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cent, protein 5.70 per cent, carbohydrates 5.61 per cent, and ash 0.96 per cent.[2] Another source lists 15.7 per cent solids, 21.7 per cent fat, 36.3 per cent protein, and 42.0 per cent carbohydrates, at an unspecified period of lactation.[8]

The placenta (diffuse) may be partially eaten by the female. Some females push their calves around roughly for a time after birth, apparently to stimulate them. The female will not defend the calf vigorously. The calf, 4.5 to 6.8 kg at birth, doubles its weight in ten days, triples it in 15. It may be necessary to separate the adult male before the female gives birth, as some males are calf-killers. If the adults are separated, they should be able to see and smell each other or reintroduction may be stormy.

CLINICAL PATHOLOGY

A healthy adult male mountain tapir had an erythrocyte count of 5,500,000/mm^3; leukocytes 8,600/mm^3; 42 per cent neutrophils, 58 per cent lymphocytes; 11.5 gm/dl hemoglobin, 30 per cent packed cell volume, 0.5 mm buffy coat.

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RHINOCEROTIDAE

Lester Nelson

INTRODUCTION AND IDENTIFICATION

There are five species of rhinoceroses still surviving. The Javan, Sumatran, and Indian are Asiatic; the black and white are African. The Javan and Sumatran species are not often seen in captivity.

The Indian rhino and white rhino both reach weights up to 2000 to 2500 kg. The black rhino is considerably smaller, with mature weights approximately 1000 to 1400 kg.

BIOLOGICAL DATA

All rhinos are characterized by massive bodies and short legs, which end on broad three-toed feet with horny pads that are fairly delicate for animals of their size. The Indian rhino is the most primitive in appearance, with its armorlike hide and small head. All are essentially nude except for bristlelike hairs on the ears and tail. The black rhino, actually dark brownish-gray in color, has the fewest folds and smoothest skin of the three species.

The integument, in spite of its rugged appearance, is highly susceptible to injury and infection. The epidermis is relatively thin and the dermis very thick, approximately 2.0 cm, depending upon the area. The dermis is extremely vascular.

The Indian rhino has a single horn, whereas both African species have two, both of which are usually much longer than those on Indian rhinos. The horns are located above thick, rough areas of fused nasal bones, with the horny material composed of keratinized cells growing from the epidermis covering a cluster of long dermal papillae. Since they are in continuous growth, if broken off they will ordinarily present no problems, for there is no real skeletal support. Regrowth begins immediately.

The Indian and black rhinos are mainly browsers, having a prehensile tip on the upper lip. The white rhino is a grazer,

characterized by a long head and square lips. It normally carries its huge head low, with nostrils only inches above the ground. The dorsum of the neck appears as a great hump, and when the head is raised, the hard nucal callosities on the midline of the nape are especially evident. The difference in shape of muzzle and upper lip between the black and white rhinos results in their commonly being referred to as hook-lipped and square-lipped respectively.

Incisors are absent in both African species but present in the Indian rhino. The lateral incisor on each side in the lower palate of the Indian rhino is long enough to almost merit being called a tusk.

The dental formula for adults of both African species is $I\frac{0-1}{0-1}$, $C\frac{0}{0-1}$, $P\frac{3-4}{3-4}$, $M\frac{3}{3}$.

The balance of the digestive system is similar to the equine, with a simple stomach, small intestine, and very large cecum and colon. No gall bladder is present.

The kidneys more closely resemble those of the bovine but are even more deeply lobulated.

Though the black rhino is the most temperamental of the species, all are known to charge objects, animals, or people at times. Their behavior would indicate severe myopia but excellent hearing. Reports of acute olfactory senses probably come, at least in part, from their habits of returning to chosen spots for defecation, this act being accomplished by a scraping motion with their back feet, presumably a territorial marking behavior.

Urination, especially in the male, is in one or several localized areas. The urine is ejected toward the rear with enough force to carry several feet. These areas, once established, are almost impossible to change.

Rhinos reach sexual maturity at three to four years in the female and five to seven years in the male. Physical growth, however, may continue for some years thereafter. Lifespan appears to be 30 to 40 years.

Respiratory rates have been observed from 20 to 40/min. Body temperatures have been recorded from 37 to 39°C (98.6 to 102.2°F). Pulse rates in juveniles have ranged from 70 to 140 beats/min, with only slight excitement immediately causing a sharp increase.

Vocalization in juveniles consists of short squeaks, similar to baby pigs, with puffing snorts and growls also heard from adult animals.

HUSBANDRY

Rhinos should be provided with a water bath or mud wallow. Even though rhinos perspire, they appear to thermoregulate by immersing themselves in water or wallowing in mud. The Indian rhino prefers clean water, but care must be taken on approaches to the water hole to minimize slipping when running or fighting occurs. The African species prefer mud wallows; in fact, water holes of any depth present a hazard to the white rhino, as it is incapable of holding its head very high for any length of time, and drowning is not uncommon.

In cold areas all species must be provided with indoor housing that can be maintained above freezing temperatures. Flooring should be relatively smooth to protect the feet. Sharp rocks forming a barrier four feet wide have proved an excellent deterrent to white rhinos molesting trees in the preserves of South Africa.

Horizontal bars of any type must be avoided in barns or enclosures, as rhinos love to play with them and any movement that could startle them could cause a fast charge upward, resulting in a broken horn.

FEEDING AND NUTRITION

As mentioned, the Indian rhino and the black rhino are both browsers. The Indian rhino, with its long, sharp lower incisors, is especially capable of cutting branches and saplings up to 4 to 5 cm in diameter. Lacking browse, both of these species, as well as the square-lipped rhino, thrive on most hay and grain mixtures. Pelleted horse feeds are readily accepted by all three species. Hay should be of good quality, but a diet of fine alfalfa hay often proves to have too laxative an effect. On coarse hay the Indian rhino tends toward constipation, but this can easily be corrected by the addition of oats, bran, yams, carrots, or greens, given to the desired effect. Total daily intake for an adult animal weighing 2000 to 2500 kg would be 30 to 40 kg on a dry weight basis.

Food and water intake will vary greatly from day to day. Care must be taken to assure the animal has a suitable drinker, especially with the African species in which horn

TABLE 27–12 Analysis of Indian Rhino Milk[5]

CONSTITUENT	10 DAYS POSTPARTURITION	40 DAYS POSTPARTURITION	50 DAYS POSTPARTURITION
Total fat (gm/dl)		4.0	3.5
Total nitrogen (mg/dl)	190.4	207.2	182.0
Residue nitrogen (mg/dl)	25.75	38.08	36.4
Amino acid (mg/dl)	2.05		3.3
Total sugar (lactose) (gm/dl)		8.3	4.4
Calcium (mg/dl)		86.0	35.0
Phosphorus (mg/dl)		28.0	20.6
Sodium (mg/dl)		26.3	23.0
Potassium (mg/dl)		82.4	75.0
NaCl (mg/dl)			63.6

length may limit the depth the animal can reach. Individuals have been known to drink as much as 200 l in a 24-hour period.

The composition of the milk from the Indian rhino, as well as frequency and duration of nursing and natal development, is well documented[6] (see Table 27–12). The composition of milk from the black rhino is also documented (see Table 27–13). A successful formula and feeding regimen for orphaned white rhinos is included in Tables 27–14 and 27–15.

RESTRAINT AND HANDLING

Although certain individuals of the Indian and white rhinos have been found to share remarkable patience, attempts in the physical restraint of any adult rhino have proved impractical. Thus, much research has been spent in the field of the chemical restraint on both African species, particularly during translocation operations.[2, 3, 4, 6] Currently, the restraint generally favored is a mixture of etorphine and acetylpromazine, either with or without hyoscine or atropine. The author's preference is a combination of 2 μg/kg of etorphine and 20 μg/kg of acetylpromazine, this being sufficient dosage for both the black and white species. Chemical restraint in the Indian rhino is not recorded.

While special needles for projectile syringes are available, the standard 4 cm barbed needle is satisfactory, as long as care is exercised in not using too heavy a charge and assuring that the dart is perpendicular to the target when contact is made. On the white rhino the indented area between the semi-tendinosus and biceps femoris makes an ideal target for such darting.

Rhinos are often prone to remain standing for prolonged periods after injection of an immobilizing drug and may be guided to waiting crates over a considerable distance by placing a lariat behind the posterior horn and under the mandible. An electric prod used prudently can serve as an effective

TABLE 27–13 Analysis of Black Rhino Milk (19 Months after Parturition)[1]

CONSTITUENT	GM/DL
Fat	Trace
Solids not fat	8.10
Lactose	6.06
Protein (total NX6.38)	1.54
Casein (NX6.38)	1.11
Soluble Protein (NX6.38)	0.29
Nonprotein N	0.02
Ash	0.34
Calcium	0.056
Phosphorus	0.040
Sodium	0.037
Potassium	0.086
Chloride	0.079
Iron (mg/dl)	0.14

TABLE 27–14 Composition of Milk Substitute Used to Feed Hand-Reared Rhino Calves

Low fat cow's milk:	50%
Nonfat cow's milk:	50%
Vitamins: Soluble Vitamin Powder (Plex-Sol-C) 1 ml/l of formula	
Corn syrup 30 ml/l of mixture, varies slightly depending on consistency of the stool	
Analysis of Mixture	
Fat:	1.0%
Solids-not-fat:	9.8%
Protein:	3.6%
Carbohydrates:	5.5%
Ash:	0.7%

TABLE 27–15 Feeding Schedule for White Rhino Calf

AGE (DAYS)	AMOUNT PER FEEDING (LITERS)	FEEDINGS PER DAY
Birth–2	0.95	7
3–8	1.2	7
9–12	1.4	7
13–28	1.65	7
29–32	2.0	7
33–50	2.4	6
51–180	3.0	5

By six months the young rhino was eating hay and a grain pellet and feedings were reduced gradually until totally weaned at nine months of age.

stimulus to keep them walking. When lateral recumbency is desired it can be achieved by pushing the rhino onto its side.

The antagonist, diprenorphine, is usually injected into an ear vein at a ratio of 2 mg/mg etorphine. Recovery is usually rapid; however, if any of the immobilizing drug was deposited in the subcutaneous tissue, the animal may require a repeated dose of antagonist one to three hours later. A full dose may be given intravenously with no fear of overdosing.

PREVENTIVE MEDICINE

Preventive medicine in the rhino is currently limited to controlling parasitism and providing good sanitation, adequate nutrition, and suitable accommodations.

MEDICATION TECHNIQUES

Topical medication can best be applied with a hand-pump spray can, as most rhinos are upset by sounds of a power sprayer or aerosol can.

Adult rhinos can be medicated orally by mixing the drug with dampened oats or bran or drinking water. Local pelleting plants will, at times, incorporate antibiotics or anthelmintics into special orders, but this practice is not permitted in many areas.

If medication is to be given by hypodermic injection, the animal must be securely confined, preferably crated: a 4-inch 16 gauge needle will usually suffice. If crating is not feasible and darting is attempted, the special needles made for elephants and rhinos should be used to eliminate the danger of breaking the needle or having an unnecessary amount of leakage.

Immobilized adults and restrainable juveniles can be medicated intravenously via an ear vein. Even newborns will accommodate a feline indwelling catheter.

DISEASE DESCRIPTION

INFECTIOUS DISEASES

Coliform diarrheas have occurred in a number of young hand-reared rhinos. If the diarrhea is accompanied by a loss of appetite or an elevated temperature, systemic treatment as well as oral treatment is advisable. Standard culture and sensitivity procedures are followed, neomycin sulfate (25 mg/kg BID) or furazolidone (5 mg/kg BID) orally are usually effective. Gentamicin sulfate (2 mg/kg BID) is recommended for intramuscular treatment.

Abscesses and skin lacerations can result in septicemia. The thick dermis of the rhino will, at times, prevent an abscess from rupturing to the surface and the infection will follow the path of least resistance to deeper tissues, eventually becoming a systemic infection. Clinical judgment must be exercised in evaluating the location and probable cause of lumps and elevated skin areas, weighing the possibilities of aiding the patient versus inflicting additional injuries through attempts at treating the animal.

A newborn white rhino with a severe foot lesion failed to respond to intense topical and systemic treatment, with the third phalange of two digits eventually sloughing. A staphylococcal valvular endocarditis resulted. Penicillin G benzathine (600,000 units/kg BID), and penicillin G procaine (600,000 units/kg BID) were administered intramuscularly but proved ineffective.

PARASITIC DISEASES

Parasites found in rhinos include bot larvae, tapeworms, and both large and small nematodes.

The bot larvae are present mostly in the esophageal region of the stomach, with some existing in the glandular region. A few have also been found in the lower portion of the esophagus. Bot larvae have been present in a number of newly imported animals from South Africa and are excreted during the

month of February. Apparently the life cycle is not completed in the northern hemisphere, as none have been seen in subsequent years. The genus of the adult fly is not known.

Tapeworm segments have been reported in imported African and Indian rhinos but appear to be self-eliminating in time.

Both large and small nematodes have been found in the caecum and colon of rhinos during autopsy, and a variety of nematode ova have been seen during fecal exams. Thiabendazole (50 mg/kg), mixed with bran, levamisole (8 mg/kg), in drinking water, and mebendazole (8.8 mg/kg) incorporated into pellets have all been used successfully in controlling nematode infestations.

MISCELLANEOUS DISEASES

Biliary hepatitis, gastric ulcers, intestinal impaction, and visceral abscesses have been described in rhinos.

Stress and trauma, from immobilizations, shipments, and fighting account for the majority of deaths of rhinos in captivity.

Most rhinos are notoriously poor patients, and any measure taken to reduce stress or injury will help prevent needless lacerations and infections.

REPRODUCTION

Reproduction in captive rhinos has occurred in all three species discussed. Courtship is often violent, causing great concern to most zoo personnel. It has often resulted in separation of the male and female during estrus. Fighting among adult male white rhinos has been observed, necessitating removal of one or more of the males to prevent deaths. Males have also been known to cause serious injury to females during pre-estrus, the African species with their horns and the Indian with its incisors.

Estrous cycles will vary from 38 to 58 days apart. It is especially notable in the Indian rhino, where it is characterized by frequent urinations and a highly intensified respiration, which is both visible and audible during expiration. Duration of estrus is approximately 24 hours, with copulation taking place during the last half of the period. Coitus usually lasts from 30 minutes to one hour.

TABLE 27-16 Hemogram and Serum Chemistries of Two Species of Rhinos

	BLACK RHINO (MEAN)	WHITE RHINO (MEAN)
PVC (%)	50	38
HB (gm/dl)		14
WBC (10^3/mm^3)	6.85	9.0
Neutrophils (%)	66	60
Bands (%)	8	9
Lymphocyte (%)	22.5	31
Monocyte (%)	2.5	0
Basophil (%)	1.0	0
Eosinophil (%)	0	0
Total protein (gm/dl)	8.0	9.2
Glucose (mg/dl)		115
BUN (mg/dl)		6
Albumin (gm/dl)		1.0
Uric acid (mg/dl)		1.5
Inorganic phosphate (mg/dl)		5.4
SGOT (IU)		85
CPK (IU)		130
LDH (IU)		320
Creatinine (mg/dl)		0.9
Bilirubin (mg/dl)		0.5
Cholesterol (mg/dl)		95
Calcium (mg/dl)		11

Gestation is from 474 to 488 days, resulting in the birth of a single calf. Because of the size and shape of the animal, it is difficult to be certain of pregnancy until the last few months. Most females show a change in temperament during the final weeks, becoming more nervous and unpredictable.

White rhino and Indian rhino calves weigh from 55 to 65 kg at birth. The black rhino is usually about 30 to 35 kg when born.

CLINICAL PATHOLOGY

Blood parameters for black rhino and white rhino are given in Table 27-16. These are for presumed normal animals. A juvenile white rhino suffering from bacterial endocarditis reached a white count of 50.35 (10^3/mm^3), with neutrophils (segmented and bands) accounting for 95 per cent of the total count.

Rhino urine is very turbid, high in carbonates, with a pH of 6.0 to 8.0, and a specific gravity of 1.01 to 1.032.

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