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Compiled and edited by Frank Rietkerk, Koen Brouwer, and Simone Smits

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EEP Rhinoceros TAG

In the absence of a report from the EEP Rhinoceros TAG, the editors have decided to include the recently published husbandry guidelines for rhinoceroses under this heading.

Husbandry guidelines for rhinoceroses

1 INDOOR/OUTDOOR ENCLOSURES

Single individuals should not be kept in zoos. The following recommendations are made with potential breeding in mind.

A breeding facility is characterized by:
a) indoor housing,
b) separation facilities.
One pen per animal plus one additional pen is recommended. In addition, separation facilities must exist. It is recommended that animals be kept jointly.

1.1 Special features

1.1.1 Technical features

Any exhibit should be equipped with a video camera. Access to a scale is not required but desirable and strongly recommended.
Facilities should have interconnecting sheds with solid walls (concrete or wood is an acceptable material) in order to avoid visual contact between individuals. With exits on either side the animals will be able to move freely between boxes.
It is recommended that per box combination at least one opening be exchangeable: solid for visual barrier, bars for visual contact.
Sheds should be 3,5 m high at a minimum, separating walls at least 2 m high.
Rough concrete or metal edges, nuts, and screws must be secured with wood fittings to prevent injuries.
Access to the house for trucks or cranes is indispensable.

1.1.2 Size of bars

See outdoor enclosures

1.1.3 Indoor enclosures

It is recommended that 30 m^2 per individual be provided at a minimum (each wall being at least 5 m long). If an animal is to spend an extended period of time indoors, more space is required.

1.1.4 Ventilation

Adequate ventilation must be available. Air exchangers are recommended, including exhausters near the floor for effective removal of ammonium fumes. Draught should be avoided.

1.1.5 Temperatures/humidity

For the Southern **White rhino** temperatures should be maintained at 16° C, for **all other species** at 18 to 20° C. Floor heating may cause problems by raising dust and ammonium fumes and should be restricted to cover no more than 1 quarter of each shed.
For the **Indian rhino** humidity should be kept at no less than 60 %; problems in this regard to not exist with the **African species**.

Indian rhinos should be provided with an indoor **pond** of at least the size of a shed; minimum requirement for depth of water is 1,7 m, for water temperature 15 to 18° C.

1.1.6 Daylight/illumination

It is recommended that the duration of (day) light be kept at 12 h, also during the winter months.
UV-therapy: see veterinary care.

1.1.7 Floor covering/topography

Floors of well draining tiles that also hold back water are recommendable. Disinfection of the floors should raise no problem; save footing should be insured.
Rubber matting for hoofed stock may be used especially for Indian rhinos.

1.1.8 Bedding material

No extra bedding material is needed if feeding hay is offered in abundance on the floor of the pen.
Pens that house calves should be furnished with more hay than is eaten.
For all species a fresh water (room temperature) source should be accessible. Self-operating water sources are not recommendable.

1.2 Special furnishings

Are not needed if social contact is guaranteed.

1.3 Captive and handling facilities

See transportation and veterinary care

1.4 Outdoor enclosures

1.4.1 Outdoor temperatures

For **African rhinos** a minimum outdoor temperature of 12° C, for **Indian rhinos** 15° C is required, as well as dry weather conditions during the time of outdoor exposure. If exposed only for a short period of time, temperatures may be below that.

1.5 Confinement barriers - all species

1.5.1 Dry moats

For using dry moats for confinement from the public concrete matted outdoor exhibits are required with a vertical wall toward the public which should be no less than 2 m high.
The moat on the animal's side should slope gradually, not exceeding 30 degrees, so that this part may also be used by the animal. The resulting space should be no less than 1,9 m across.

When designing an outdoor exhibit fenced in by a moat the construction of the surface must be payed considerable attention to with regard to save footing for the animals. Ditches with strictly vertical walls are considered dangerous and are not recommendable especially with social grouping. Recommendation is that existing vertical walls of ditches be modified to a gradual slope.
For interim solution exits on either side of the ditch must be provided.

1.5.2 Fences

For fencing vertical iron bars, concrete blocks reinforced with pipes, stone, and treated poles are recommended. In general, fences should be at least 2 m high. If using poles, each should be about 30 cm thick and set into the ground in concrete. Bars or poles should be connected vertically to prevent the fence from being uprooted by the animals.
If calves are kept outdoors, adequate measures are to be taken to prevent escaping.
It is important to always consider fence spacing and keeper access respectively exit for emergency cases. Keepers should always fit through any two bars of the fence.
If poles are used, they must be treated only with none-toxic compounds.
The use of rocks on the enclosure is recommended for tree or other object protection.

1.5.3 Other types of barriers

Other possible types are horizontal cables such as hot wires and chain links. These, however, should not be used exclusively for shielding from the public but in conjunction with other measures.

- Separation means
  Solid visual and physical barriers are necessary between enclosures. However, adjacent enclosures should be accessible through at least 2 gates, giving the animals the possibility to roam without danger of being trapped.
- Water
  Water is not recommendable because of danger of drowning, especially if young calves are kept on the enclosure.
- Doors
  Doors should be reinforced with strong hinges and locks. They should be constructed of either heavy metal, galvanized steel, pipe that is either hinged or sliding, or of wood reinforced with steel. The bottom part of a door should be reinforced with steel plates to minimize possible damage.

1.5.4 Connecting path ways or tunnels between indoor/outdoor facilities

They should be approximately 1,5 m wide for an adult animal to pass freely without feeling trapped but is prevented from turning back.

One side must be of vertical bars or poles to allow the keeper emergency exit.
Long pathways should have bar doors to be closed after the animal has passed through.
Outdoor facilities must have at least one entrance/exit for heavy trucks.

1.6 Size of enclosures

1.6.1 White rhino

The size of an enclosure for a breeding group (2.3 individuals) should measure no less than 1 ha (see social system). With keeping more individuals the enclosure should be accordingly larger. It is recommended to have at disposition at least two connecting enclosures.

1.6.2 Black/Indian rhino

Institutions keeping the species should hold no less than 2.2 individuals. For these, 3 connecting outdoor enclosures of at least 200 m^2 each will be adequate.

1.6.3 For all species

To prevent individuals from being hurt the bars should have no sharp edges, angles should be no less than 90 degrees. The ground should not be quite level.

1.6.4 Surface

A self-draining surface that provides adequate footing is recommended. Various natural materials are acceptable.
In addition a **mud bath** is recommended. Renovation of the mud bath (no concrete) needs to be carried out once a year.

1.6.5 Water access

For the **Indian rhino** a **pool** or **pond** is an absolute must, minimum size for 2 animals being 25 m^2 of water surface, depth 0,8 to 1,7 m.
For all species
A permanent fresh water source should be accessible.

1.6.6 Special furnishings

Several rubbing posts should be provided.
A study of enrichment possibilities is currently being conducted, results will be implemented in future editions.

1.6.7 Sun shelters

Access to shade is a must.

Options: natural = trees and/or other vegetation,
artificial = roofs.

It is recommended that a number of adequate shady zones be provided.
Sun shelters should always be also usable for rain shelters; trees do rarely serve the purpose. Not acceptable is the use of the night shelters for sun protection unless they are accessible at all times.
In parts of the enclosure wind protection should be provided, unless a solid wall barrier already exists.

1.7 Mixed species exhibits

Success has been reported with birds and hoofed stock, however, in either case a nonbreeding situation was given. Space and refuge availability is reported to have been a critical factor.

2 MANAGEMENT

2.1 Identification

Individual traits may be documented through photographs. TROVAN-transponders are recommended for primary identification method. They should be placed behind the left ear.

2.2 Behaviour and social grouping for successful breeding

It is necessary to provide ample space and hide-outs. However, it should be noted that successful introduction of individuals is largely dependant on the introduced animal's personality. Captive animals of both sexes have shown aggression on introduction.
The most important element in the introduction of individuals for breeding is the age factor and social status, which should harmonize. For instance, a subadult male will not know how to approach an adult female; the female will subsequently fight or intimidate the male. A proven breeder under normal circumstances will breed with a young female. For "training" a young male may be introduced to a young female, while an older male will be brought into action to cover her.

2.2.1 General steps which may be taken when introducing rhinos

Provide auditory, olfactory, and visual contact between the newcomer and the herd. Subsequently, tactile contact through bars should be provided with a few members of the group, and, finally, the individual is introduced to either the dominant animal or the entire group.
Normally during introduction a veterinarian and experienced staff members will be present - a high pressure waterhose should be ready.

2.2.2 Black/Indian rhino

Rhino keeping facilities should be able to provide room for at least 2.2 adult individuals.
Since Black rhino males are territorial, each bull should have his own enclosure for his territory.
Indoors each animal should have his own shed.
Outdoors males must always be kept separate. For males barriers must be solidly built (no visual contact).
Two or more females may be kept in one enclosure, depending on the character of the individual.

Introducing a new adult female to a female group

Prior to first introduction the female should be familiarized with the enclosure. Indoors females should have contact through bars. Before actually being introduced they should no longer show aggression toward each other. After introduction close observation should be continued if necessary.

Male/female introduction

Prior to first contact each animal should be familiarized with the enclosure. If it is not his own, the male should have marked the enclosure which should not be cleaned out! Again, the contact through bars (indoors) must be sufficiently long until no more aggression is shown.
Introduction should take place when the female is in heat. Observation should continue if need be.
In any case but especially when aggressive situations arise, preferred feed should widely be distributed throughout the enclosure (fresh greens, bread, carrots etc.).
It must be stressed that in Indian rhinos in particular successful mating is often preceded by several hours

of serious fighting, which can be fatal - even in free-ranging individuals. This concludes that careful observation must be executed when trying to pair up.

2.2.3 White rhino - captive management

A minimum of 1.3 adult individuals should be maintained.

Descendants may be kept in groups, males as long as they are tolerated.

Introducing a new adult female to a female group - see Black rhino

Formation of a group

All animals should independently get to know the enclosure and each other through bars.
Recommendation is, that females should be grouped first and the male introduced later.
When introducing new animals all known behaviour patterns will be observed: aggression, greeting, fighting, bluff charging. Also, the new animals may show fear and diarrhoea.
Reported time for integration lies between 1 to 10 weeks.

Introducing a new male to a female group

Males are territorial, they mark their territories with faeces and urine-scrapping hindlegs, spreading dung. The animal's territorial marking should not be removed prior to introducing the female group to the male.
Females tend to form strong pair bonds between either related or unrelated individuals. In cases, these bonds may interfere with successful breeding if the female mates continuously drive off the approaching male. A second male, kept in an adjacent enclosure, may through potential competition stimulate breeding.
When introducing a male to a female group, be sure that the females are together and comfortable prior to introduction. The new male will exhibit aggression, greeting, bluff charging, and fighting. The females will show the same.
Reported time for integration is 5 weeks.

3 REPRODUCTION

3.1 Sexual maturity

African rhino

Males and females become sexual mature at about 4 to 6 years. However, females are observed to have been mounted as early as 3 years, and one male reportedly became sexually active at 3 years.
In the wild females reportedly gave first birth at 6,5 to 7 years. Males do not have sexual access to females until they are 12 years old, holding a breeding territory.

Indian rhino

The Indian rhino will reach sexual maturity somewhat earlier: females will mate at about 3 years, males at the age of 5 to 6 years.

3.2 Oestrus cycle

The oestrus cycle can vary in length. The recurring of cycle in regular intervals is more important than length of cycle in days.

White rhino

On an average the oestrus cycle will occur every 28 to 32 (up to 70) days. The male will show interest for 24 to 48 hours. The female will be receptive for 12 hours at the longest.

Black rhino

A 21 to 28 day cycle is shown in a survey with the female being receptive for 24 to 48 hours.

Indian rhino

Reports state a 40 to 50 day cycle, the oestrus lasting 24 hours.

3.3 Copulation

Black rhino
Copulation will last 20 to 45 minutes with multiple ejaculations. Mating will last 1 day.
White rhino
Copulation will last 30 minutes or longer, and will occur several times at peak of oestrus. The male may remain mounted 19 minutes or much longer.
Greater one-horned rhino
Copulation averages between 60 and 80 minutes.

3.4 Pre-copulation

Males in captivity may show interest in females outside of peak of oestrus. Greatest interest is seen at peak of oestrus. Males frequently exhibit the following behaviour at peak of oestrus:
- erection, genital inspection and flehmen response, head resting, chasing, mounting, copulation, failing copulation attempts.

Females will frequently show vulva changes and exhibit behaviour patterns such as:
- positive male solicitation,
- resentation of hindquarters,
- aggression toward the male,
- running from the male,
- ignoring the male,
- copulation as well as refusing to copulate,

Vulva changes include:
- squirting of white or cloudy urine,
- vulva swelling with occasional mucousal discharge prior to breeding.

3.5 Courtship

White rhino
A male will approach the female with either head down or up with little vocalization. Any vocalization will express itself in a whimper and heavy breathing sounds, the tail will be curled.
The female will finally tolerate the bull to rest his head on her rump.
Male and female should not be separated for the night after courtship has begun during the day. Most copulations will take place at dusk or dawn.
Black rhino
Ideally a male will show interest for a female 1 to 3 days prior to oestrus. The couple may be separated for the night. Copulation normally occurs the next day.
Indian rhino
Females in oestrus will show obvious changes in behaviour such as:
- vocalization,
- frequent urination.

It is recommendable that the female be paired immediately after these changes occur. Copulation will occur after several hours of chasing and fighting. The pair should not be separated for the night.

3.6 Gestation

White rhino: 515 to 540 days on an average.
Black rhino: 440 to 460 days.
Indian rhino: 470 to 480 days.

3.7 Birth intervals in captivity

According to behaviour studies separation of an infant from its mother should not be executed before 1 year for it causes stress to both mother and child.
For all species it is recommended that the young remain with the mother at least 1 year. During that period the female should not be paired with a male.

After separation of mother and child, the female may be paired again and will possibly conceive.
Recommended birth interval is no less than 4 years for the **White rhino**, for the **Black** and **Indian rhino** 3 1/2 years.
In large White rhino groups where mother and child are not separated, birth intervals will depend on the individual animal.

3.8 Separating the male and the other females in a group from a pregnant female

White rhino

- **extensive exhibits**

  The pregnant female seems to avoid the male and other females in the group. The male should always be separated from the group before the birth of a young.

Separation of a pregnant female from other females in the group depends on:

- mode of behaviour of the female mates toward the pregnant female,
- size of enclosure.

With arising problems, the pregnant female should be separated.

- **standard zoo procedures**

Females will be separated from the group for various reasons such as:

- evidence of pregnancy,
- 1 month prior to birth giving,
- 1 to 2 weeks prior to the day of parturition,
- the udders are filled.

The decision will be made in accordance with the conduct of the pregnant female toward the rest of the group.

Black rhino

If animals are held jointly recommendation is that the male is separated from the group several months prior to the birth of a young.

Indian rhino

The pregnant female should always be separated.

3.9 Delivery

All species

Delivery is of short duration:

- labour about 40 minutes,
- parturition about 10 to 20 minutes, standing up or lying down.

On a normal scale, delivery will occur in the evening or at night. The female should not be interfered with. For observation a video camera should be ready to hand without disturbing the mother to be. For the infant to be able to stand up it is necessary to prepare a none-slippery floor surface.
The placenta will be discharged right after birth giving and in many cases be ingested by the mother.

3.9.1 Infants

First standing up will commonly be seen after 15 minutes. It may, however, take 1 to 2 hours.

3.9.2 Nursing

- in captivity

Suckling will be done either standing up or lying down on the side. The latter may result in the infant's falling asleep.
First nursing has been seen within less than 1 hour or within 24 hours after birth.

3.10 Rearing methods

- **hand or parental**

Hand rearing will become necessary if:

- the young is rejected by the mother,
- medical problems exist of the mother or the infant,
- the infant fails to nurse.

Hand raising an infant must be considered very carefully.
The infant should always remain with the mother and (if need be) be additionally bottle fed, unless the female shows aggression toward the young or medical problems.

Hand rearing

Hand rearing of rhinos is executed in accordance with the known procedures for other species.
Hygiene is an absolute must in order to avoid contamination of the milk, also intensive care by one or more keepers (Hagenbeck, 1966, 1969).
The applied milk preparation should simulate the natural mother milk. Skimmed, pasteurized or homogenized milk (3,2 % fat, 3,3 % protein, and 4,7 % lactose) is well suited (Kreag, 1966; Hagenbeck, 1966, 1969; Wallach, 1969).
Supplementation of vitamins and minerals is recommendable.
If possible, colostrum should be given within 24 hours after birth. Alternatively rhinoceros serum may be given.
For hygienic reasons and to avoid hasty drinking the young should rather be bottle fed than with a bucket.
In the beginning daily rations are 1 to 2 l, later up to 20 l per day, portioned into 8 to 10 meals.
Puschmann (1983) reports of add-feeding solids such as gruel made of rice, Indian corn, and rolled oats between the 5th and 7th week, gradually adding crispbread, banana, carrots and fruit.

3.11 Reproduction by artificial means

Any method of artificial insemination has yet to be scientifically proven and cannot be recommended.
Research is being conducted on methods for semen collection, cryopreservation, artificial insemination and embryo transfer.

Current methods

Determination of ovarial cycle and pregnancy
For determination of the ovarial cycle or pregnancy currently faeces and/or urine hormone analysis are carried out.
Dr. Schwarzenberger of the University of Vienna, Department of Biochemistry, has developed a method for faecal analysis.
Urinalysis was established by Prof. Hodges of Deutsches Primatenzentrum Göttingen.

4 NUTRITION

All required essential nutrients should be provided by feeding good quality forage, for balancing energy, protein, mineral, and vitamin requirements concentrate feed should be added.

4.1 Nutrients

Dierenfeld states of the domestic horse to be the best model for nutritional needs of the rhino (according to Gansloßer this does not apply to the Black rhinoceros).

Essential nutritional requirements:

Nutrients Physiological Stage			
	Growing	Mature/Main	Pregnancy/Lactation
digest. energy (Mcal/kg)	2.45-2.90	2.00	2.25-2.60
crude protein (%)	12-15	8.0	10-13
Ca (%)	0.6	0.3	0.4
P (%)	0.3	0.2	0.3

	Growing	Mature/Main	Pregnancy/Lactation
Mg (%)	0.1	0.1	0.1
K (%)	0.3	0.3	0.4
Vitamin D (IU/kg DM)	800	300	600
Vitamin E (IU/kg DM)	80	50	80

Blood levels should read for:

NA	0.1	%
S	0.15	%
Fe	50	mg/kg
Mn	40	mg/kg
Cu	10	mg/kg
Zn	40	mg/kg
Se	0.1	mg/kg
I	0.1	mg/kg
Co	0.1	mg/kg

Analysis (example):

crude protein	no less than 12.00	%
crude fat	no less than 2.25	%
crude fibre	no more than 23.00	%
ashes	no more than 11.50	%
added materials	no more than 2.00	%

4.2 Food stuff

- bulk forage
  - grass
  - hay
  - fresh leaves or twigs
  - fresh alfalfa over hay

White rhinos are grazers and should in summer be offered grass and hay, in winter hay ad libitum.
Black and Indian rhinos are browsers and should be offered bulk forage ad libitum:

in summer

- grass and hay	50 %
- alfalfa, fresh	20 %
- fresh green stuff	30 %

in winter

- hay	80 %
- alfalfa hay	10 %
- dried/frozen green stuff	10 %

4.3 Browsing

Browsing is very important for the health and dietary demands of an animal and contributes to its overall well being.

Preferred fodder plants are (note: oak should not be fed): Silvermaple (*Acer saccharinum*), White poplar (*Populus alba*), Sugar maple (*Acer saccharum*), Black locust (*Robinia pseudoacacia*), Alder (*Alnus* sp.), Willow (*Salix*), Hackberry (*Celtis occidentalis*), Fragrant Honeysuckle (*Viburnum* sp.), American beech (*Fagus grandifolia*).

- Concentrates
  pellets
  alfalfa pellets
  fruit
  vegetables

Pellets should not exceed 1/3 of the daily total intake of energy rations.
All available food stuff should be examined with regard to their components.

If pellets of balanced dietary requirement are not available the following should be added to the diet on a regular basis:
Vitamins and minerals see veterinary care.
Fruit and vegetables
White rhino
[For White rhinos alfalfa pellets are not recommendable.]
Only in winter:
- apples, pears and carrots 1-2 kg/animal and day.

Black/Indian rhino
[For Black/Indian rhinos alfalfa pellets should not exceed 20 % of the total pellet intake.]
Throughout the year:
- apples, pears and carrots 4-5 kg/animal and day.

5 DEFICIENCIES/INTOXICATION

5.1 Problem-causing diets

Cabbage, kale onion, and red maple should be avoided. An extremely high quality alfalfa forage diet may lead to mineral imbalances, colic and diarrhoea.

5.2 Supplementation

Licking salt, with or without minerals added, should be at disposal at all times.
Vitamins: see veterinary care.
Tests for mineral content in the forage should routinely be carried out to gain data for balanced dietary demands.

Feeding

- **Location**
  The existence of sand impaction is documented, it is therefore recommended that the feed be offered on concrete floors, from a feeding trough, however, not on dirt floors.

- **Mode**
  In general feeding should take place in groups, provided each individual has its own feeding place. If possible, rhinos should be trained to take bits from the keeper for supplementation and medication to be easily controlled.

6 TRANSPORTATION

6.1 Crating

See veterinary care for capture, health, and immobilization.
For transportation the animals should be crated, although loading them onto trailers has worked out. The animal's overall condition should be closely monitored when transported in a trailer.

6.2 Crates

Crates are normally made of wood reinforced by steel. The crate's size should be designed in accordance with the animal's volume; it should always extend the size of the animal by 1 m in width and length when laying on its sternum. Narrow bars in front help prevent eye and face injuries. To avoid breaking of horns or facial injuries the bars should be angled away from the animal, sharp edges should be payed attention to.
Crate training is recommended and requires about 2 to 6 weeks. First step will be to introduce the crate as a none-interactive part of the environment, which is followed by placing food stuff into the crate. For training the crate can be placed between the indoor and outdoor enclosure. This way the animal will get accustomed to passing through.
Forced crating should not be practiced.
Sedation before shipping is recommendable (see veterinary care).

7 VETERINARY CARE

7.1 Health

Sedation and immobilization
Sedation or immobilization of rhinos is considered to pose no problem.

Sedation
Sufficient sedation for transportation or for taking blood samples can be reached by applying:
a) intramuscular **Xylazine/Ketamine** at a dose of 0,3-0,6 mg/kg BW each.
b) per os **Acepromazine** (Vetranquil®, Albrecht) or **Diazepam** (Valium®, La Roche) at a dose of 0,5-1,0 mg/kg BW.

As an **antidote** for Xylazin
Yohimbine, applied intraveniously or intramuscular at a dose of 0,1-0,2 mg/kg BW, is well-tried.

Immobilization
Etorphine (Large Animal Immobilon®, C-Vet. Ltd.) is either used alone at a dose of 1,2-1,6 ml (2,7-3.6 mg)/adult individual or preferably in Combination with **Xylazine/Ketamine** at a dose of 30-50 mg.

To prevent an animal from getting caught in an acute angled corner, between bars, or feeding troughs, it is to be observed closely during the immobilizing phase.
Before crating the animal should be observed for renarcotising symptoms for 24 hours.

7.2 Parasites

Parasites only play a major role in newly captured animals and in animals kept on grass land in tropical climatic zones.
With the modern broad range anthelmintics for horses also rhinos can be treated (according to body weight) successfully and without problem.
If an animal is newly arrived from an area of tropical climate screening should include blood exams for haemic parasites, trypanosomes, theileriasis and leishmaniasis.
Skin lesions in wild caught Black rhinos should be biopsied and examined for *Stephanofilaria dinniki.*

Commonly observed parasites
1 Protozoa, ***Trypanosoma, Babesia, Theileria***
are widespread in rhinos in Africa; they are of no relevancy in zoos.
Treatment has been tried with Diminazenaceturat (Berenil®, Hoechst) at a dose of 2-5 mg/kg BW.
Coccidiosis, ***Balantidium coli*** and **Trichomoniasis**
occasionally cause diarrhoea especially in young rhinos.
Successful **treatment** has been executed with Amprolium
(Amprolvet®, MSD-Agvet) respectively with Jodochlor hydroxyquin.

2 Cestodes

Indian and African rhinos, newly arrived from the wild, for years may show in the faeces proglottides from *Anoplocephala* sp. and *A. gigantea*.
Animals weakened by other illnesses sometimes show massive infestation.
Treatment: Recently, successful treatment has been executed with 0,5-1 mg/kg BW Praziquantel.

3 Nematodes

A large number of gastro-intestinal nematodes has been seen in all rhino species such as *Strongyloides* sp., *Kililuma* sp., *Quilonia* sp., *Drascheia* sp., *Probstmayria* sp., *Oxyuris karamoja*, *Habronema khalili*, *Parabronoma rhinocerotis*, *Grammocephalus intermedius* and *Gr. clathrotus*.
Treatment: With the application of modern broad range anthelmintics such as Thiabendazole, Fenbendazole, Mebendazole, Pyranthel Tartrate and Ivermectin, parasites are kept well under control (doses to be based on those for horses).

4 Arthropodes

White and Black rhinos are often carrier of larvae of the warble-fly *Gyrostigma pavesii*, while *G. conjugens* only occurs in Black rhino.
Also, *Gastrophilus*-larvae are often found in rhinos newly arrived from the wild.
These larvae cling to the gastric wall and are excreted with the faeces. Severe infestation can cause inflammations. For some time flies still may hatch from larvae in imported rhinos when kept in well heated enclosures.
Treatment with Ivermectin per os will eliminate the larvae.

7.3 Major diseases/treatment

A comprehensive study of diseases in rhinos and their treatment has been published by Göltenboth (1995). A medical bibliography for rhinos has been published by Miller (1992), and a literature evaluation of diseases in rhinos by Kulow (1990).

7.3.1 Inoculations (type and schedule)

For all rhino species vaccination against **tetanus** may be necessary. In endemic areas it is recommended that rhinos be vaccinated for **clostridial** diseases.

For all rhinos vaccination is recommended against elephant-pox with the Modified Vaccinia-Virus Ankara (MVA).
The vaccine must be applied for with the veterinary officials, and, after authorization, can be obtained from:

- Institut für Medizinische Mikrobiologie, Infektions- und Seuchenmedizin der Universität München, Veterinärstraße 13, D-80539 München (Germany).

Whether in future all captive rhinos should be vaccinated against leptospirosis is still controversial (ref. bacterial infections).

7.3.2 Bacterial infections

Multi-bacterial infections can be hazardous to all rhino species.
They are caused mainly by traumatic injuries, affection of the lungs and the gastro-intestinal tract and often lead to general septicaemia that prove fatal.
Successful **treatment** is dependent upon the possibility to apply high doses of the appropriate antibiotics.

It must be stressed that **tuberculosis** is dangerous to all rhino species.
Like in other zoo animals, intracutanous tuberculinization is best set on the upper eyelid. Set behind the ear or on the tail it is of little evidence und must be done in support of an ELISA-test or the direct demonstration of the infectious agent.
Very rarely **treatment** is indicated and seldom shows satisfactory results.

Salmonella-infections can successfully be treated with Enrofloxazin (Baytril®, Bayer).

Leptospirosis is discussed as one of many causative factors for haemolytic anaemia.

In the USA a number of Black rhino has been vaccinated with a vaccine of 6 different serovar (Leptoferm-6).

7.3.3 Virus diseases

With the outbreak of elephant-pox in captive elephant herds also Black and White rhinos became infected, in cases showing acute systemic disturbances (ref. inoculations).
In cases of ulcerative dermatitides and pox-like skin diseases the presence of a *Herpesvirus*-infection should always be taken into consideration.

7.3.4 Mycosis

Aside from **dermatomycosis**, especially seen in the Black rhino, also pulmonary mycosis may be seen, caused by *Aspergillus*- and *Mucor*-infections.
In the USA some rhinos suspectedly only developed mycosis after treatment with corticosteroids.

7.3.5 Haemolytic anaemia

The haemolytic anaemia syndrome at this stage is only seen in captive Black rhinos.
Cardinal symptoms: red urine because of haemoglobinuria, erythrocytic count reduced to below 1 million.
Observations are: slight red gradations of the urine without symptoms of disease, massive excretion of bloody urine with fast degeneration and exitus.
Currently discussed are multicausal factors such as **leptospirosis-infection, vitamin-E-deficiency**, previous damage of the intestinal mucosa through **entero-pathogenic viruses** and **erythropenia** of ATP (Adenosin-triphosphat) and the **enzyme catalase.**
Prophylaxis
Due to metabolism of Black rhino red blood cells and their predilection to haemolysis as well as to the lack of specific information for the other species, it is recommended that treatment is avoided with haemolytic capabilities in all species. Some of these are antimalarials, sulfonamides, sulfones, nitrofurans, acetanilid, chloramphenicol, some vitamin K analogs, fava beans, and a number of chemical compounds including wood preservations, rodent control poisons or other pesticides and household cleaners, containing naphthalene.
A possible link has been established between the use of aspirin, phenacetin, aminopyrine, acetaminophen, probenecid, dimercaprol, p-aminsalicylclic acid, L-DOPA and haemolysis. These compounds should therefore be avoided!
Stress (moving, transportation, noise pollution etc.) should be avoided. In winter vitamin E-preparations (see vitamin deficiencies) should be added to the diet.
Treatment: With the onset of symptoms for therapeutic measures high doses of vitamins such as E and selenium, and penicillin/streptomycin, anabolics and phosphorus preparations should be given, also glucocorticoids for a short duration. Also, blood substitutes or blood from other Black rhinos may be transfused.

7.3.6 Diseases of the locomotor system and the skin

Older individuals may suffer from **degenerative arthritis**. In all 3 rhino species paralytic symptoms are seen, similar to laminitis of the horse.
Therapeutic measures: Denial of concentrate feed and application of diuretics, antibiotics, and analgetics will have a favourable effect.
Skin lesions must be treated in an early stage to avoid secondary infections or subcutaeous spreading.
Weeping eczema in the creases of the skin between the knee and the abdomen are mainly seen in Indian rhinos during the summer months.
Captive rhinos tend to wear out their **horn** (fraying and grooving will occur) on concrete fixtures, rocks, and emerging bolts, not seldom resulting in the population of putrefactive bacteria and dermatomyiasis.
Therapy: Anti-bacterial sprays, wood tar or partial dehorning. Horns only partly damaged for prophylactic reasons should be removed.
The tender and often bleeding **stump** is **treated** with therapeutic powders and sprays. The horn will grow back without problem.
Keeping rhinos on contaminated floors or hay may result in the population of putrefactive bacteria *and* secondary infections of the **soles** and between the **toes.**
Many individuals with excessively long toenails and horn proliferations between the toes must undergo orthopaedic treatment. Especially in Indian rhinos deep transvers tears in the soles are seen behind the toes.

Treatment - often for years: cutting of nails, removal of the (often) necrotic horn masses, if possible, compression bandages.

7.3.7 Vitamin deficiencies

Vitamin A deficiency is believed to cause skin and eye diseases and disturbances of the digestive system. Already on tentative diagnosis high doses of vitamin A should be applied intramuscular.

Vitamin E: In recent years extreme low blood levels of vitamin E has been seen in Black rhinos. This deficiency now is made responsible for the development of an overall weak resistance and haemolytic anaemia in individuals.

Research has shown, that the vitamin E (either fat or water soluble) level in the blood cannot be raised with commonly used concentrate feed (pellets), even if given in high doses.

However, it is said, that the water soluble TPGS (EL-Vite-Pellets, Emsicon) will raise the vitamin E blood level sufficiently.

Recommendation - for all rhino species:

2 mg/kg BW daily a-tocopherol (Rovimix-E-50, Hoffman-La Roche).

Throughout the summer: fresh grass, alfalfa, leaves and twigs, adding EL-Vite-Pellets during the winter months.

In winter **UV-therapy** should be conducted daily for 1 hour especially for young individuals.

7.4 Post-mortem protocols

A detailed post-mortem protocol should be supplied. A copy of which should be sent to the International Studbook Keepers: Dr. R. Göltenboth (*Diceros bicornis*) and Dr. A. Ochs (*Ceratotherium simum*), Hardenbergplatz 8, D-10787 Berlin (Germany).

It is recommended that at a minimum, tissues from frozen liver, kidney, fat, skeletal muscle, heart and spleen be collected.

Whenever possible, blood should be collected for haemic parasites and vitamin E analysis, vitamin A and vitamin C levels and for determination of titres from herpesvirus, poxvirus and others.