

(average, two) every 28 to 101 days (average, 50 to 80) and at 15 to 35 days after parturition.

Estrus is difficult to determine unless courtship is observed. Courting tapirs stand side by side, nose to tail, and vocalize frequently. Each snaps at the other's hind legs while circling to avoid the bites of its spouse. Copulation occurs on land or in water. After several copulatory acts in rapid succession, the female chases the male away.

A single offspring (rarely twins) is born 383 to 405 days after copulation, at any time of the year. Imminent parturition is not always obvious and may be indicated only by pronounced restlessness. Vulvar swelling may be noted a week before parturition. Vulvar "winking" and dribbling of mucus may be noted a day or two before parturition; mammary engorgement may also be evident.

The calf is born head-first with the dam either standing or lying; the umbilical cord often parts as the calf hits the ground. The calf may suckle immediately or not for as long as five hours. A single pair of mammary glands is located in the inguinal region. The calf locates the mammary glands by trial and error, although an experienced female may nuzzle the calf into position.

The milk of a Brazilian tapir in early lactation was found to be composed of total solids, 15.67 percent; fat, 3.4 percent; solids (that were not fat), 12.27 percent; protein, 5.70 percent; carbohydrates, 5.61 percent; and ash, 0.96 percent. Another source lists 15.7 percent solids, 21.7 percent fat, 36.3 percent protein, and 42.0 percent carbohydrates at an unspecified period of lactation.

The placenta diffusa 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 and triples it in 15. It may be necessary to separate the adult male before the female gives birth, as some males kill calves. If the adults are separated, they should be allowed to see and smell each other; if not, reintroduction may be stormy.

CLINICAL PATHOLOGY

A healthy adult male mountain tapir had an erythrocyte count of 5,500,000/mm³; leukocytes, 8,500/mm³; 42 percent neutrophils; 58 percent lymphocytes; 11.5 gm/dl hemoglobin; 30 percent packed cell volume; and 0.5 mm buffy coat.

A healthy adult male at the Los Angeles Zoo, immobilized for minor dental work, had an erythrocyte count of 6,900,000/mm³; leukocytes, 11,000/mm³; 46 percent neutrophils; 34 percent lymphocytes; 12 gm/dl hemoglobin; and 35 percent packed cell volume.

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RHINOCEROTIDAE

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INTRODUCTION AND IDENTIFICATION

There are five species of rhinoceroses still surviving. The Javan (*Rhinoceros sondaicus*), Sumatran (*Didemnoceros sumatrensis*), and Indian (*R. unicornis*) are Asiatic; the black (*Diceros bicornis*) and white (*D. sinus*) 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; mature weights approximate 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 brown-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 is very thick, approximately 2.0 cm, depending upon the area. The dermis is extremely vascular.

The Indian rhino has a single horn, whereas the 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, and the horny material is composed of keratinized cells growing from the epidermis covering a cluster of long dermal papillae. Since they are in

continuous growth, horns that are broken off will ordinarily present no problems, for there is no real skeletal support. Regrowth begins immediately.

The Indian and black rhinos are mainly browsers and have 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 its nostrils only inches above the ground. The dorsum of the neck appears as a great hump, and when the head is raised, the hard nuchal 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 jaw 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 0-1/0-1, C 0/0-1, P 3-4/3-4, M 3/3.

The balance of the digestive system is similar to that in equine species: it has a simple stomach, small intestine, and very large cecum and colon. No gall-bladder is present.

The kidneys more closely resemble those of the ruminants 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 is accomplished by a scraping motion with their back feet; it is presumably a territorial marking behavior.

One or several localized areas are used for urination, especially by males. 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. Life span 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, and only slight excitement immediately causes a sharp increase.

Vocalization in juveniles consists of short squeaks, similar to those of 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 mixtures of hay and grain. 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

Table 50-6. ANALYSIS OF MILK OF INDIAN RHINO (*Rhinoceros unicornis*)

Constituent	10 Days After Parturition	40 Days After Parturition	50 days After Parturition
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) (mg/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

Data from reference 7.

laxative an effect. On coarse hay the Indian rhino tends to become constipated, but this can easily be corrected by the addition of oats, bran, yams, carrots, or greens. Total daily intake for an adult animal weighing 2000 to 2500 kg would be 30 to 40 kg dry weight.

Food and water intake will vary greatly from day to day. Care must be taken to ensure that the animal has a suitable place for drinking water, especially with the African species, in which horn 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 documented¹¹ (Table 50-6). The composition of milk from the black rhino is also known (Table 50-7). A successful formula and feeding regimen for orphaned white rhinos is included in Tables 50-8 and 50-9.

RESTRAINT AND HANDLING

Although certain individual 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 chemical restraint on both African species, particularly during translocation operations.¹²⁻¹⁴ Currently, the restraint generally favored is a mixture of etorphine and acepromazine, 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 acepromazine, this being sufficient dosage for both the black and white species. Chemical restraint in the Indian rhino is not recorded.

Special needles for projectile syringes are available, but the standard 4-cm barbed needle is satisfactory, as long as care is exercised in not using too heavy a charge and in ensuring that the dart is perpendicular to the target when contact is made. On the white rhino the indented area between the semitendinous

Table 50-7. ANALYSIS OF MILK OF BLACK RHINO (*Diceros bicornis*) 19 MONTHS AFTER PARTURITION

Constituent	Amount (gm/dl)
Fat	Trace
Solids, not fat	8.10
Lactose	6.06
Protein	1.54
Casein	1.11
Soluble protein	0.29
Nonprotein nitrogen	0.02
Ash	0.34
Calcium	0.056
Phosphorus	0.040
Sodium	0.037
Potassium	0.086
Chloride	0.079
Iron	0.14 (mg/dl)

Data from reference 1.

Table 50-8. 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 of formula
Corn syrup	30 mL of mixture [†]
Analysis of Mixture	
Fat	1.0%
Solids, not fat	9.8%
Protein	3.6%
Carbohydrates	5.5%
Ash	0.7%

[†]Ver-A-Mix Laboratories

[†]Varies slightly, depending on consistency of the stool.

and biceps muscles of the thigh 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 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. 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.

Table 50-9. FEEDING SCHEDULE FOR WHITE RHINO CALF (*Diceros sinuatus*)

Age (days)	Amount per Feeding (L)	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 the animal was totally weaned at nine months of age.

MEDICATION TECHNIQUES

Topical medication can best be applied with a hand-pumped 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 with drinking water. Local pelleting plants will, at times, incorporate antibiotics or anthelmintics into special orders, but this practice is not permitted in many areas.

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

DISEASE DESCRIPTION

Infectious Diseases^{2, 10}

Infectious diseases reported in rhinos include tuberculosis, salmonellosis, leptospirosis, clostridial diseases, coliform diarrhea (in calves), staphylococcosis, and a variety of other bacterial diseases common to many mammals. Culture, sensitivity testing, and treatment with indicated antimicrobials are recommended. There are no medication idiosyncrasies with these species.

Parasitic Diseases¹⁰

Anoplocephala, *Habronema*, *Oxyuris*, and *Strongylus* are genera found both in rhinos and equids. Rhinos are also infested with *Gasterophilus*. Recently imported animals may pass a large bot larva, unique to rhino, *Gyrostigma*. Bot larvae are present primarily in the esophageal region of the stomach, but some exist in the glandular region. A few have also been found in the lower portion of the esophagus. Apparently, the life cycle is not completed in the northern hemisphere, as none have been seen in subsequent years.

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 cecum 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.

Hemolytic Anemia.^{1, 11} Hemolytic anemia has been reported in 17 black rhinoceroses in North American and European zoos. The disease is characterized by

peracute or recurrent episodes of hemoglobinuria. Packed cell volumes range from 4.5 to 14.5 percent. Death may occur during restraint procedures to collect laboratory specimens.

The cause of the syndrome is not known. In two animals that died at the same zoo within a 10-day period, a diagnosis of leptospirosis was based on serum titers of a single sample to *L. icterohaemorrhagiae*. Similar titers for other serovars have been made in other ailing rhinos, but no acute and convalescent titers have been done.

Free-living rhinos in Africa die from babesiosis and trypanosomiasis, but no hemoparasites have been noted in captive animals. Other causes of hemolytic anemia in domestic animals and man have been considered in many of these cases but have been ruled out for various reasons. Autoimmune hemolytic anemia has not been adequately evaluated.

Ulcerative Stomatitis. A proliferative, ulcerative stomatitis lesion has been diagnosed at three different zoos. The surface of these lesions is friable, and minimal trauma will cause hemorrhage. Similar lesions have been noted in the nostril, resulting in epistaxis.

These lesions are responsive to steroids. In some cases a change in the diet has also brought about regression and healing.

The histopathological condition is similar to that of an eosinophilic granuloma. The hemogram shows a neutrophilic leukocytosis with eosinophilia.

Skin Problems. Rhinos are susceptible to skin disorders. *Stephanofilaria dimmiki*, a filarioid nematode, is responsible for ulcerative skin lesions in Africa. *Corynebacterium pseudotuberculosis* has been isolated from a generalized acute dermatitis. *Staphylococcus*, *Pseudomonas*, *Proteus*, *Fusarium*, and *Alternaria* have all been isolated from skin lesions.

Constant contact with creosote-treated posts has caused the death of four rhinoceroses.

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 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 use their horns and the Indian species attacks with its incisors.

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

Gestation is from 474 to 488 days and results 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

Table 50-10. HEMOGRAM AND SERUM CHEMISTRIES (MEANS) OF TWO SPECIES OF RHINOS

	Black Rhino (<i>Diceros bicornis</i>)	White Rhino (<i>Diceros sinus</i>)
PCV (%)	50	38
Hb (gm/dl)	—	14
WBC ($\times 10^3/\mu\text{l}$)	6.65	9.0
Neutrophils (%)	66	60
Bands (%)	8	9
Lymphocytes (%)	22.5	31
Monocytes (%)	2.5	0
Basophils (%)	1.0	0
Eosinophils (%)	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

show a change in temperament during the final weeks, becoming more nervous and unpredictable.

Calves of the white and Indian rhinos weigh from 55 to 65 kg at birth. The black rhino is usually about 30 to 35 kg when born.

CLINICAL PATHOLOGY

Blood values for both the black and white rhino are given in Table 50-10. These are for animals that

are presumed normal. A juvenile white rhino suffering from bacterial endocarditis reached a white count of $50.35 \times 10^3/\mu\text{l}$, with neutrophils (segmented and bands) accounting for 95 percent of the total count.

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

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