicate that iron levels are also high in captive Sumatran rhinoceroses (another browsing species), but normal in white and greater-Asian one-horned rhinoceroses (grazing and intermediate grazers/browsers respectively).¹⁶ It has been theorized that by including increased production of toxic hydroxyl free radicals, increased iron could either lead to or aggravate a number of the disease syndromes in black rhinoceroses.¹⁶

Other Diseases/Syndromes

Black rhinoceroses are susceptible to a number of diseases that affect other, related species of large domestic and exotic animals. Tuberculosis, caused by *Mycobacterium bovis* and

M. tuberculosis, has been reported in North American black rhinoceroses (and also white rhinoceroses). It has been reported that black rhinoceroses are highly susceptible to toxicosis from creosote,^{1,5} and indeed a significant mortality of recently imported southern subspecies was ascribed to that syndrome.⁹ Pre-mortem tests were remarkable for marked hyperbilirubinemia (both direct and indirect forms were elevated). Post-mortem examinations were notable for a remarkable degree of bile stasis in the liver of the affected animals. Salmonellosis, sometimes resulting in mortality, has been reported in several black rhinoceros in North America. One other, seemingly unusual incidence, is a high rate of severe dental disease characterized by massive tartar accumulation. This often results in tooth loss and subsequent poor mastication and digestion. It may also provide a focus for sepsis. It has been speculated that the condition may be aggravated by the types of hay fed in captivity (e.g., alfalfa [lucerne]).

On another note, it has been observed that many black rhinoceroses undergoing other disease processes often develop significant hypophosphatemia. Sera levels may drop so low as to affect red blood cell stability (such as can occur in domestic bovids during „milk fever“), and so monitoring and supplementation as needed has been recommended..

Summary

In summary, although much has been learned about the disease of black rhinoceroses, much remains to be learned. „Common denominator“ theories of disease predisposition, such as the apparently marked and abnormal accumulation of iron during captivity offer hope of elucidating this unusual pattern of disease. Clearly, our best opportunity for definitive answers will come from a holistic approach that includes not only medicine, but nutrition and animal management factors. A new approach to this task has been the initiation of a PhD student program in veterinary epidemiology at the Ohio State University College of Veterinary Medicine and sponsored in conjunction with The Wilds and the Saint Louis Zoo. The program is designed to survey medical, management and nutritional aspects of black rhinoceros management in North America and to correlate those data with black rhinoceros health.

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