

MEDICAL PROBLEMS OF CAPTIVE AND WILD RHINOCEROS – A REVIEW OF THE LITERATURE AND PERSONAL EXPERIENCES

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Introduction

This paper reviews the literature and, where applicable, adds personal findings on the medical and surgical problems of rhinoceros. A bibliography of some of the older rhinoceros literature prior to 1955 is available.⁴³

The family *Rhinocerotidae* ("nose horns") is represented today by miniature descendants compared to the *Baluchiterium* species of a million years ago, which was a hornless rhinoceros, seventeen feet at the shoulder and thirty-four feet from the nose to the tip of the tail.

Five species are in existence today, two African and three Asian, *Diceros bicornis* (African black or hook-lipped rhinoceros), *Ceratherium simum* (white rhinoceros or Burchell's rhinoceros), and *Rhinoceros unicornis* (Great Indian rhinoceros). The first two species occur in Africa, while the latter is the largest Asian representative. *Rhinoceros sondaicus* (Javan or lesser one-horned rhinoceros) and *Dicerorhinus sumatrensis* (Sumatran or Asiatic two-horned rhinoceros) are the other Asian species - with their survival in the wild, at best, precarious. Neither are they represented in captive collections.

As is true in all zoo animal medicine, knowledge of anatomy, physiology, ethology, and ecology of these

"temperamental giants" is essential to correct diagnosis and intelligent medical care. Several books and scientific papers have been written on the ecology and ethology of the various rhinoceros species.^{30,52,56,72,81,89}

Anatomy

The horns are outgrowths of the skin that grow throughout the life of the animal. The African black and white rhinos and the Asian Sumatran rhinoceros have two horns. The other Asian rhinoceros have one horn. Rhinoceros horn is composed of laminated keratinaceous filaments arranged in parallel layers with only a very short and rudimentary bony support. Lack of interfilamentous material gives rise to the fraying that has caused some to state that the horn is composed of hairs.⁸⁶

Rhinoceros skin is composed of a thin epidermis and thick, well vascularized dermis with numerous sebaceous and apocrine sweat glands.^{19,20} Eyelashes are present in all species and there is regional distribution of hair follicles containing roots and reduced hair shafts.^{19,20} The greater Indian and Javan rhinoceros have pedal scent glands on all four feet.¹⁸ Asian species usually have great folds of skin, while the African ones have small folds. All species have three toes on each foot with horny, compact soles.

The Asian group has well-developed incisor and canine teeth, while both are absent in the African species. Similar to the *Equidae*, the rhinoceros has no gall bladder.²⁸

An accurate estimate of weight is essential to calculations of drug dosages for immobilization and therapy, for feeding, and for monitoring growth. Formulae have been developed for free-ranging black rhinoceros that predict within 2%, weights of males and females from vertebral column length and/or chest girth.²⁷ Age classes have also been developed based on dental eruption and wear in known-age captive and wild rhinoceros.³³ Table 1 lists average weights of rhinoceros.

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TABLE 1
 Weight Range for Black, White and Indian
 Rhinoceros

Species	New Born, kg	Adult, kg
<i>Diceros bicornis</i> (black rhinoceros)	30 - 35	1000 - 1050
<i>Ceratotherium simum</i> (white rhinoceros)	55 - 65	2000 - 3000
<i>Rhinoceros unicornis</i> (Indian rhinoceros)		2000 - 3500

Normal Values

Body temperatures for white rhinoceros kept in a large paddock ranged from 33.6° to 37.5°C, (92-100°F) depending on ambient temperature and exposure to sunlight.² In a similar study, core temperature of a 2-year old black rhinoceros varied from 37.7° to 40°C (100-104°F).¹²

Normal values for blood serum constituents for captive whites⁹³ and values for wild white and black rhinoceros have recently been published.⁵⁹ Jayasinghe has reported electrocardiographic values from an unsedated black rhinoceros.⁵³

Restraint

Tame adult rhinoceros may be given a cursory examination without resorting to restraint. Quiet but untame animals may be enticed with food into a shipping crate for closer inspection of either end of the animal. Aside from these situations more involved physical examination or collection of a laboratory sample requires chemical immobilization. Although numerous chemical restraint agents or combinations have been used, the authors' preference is etorphine hydrochloride (M99), 2-4 mg/animal.^{1,42,47,58,116} Ophthalmic ointment should be used to protect the cornea of immobilized animals.

Problems of immobilization often result from the respiratory depressant effects of

narcotic drugs used. Severe respiratory depression under etorphine anesthesia has been reversed to tolerable levels by injection of fractions of recovery doses of narcotic antagonists.^{62,99} Naloxone has been suggested as the ideal narcotic antagonist because it has no demonstrable pharmacologic effects in the absence of a narcotic. It may be used to reverse both etorphine and fentanyl.⁹⁴

Improper positioning for transport results in regurgitation, leading to aspiration, pneumonia, and death after immobilization with etorphine and acepromazine.⁶²

Preventive Medicine and Husbandry

All new arrivals should be examined for ecto- and endo-parasites and treated when indicated.

Though many veterinary practitioners in the United States advocate the use of western and eastern encephalitis vaccines in captive rhinoceros, the authors could find no reports of infection from these viruses.

Tetanus toxoid is probably justified. Although no cases of tetanus in rhinoceros have been reported, this disease can affect all mammals.

Except for autogenous bacterins when clinically indicated, the authors find no justification for the use of available bacterins and vaccines in these animals.

New enclosures should be inspected for

possible sources of hardware that might lead to medical problems if eaten, stepped upon, or accidentally rubbed against.

The authors have found over the years that both black and white rhinoceros will do well on good grass hays, such as timothy and coastal bermuda. The common "sweet feeds" used by ranch owners appear to satisfy their needs for grain. They have also been fed successfully on combinations of alfalfa, horse pellets, and sudan hay. Supplementation with salt and minerals may be desirable. (a)

Casual observation of rhinoceros may not be adequate to evaluate nutritional status. Because of the thickness of skin, loss of subcutaneous fat and emaciation may not become obvious until there is a marked decrease in weight.⁶⁹

Though all species of rhinoceros are tempermental to some degree, the white rhinoceros tend to be quite gregarious. In captivity they get along well in groups, though minor fighting will occur at times between males and more rarely between females. Often they will develop strong psychological attachments for another member of the group. This may or may not be sex-related, but individuals became quite dependent on one another.

The authors feel that a white rhinoceros that is ill responds much better to therapy when a mate is close by. When an individual is isolated, another stress seems to be inflicted on the already sick individual which often will lead to the animal's death. This has not been the case with black rhinoceros, for they are extremely individualistic and do well in solitary situations.

Skin and Adnexa

Jones, et al have reviewed skin diseases in rhinoceros.⁵⁵

In cold areas, frostbite of the pinna and penis has been reported in Indian

a. Behaviorally, the white rhinoceros is a grazer and the black rhinoceros is a browser. Black rhinoceros might do better if given browse or higher protein feeds such as alfalfa.

rhinoceros. (b) Hematomas in the ears of a young black rhinoceros have been reported. The hematomas responded to surgical treatment, as described in canine surgery texts.

Horn problems: Captive rhinoceros require suitable objects for horn-rubbing as part of the grooming behavior. Tree stumps firmly mounted in enclosures afford suitable material for horn grooming. An animal forced to resort to concrete, for lack of anything better, may quickly erode the horn.⁵⁰

Several reports of loss of horns during capture or transport suggest that the horn can be easily detached.^{9,99} Regeneration of horns lost by accident in the wild or in captivity and after complete removal have been reported.^{9,55,64} Regeneration times vary from one to ten years, depending on horn length. A case of cancer of the horn has also been published.⁷⁴

Bacterial dermatitis: Two young female white rhinoceros developed a severe, exudative dermatitis, characterized by coalescing pustules and ulcers, soon after importation to Britain from Natal. Bacteria; *Staphylococci*, *Pseudomonas* and *Proteus sp.* and fungi; *Fusarium sp.* and *Alternaria sp.* were isolated from the surface of the dermis. On hematologic examination, there was a leukocytosis with neutrophilia, eosinophilia and monocytosis. Initial treatment of debridement and application of sulfanilamide powder was ineffective. After three weeks of daily treatment of lesions with a suspension of 0.5% thiabendazole and 2.0% oxytetracycline, lesions ceased to expand and new epidermis began to appear. Although the etiology was not clear, it was felt that the stress of shipping plus poor conditions were inciting factors.⁵⁵

The senior author has treated five adult white rhinoceros with pustular dermatitis. In one case, the animal died as a result of an overwhelming septicemia following failure of

b. Bush, M. Nat'l Zoological Park—personal communications.

antimicrobial therapy. *Staphylococcus aureus* and *Streptococcus* sp. were cultured from skin lesions. Both responded to intramuscular ampicillin hydrochloride (20 mg/kg) given twice a day for seven to ten days. An infection with *Pseudomonas* sp. responded to treatment with gentamicin sulfate (4 mg/kg) given once a day intramuscularly.

Mycotic dermatitis: An exfoliative dermatitis in an Indian rhinoceros due to *Pityrosporum pachydermatis* has been reported.¹⁰³

Trichophyton mentagrophytes var. *asteroides* was the cause of a dry, scaling eczema seen in 10 to 19 white rhinoceros housed for six weeks after importation in a reconstructed cowshed. The organism was isolated from skin samples and from a wooden post in the shed. Topical applications of Elisazol HCl (c) were curative.¹⁰⁴ A case of *Trichophyton* sp. in a white rhinoceros adult has been reported by Dolensek. (d) The animal was released from winter quarters and the condition resolved spontaneously.

Parasitic dermatitis: Granulomatous dermatitis due to infestation by *Stephanofilaria dinnike* commonly occurs in wild black rhinoceros and has been observed in captive black rhinoceros.⁸⁴ Typically, the lesions, consisting of erosions, ulcers and encrustations are on the flanks behind the point of the elbow but may also occur on the limbs.⁹⁷ Lesions are pruritic, becoming larger in the summer and virtually disappearing in the winter. Histological sections reveal the presence of microfilariae and mature filarids.⁹¹ An ointment that has been used to provide some remission of active lesions has been described (10% iodoform, 10% sulfanilamide, 50% benzene hexachloride, 10% zinc oxide, 20% q.s. with Stockholm tar).¹¹⁰

Miscellaneous dermatologic problems: Progressive tenderness and lameness of the

front feet of a black rhinoceros was due to a papilloma in the space between the medial and central digits. The masses were removed surgically and copper napthenate (e) and a temporary bandage applied. The corns recurred 26 months later and the same treatment, was carried out with equal success.¹³

Decubital ulcers are common in all species of rhinoceros after prolonged transportation in cramped shipping crates. We have found these to respond rapidly to topical treatments with antimicrobial ointments, copper napthenate (e) or astringents such as scarlet oil. Removal from the shipping crate aids in recuperation.

Creosote poisoning in black rhinoceros (apparently due to constant contact with creosoted poles) led to the deaths of four animals. Raised and crusted wheals on the skin were noted.⁴

A fowlpox virus has been isolated from epidermal erosions on a black rhinoceros.^{40,68}

Ectoparasites

Ixodid ticks parasitize both black and white rhinoceros.^{67,71,102,113} Sites of attachment are usually skin folds in the genital and anal regions, in and on the ears, and around the eyes.^{7,89} The majority of ticks parasitizing rhinoceros are not host-specific; genera common to both North America and Africa include *Rhipicephalus*, *Dermacentor*, *Amblyomma*, and *Haemaphysalis*. *Amblyomma crenatum* was recovered from a lesser Indian rhinoceros.⁶⁵ Ticks serve as vectors for babesiosis and theileriosis in rhinoceros.

The senior author has often seen *Dermacentor rhinocerinus* on imported white rhinoceros. These ectoparasites respond to the approved equine and cattle sprays.

Flies may transport parasites as well as directly damage their hosts. Flies associated with black rhinoceros in Africa are *Lyperosia* sp., *Rhinomusca*, *Tabanus*, and *Glossinia*

c. Ectimar - Bay. Vet - Kansas City, MO.
d. Dolensek—Personal communication.

e. Kopertox - Ayerst Laboratories, New York, NY.

species.^{69,77,89,105} *Glossinia* sp. (tsetse fly) both feed on and carry trypanosomes infection for rhinoceros.⁶⁹

Larvae of the genera *Gyrostigma* and *Gasterophilus* are known to infect rhinoceros.^{25,37,101,113} Presumably, infection of a black rhinoceros' eye with thelaziasis was through a fly.⁸⁹ *Stephanofilaria dinniki*, the parasite causing granulomatous dermatitis, is probably transmitted by flies.⁹¹

An insect growth regulator [Thompson-Hayward TH6040: N-(4-chlorophenyl)-N-(2,6-difluoro-benzoyl) urea] incorporated into the feed of 19 captive rhinoceros, resulted in complete inhibition of development of *Musca domestica* (housefly) and *Stomoxys calcitrans* (stable fly) in the feces.¹⁰⁷

An unusual skin-piercing, blood-sucking moth was observed feeding on a captive black rhinoceros in Malaysia.³

Neurological and Musculoskeletal

Transient and permanent cases of radial paralysis in black rhinoceros immobilized and down on one side for 5.8 and 17.6 hours, respectively, have been reported.⁶¹

An abscess of the lower jaw was surgically treated under chloroform/ether anesthesia.¹¹ A diagnosis of actinomycosis of the mandible of a fossil rhinoceros was made, with osseous lesions essentially the same as those of a present-day case of lumpy jaw in a cow.⁷⁰

Chronic osteoarthritis in a captive Indian rhinoceros cow, secondary to trauma, has been observed.⁴⁴ Degenerative polyarthritis in a free-ranging black rhinoceros, due probably to systemic disease, was diagnosed at necropsy.¹⁰⁰

Two cases of organophosphate spray-related deaths with associated degenerative myopathy have been reported.^{69,72} In both cases, spraying with a pesticide was followed by muscle weakness, ataxia, collapse, dyspnea, and death within hours to days. Postmortem examinations revealed muscles of limbs and trunk which were pale and parboiled in appearance. Some bladders were full of dark brown urine.

Microscopically, affected muscle showed

hyaline and granular degeneration and calcification; in the longest survivor active regeneration of muscle was evident.⁷² (f)

Cardiovascular and Respiratory

Cardiac conditions: A 25-year old "African" rhinoceros died after a progressive weight loss over a year's time despite an excellent appetite. Postmortem diagnosis of the cause of death was endocarditis of the right ventricle.⁶ An Indian rhinoceros in good health for four years died suddenly after a clinical illness of three weeks. Postmortem examination revealed extensive nodular growths on the heart and lungs comprised microscopically of sarcoma cells.⁹²

Pulmonary disorders: Postmortem findings from one captive black rhinoceros were severe pulmonary emphysema and gross arterial lesions which the author stated were similar to those of equine viral arteritis.⁷³

Tuberculosis is documented in both captive and wild rhinoceros.^{39,45,57,60,79} In cases where clinical data are available, a history of progressive weight loss over several months to a year and/or dyspnea and productive coughing are common. One rhinoceros developed dyspnea and died one week later. Lesions are always present in the thoracic cavity; in two cases there were miliary lesions in the liver and mesenteric lymph nodes. Two unsplicated types of *Mycobacterium*, two *M. bovis*, and one *M. tuberculosis* var. *hominis* were identified.^{39,45,57,60,79}

Behavioral comment: Calf-calling vocalizations by wild black rhinoceros cows have been reported to sound much like impaired breathing due to pathologic lung conditions.²⁶

Digestive System

Reports of enteritis are relatively common in the rhinoceros literature. Many enteric diseases may be infectious, but rarely is the

f. Editors Note—In view of the recent literature, one would have to surmise that the muscle necrosis was probably due to the capture myopathy syndrome and not as a toxic effect of the insecticide.

specific etiology identified. Usually, clinical observations and gross necropsy findings are used to arrive at a diagnosis.^{66,73}

Bacterial enteritis: A 2-month old white rhinoceros (found and hand-reared) died on the 12th day of captivity. The whole digestive tract was inflamed, with a few hemorrhages near the duodenum. The mesenteric lymph nodes were hyperemic. *Pseudomonas pyocyanea* was cultured from the intestine. It was speculated that the stress of an environmental change decreased resistance and allowed proliferation of an organism normally of mild pathogenicity.⁹⁵

Salmonellosis was diagnosed in a black rhinoceros kept in an unsanitary holding pen after capture by immobilization.

Drinking water, placed in a depression in the ground, quickly became contaminated with feces. Poor quality forage was also given. On the sixth day of capture, the animal went down, showing dyspnea and frothing at the mouth. Postmortem lesions included excess fluid in the abdominal cavity, marked enteritis, hemopericardium, and a collagenous appearance of the left ventricle. *Salmonella typhimurium* was isolated in pure culture from the liver. Death was attributed to *Salmonella* septicemia precipitated by stress of poor management.¹⁰⁶

A 26-day old female white rhinoceros died after suffering from profuse watery diarrhea, dehydration, and weakness. Prior to death, oral sulfonamides, neomycin, and belladonna alkaloids, intramuscular sulfachlorpyridazine and atropine, and intraperitoneal sodium chloride and 5% dextrose in lactated Ringer's were given. Pulmonary congestion, patent ductus arteriosus, membranous enteritis, hyperemic and necrotic mucosa of large intestine, focal necrosis of the liver, and swollen mesenteric lymph nodes with petechiae were observed. The postmortem and histopathologic were compatible with salmonellosis and other bacterial infections, although *Salmonella* was not isolated.

Noninfectious intestinal disorders: A carcinoma of the stomach was an incidental finding at necropsy of an African rhinoceros of unstated species.⁶

Volvulus of a portion of the small intestine was the apparent cause of death in a wild adult white rhinoceros. The peritoneum contained a large quantity of hemorrhagic purulent fluid; diffuse peritonitis was also present. The walls of the involved intestine were gangrenous and congested.²³

A case of volvulus at the ileocecal junction in a adult male black rhinoceros resulting in the animal's death was reported by the authors. This male mounted a female a few hours before its death and presumably this was the initiating cause of the volvulus. The rhinoceros, like equids, may accumulate sand in the large bowel. Twenty four kilograms of sand was removed from the cecum of a black rhinoceros dying of other causes.⁷⁵

Rectal and Perianal Disorders

A rectal mucosal prolapse in a 13-year old was successfully treated by reducing the volume of the edematous mucosa by applying granulated sugar. Lidocaine and corticosteroid ointments and a modified pursestring suture of umbilical tape completed the therapy. Reduction of roughage and available food plus acepromazine sedation were felt to contribute to the success of the reduction.²⁴

A rectal prolapse in a 4.5-month old black rhinoceros female was repaired under general anesthesia. The first sign of a problem was a flow of fresh blood from the rectum, without diarrhea or straining. In three hours there was an eversion of bowel mucosa through the anus. Straining and contraction of the anal sphincter produced a congested, turgid, and edematous bowel. A submucosal resection and apposition of the free mucosal borders led to an uncomplicated recovery.⁷⁸

A 9-year old female white rhinoceros was attacked by a male rhinoceros and severely horned in the rear quarters. She exhibited

dysuria and anorexia and failed to pass feces for 80 hours. Immobilization was done with fentanyl and azaperone, and rectal examination revealed dry, hard fecal balls. Manual evacuation of the rectum was followed by a 12 liter enema and parenteral penicillin. Ten hours later, copious feces and urine were passed and her appetite returned.⁴¹

Endoparasitology

The *Rhinocerotidae* demonstrate their affinity with the *Equidae* in the similarity of internal parasites each hosts. Genera common to both families are *Anoplocephala*, *Habronema*, *Oxyuris*, and *Strongylus*.^{5,83,87} Thus the potential for infection of rhinoceros by internal parasites of domestic and wild equids is present. Several reviews of parasites of rhinoceros and an extensive well-referenced monograph on helminth parasites of African mammals have been published.^{83,113,114,115}

Necator americanus, a human parasite, has been reported from an adult black rhinoceros.¹⁷ *Anoplocephala* species have been reported from the Indian rhinoceros and both African species.²⁹ Death of a captive Indian rhinoceros calf was attributed to infection by *Fasciola gigantica*.⁸

Larvae of *Gyrostigma* and *Gasterophilus* species are commonly found in the stomachs of rhinoceros.^{25,37,89,101,113} On a number of occasions, the senior author has found larva of both genera in captive white rhinoceros upon necropsy.

Death of 3 captured black rhinoceros was attributed to massive loads of *Strongylus tremletti*, *Kiluluma* sp. and other species. The carcasses were emaciated, with severely depleted fat reserves.⁶⁹

Balantidium coli infection was an incidental finding in a captive black rhinoceros that died of human tuberculosis.⁷⁹

Rhinoceros defecate in well-defined areas scattered throughout their home territory.^{76,81,89} Coprophagy, observed both in the wild and in captivity, has the potential of increasing the load of those parasites

having a direct life cycle.^{16,69}

Some anthelmintics successfully used by the authors in treating intestinal nematode infestation in both black and white rhinoceros are dichlorvos (36.5 mg/kg of body weight) given once and mebendazole (15-20 mg/kg) once a day for 3 treatments.

Genito-Urinary System

The age of sexual maturity has been listed for female white rhinoceros as 5 years, black rhinoceros females 3.8 to 5.0 years and males 4.3 to 4.5 years, and female Indian rhinoceros as 4.5 years.^{34,76,96} Estrous cycles have been listed from 17 to 60 days, with the length of estrous in Indian rhinoceros being 24 hours.^{35,76,96} Estrous cycles are generally continuous throughout the year but at least the white rhinoceros shows peak estrous behavoir from November through February.^{35,76,96} Gestation periods range from 15 to 16 months.^{22,89,96} The intercalving interval for wild black rhinoceros is 2.5 - 3.5 years.⁸⁹ Obstetrical problems in rhinoceros are not common. Delivery of one white rhinoceros calf took 10 minutes after labor began.⁸⁸ The placenta of a black rhinoceros cow passed 4 hours postpartum.³⁵

A uterine prolapse which occurred 9 days postpartum in a black rhinoceros cow spontaneously retracted, only to reappear 2 days later. The cow died of shock; at necropsy there was a uterine tear.⁶⁶

A black rhinoceros cow approximately 12 years of age was noted to have a clear vaginal discharge. Shortly after, the animal started passing fetal parts. The animal was immobilized and the uterus flushed with a 12% nitrofurantoin solution. At this time the cow received 20 mg of estrogen intramuscularly and systemic antibiotics. Fetal parts were passed over a month's time. Eventually, the cow developed a white, foul smelling vaginal discharge. At this time, the cow received 20 mg of estrogen intramuscularly. It was immobilized twenty-four hours later, and once again, the uterus was flushed with nitrofurantoin. This

procedure was repeated weekly for five treatments and the animal apparently recovered.

The author treated a case of abortion of a near-term black rhinoceros calf. No infectious agents could be implicated, but the dam had been distraught for several days prior to the incident. It was felt that the prepartum stress and agitation led to the abortion.

Artificial insemination techniques so commonly used in domestic livestock have rarely been attempted in breeding rhinoceros in captivity. However, semen has been collected from tractable rhinoceros by masturbation.¹⁰⁸ Knowledge of specific infectious diseases of the genital tract is meager.

A survey of brucellosis in game animals in Rhodesia uncovered one suspicious agglutination reaction in a rhinoceros.⁸²

Blood Parasites

Babesiosis: Erythrocytes parasitized by *Babesia* sp. are commonly encountered when examining blood smears from wild African rhinoceros.^{10,14,15,69} Only rarely does overt clinical disease develop.¹⁴

Sudden death of 2 black rhinoceros after capture was attributed to babesiosis. Numerous large forms of *Babesia* sp. were seen in the blood taken from each rhinoceros. In both cases, anulocytosis, anisocytosis, and in one case, poikilocytosis, were seen on smears. Prophylactic treatment at capture with 3-10 grams of diminazine aceturate, a trypanosomicide, was ineffective against *Babesia*.⁶⁹

Attempts to control tick vectors of *Babesia* by spraying captured rhinoceros with organophosphate pesticide was associated with high mortality.⁶⁹

Theileriosis: Theileria-like piroplasms have been reported from both black and white rhinoceros, but no disease has been associated with their presence.^{10,14,15,69}

Trypanosomiasis: Trypanosomiasis is endemic in the black rhinoceros.¹⁵

Trypanosoma vivax and trypanosomes of

the *brucei* subgroup have been reported.⁶⁹ Several species of tsetse flies are known to feed on black rhinoceros.^{77,105}

Presence of trypanosomes in a blood smear indicates infection, but does not indicate whether the infection is acute or latent. Absences of trypanosomes in blood smears does not rule out infection.⁶⁹

Clinical and postmortem data are available for two black rhinoceros that died after capture, despite prophylactic diminazine (1.5-3.0 grams) treatment at capture. The two animals were more lethargic and less aggressive than usual but maintained an approximately normal appetite. Rapid weight loss and a marked deterioration in condition led to death. Postmortem findings were marked pulmonary edema and froth in bronchioles; catarrhal inflammation of small intestines; and depletion of fat reserves. Trypanosomes of the *brucei* subgroup were found in blood smears of one rhinoceros.⁶⁹

Treatment with diminazine aceturate has been advocated to reduce stress-associated trypanosomiasis after capture. Diminazine aceturate, homidium bromide, and pyrithidium (alone or in combination) have also been used.^{46,69}

Sensory Organs

There are no unique diseases of the ears or eyes reported in the rhinoceros. The congenital absence of the pinna has been described in black rhinoceros.³² Ulcers and proliferative lesions occurring around the eyes of white rhinoceros have been observed. An ulcer at the medial canthus of a white rhinoceros was successfully treated topically with an ophthalmic ointment.¹⁰⁹

Eosinophilic inflammatory polyps were removed from the third eyelid of a white rhinoceros. The lesions waxed and waned in size over a 5-year period, being worse in summer and regressing in winter.⁵⁴

Vitamin A deficiency was thought to be involved in the appearance of corneal opacities in a captive black rhinoceros.⁶⁹ The opacities resolved following oral administration of vitamin A.

Cataract surgery on an Indian rhinoceros was successfully performed under chloroform anesthesia.¹¹

A 30-year old wild black rhinoceros cow was observed to have a prolapsed eyeball. She was immobilized with phencyclidine, followed by local anesthesia with procaine hydrochloride. A transpalpebral enucleation was performed. The wound was packed with sulfonamide powder and sutured with vetafil, leaving a space at the medial canthus for drainage. Intramuscular oxytetracycline (2.5 gm.) was given. A two-year follow-up showed complete healing and no apparent interference with behavior.⁸⁰ The ubiquitous nematode *Thelazia* sp. has been recovered from the conjunctiva of a wild black rhinoceros.

General Infection

Leptospirosis: *Leptospira* sp. was cultured from the liver of an adult wild black rhinoceros that was euthanized after being found unable to rise. No signs of malnutrition were observed. The body cavities contained large quantities of clear fluid.⁸⁹

Clostridial disease: An adult male black

rhinoceros began weaving and panting, eventually progressing to recumbency, open-mouthed breathing, and death 3 days after initial observation of unusual behavior. Necropsy was performed the next day. Gross lesions included extensive gingivitis, small hemorrhages on the gums, slightly emphysematous lungs, edematous and hemorrhagic subcutis of the lower neck and shoulders, and a swollen, friable liver, which exuded gas bubbles from the cut surface. *Clostridium sordellii* was cultured from lungs and liver.²¹ Many other generalized infectious diseases are potential in rhinoceros.

Metabolic Disease

Agalactia in two black rhinoceros cows, an apparent consequence of stress during capture and translocation, resulted in sudden hypoglycemic coma in their nursing calves. One calf, was saved by prompt administration of one liter of 10% dextrose in 0.9% saline solution.⁵¹

Rhinoceros milk is quite low in fat.³⁶ An analysis of milk samples from colostrum through 16 months of lactation has been published.³⁸

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