5. HEALTH (F. von Houwald)

Indian rhinos (IR) in zoological gardens are generally considered to be healthy. In some respects this may be true when compared to Black rhinos; however, chronic foot disease (CFD) is becoming increasingly recognized in the captive IR population. The health chapter will concentrate on CFD and other diseases known specifically from IR, as well as on anaesthesia. For general health aspects and physiological normals of rhinos, I refer to the 'health' chapter written by Eric Miller in the Rhinoceros Husbandry Resource Manual (Fouraker and Wagener, 1996). Further 'normal values' for Indian rhinos, such as weight, height, and several other body and foot measurements are listed in von Houwald (2001). Blood values can be obtained from Göltenboth (1995).

5.1. FOOT PROBLEMS

5.1.1. Clinical Findings

IR suffer from different foot problems in zoological gardens (von Houwald, 2001).

5.1.1.1. Cracks between the Sole and the Pad

Description and prevalence

All breeding bulls in European collections suffer from cracks, which form alongside the central sole and the adjacent pad. More than half of the breeding females in Europe are affected by these cracks as well. Over 25 % of the world captive population is recorded to have these problems (von Houwald and Flach, 1998). These cracks occur rarely in young animals (under the age of 5). They often start to develop on the medial side and can reach all the way to the lateral part of the pad. They can extend very deep into the tissue, leading to the formation of granulation tissue and the production of poor horn quality. The exuberant growths of granulation tissue leads to further irritation and prevents the tissue to fully regenerate.

Clinical signs

Clinical evidences of foot problems likely to be noticed, are blood tracks on the floor and exuberant granulation tissue on the sides of the central hoof. Lameness occurs only in severe cases. Under close observation and previous cleaning of the feet even very small cracks become easily visible.

When standing, the animal often relieves the strain on the affected foot by lifting it partly up. Most animals tend to remain recumbent and prefer access to water. Pain appears to be tolerated during mating.

Due to the large amount of granulation tissue forming around the affected areas, some animals start to put more weight on the palmar / plantar part (hind part) of the pad, which can eventually lead to a change in conformation of the hoof and the associated joints.

Diagnostics

Close observation is the most effective diagnostic tool.

On several occasions, swabs have been taken for microbiology. In general the lesions are infected with common bacteria, very seldom with fungi. It is believed that the bacteria and fungi are secondary invaders, and have no role, concerning the primary development of the cracks, but do delay the healing process.

5.1.1.2. Vertical Cracks in the Horn Wall

Description and prevalence

At least 38% of the Indian rhinos in European collections show vertical and / or horizontal cracks in the horn walls of their hooves. They can reach from the coronary band to the sole or can run horizontally across the horn wall. Vertical cracks are more often found in side hooves and can even reach across the whole length of the sole surface (footing surface). They are often not diagnosed since the hooves are covered by dirt. They can appear from one day to the next.

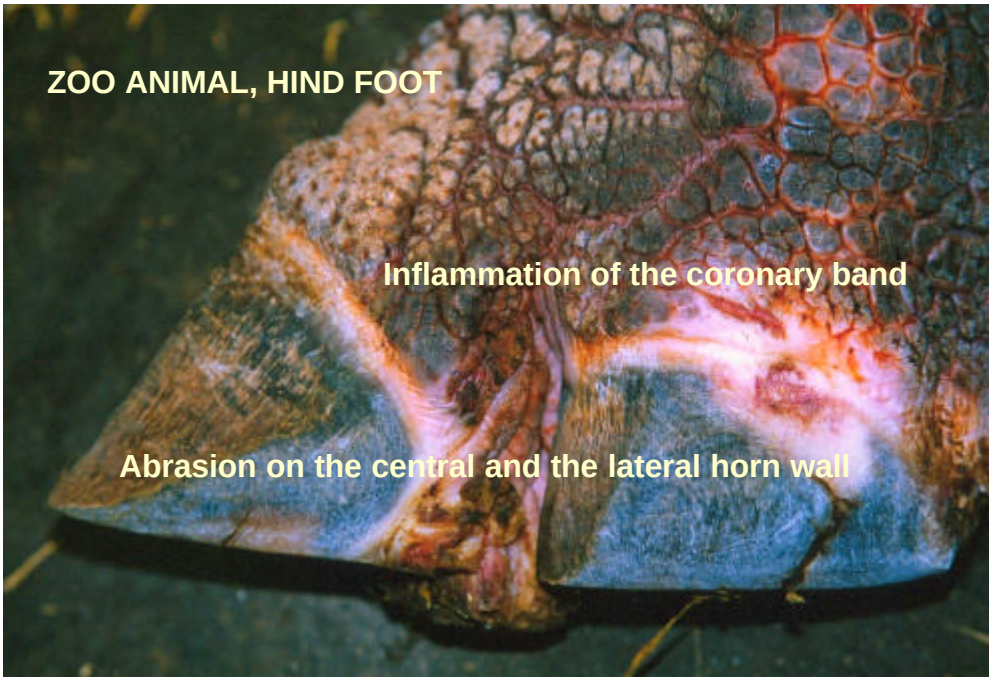
Clinical signs

During ambulation, the cracks open and close due to the weight shift. An infected horn wall can lead to complications such as sole abscesses, 'loose wall' (‘break down’ between the horn and the living tissue), and abscesses along the coronary band.

5.1.1.3. Abraded Horn Wall

Description and prevalence

At least 70 % of captive European IR have abraded lateral horn walls. This is mainly visible on the hind but also on the fore feet. The medial hooves are less affected. The coronary band is often reddened and sometimes infected. Cracks, as mentioned above, are often seen in association with highly abraded horn walls.



Clinical signs

Inflammation and reddening of the coronary band. In general the animal shows no direct sign of discomfort, unless the inflammatory process also includes the horn wall.

5.1.1.4. Ulcers and Lesions of the Pad

Description and prevalence

16% of the Indian rhinos in Europe exhibit ulcers on different locations on their pad. The lesions can reach deep into the subcutis of the pad. While cleaning, one can sometimes follow a track into the soft tissue for several centimetres.

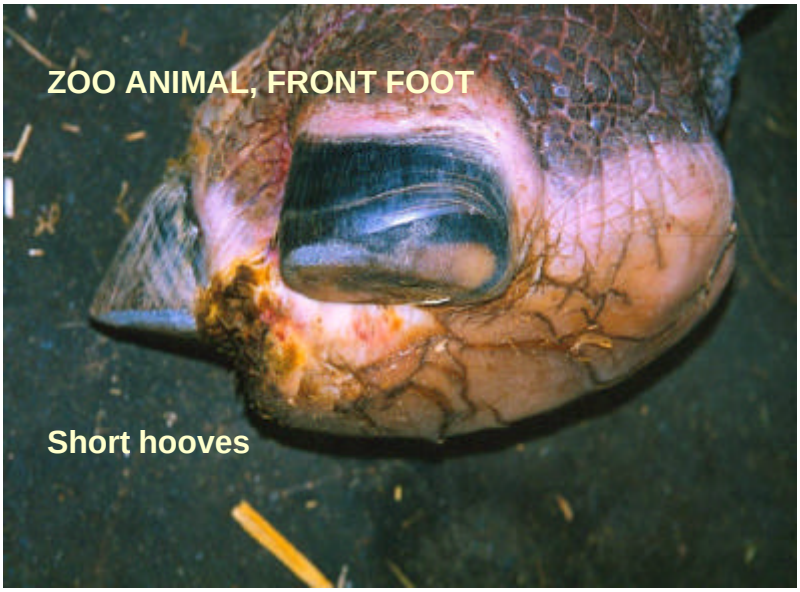
5.1.2. Causes of Foot Problems in Indian Rhinos

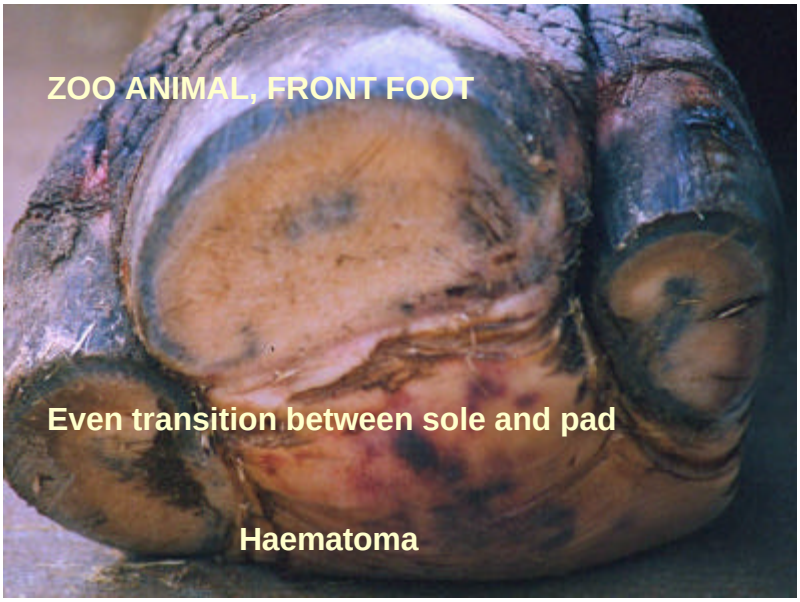
Studies of the anatomical structures of captive and wild Indian rhinoceros feet have helped to recognize the high prevalence and understand the causes for the occurrence of the different types of foot problems in Indian rhinos.

Captive animals

1. They have whitish, flat, and thin foot pads (often affected by haematoma).
2. The horn walls are short.
3. The soles are short, flat, and adjoin the adjacent pad at an even level.
4. The side parts of the hooves (in particular the lateral hooves) are abraded and show white, thin, and flattened horn walls.

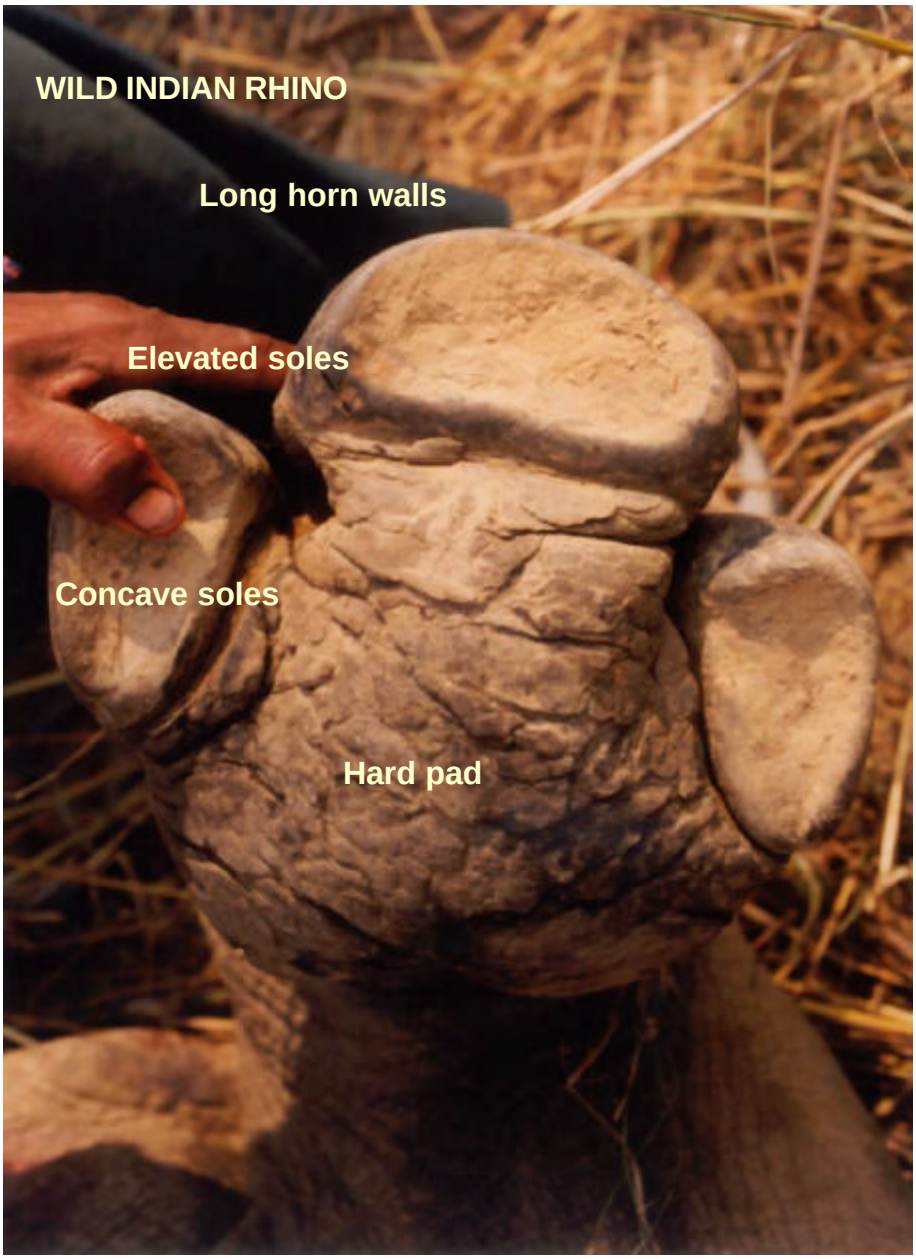

ZOO ANIMAL, FRONT FOOT
Haematoma in the pad


ZOO ANIMAL, FRONT FOOT
Short hooves


ZOO ANIMAL, FRONT FOOT
Even transition between sole and pad
Haematoma

Wild animals

1. The foot pad is grey, appears strong and shows minor cracks. Those cracks seem to be of superficial nature only.
2. The horn walls are long. The side hooves are slightly curved backwards, resembling the shape of a claw.
3. The soles are long and concave. They do not join the adjacent pad at an even level and appear ‘higher’ than the pad. There is a well visible elevated dark rim (2 cm wide) in the palmar / plantar (hind part) of the sole. The main weight seems to be carried by that dark rim and the weight-bearing border of the hooves.
4. Of the feet examined, no signs of abrasion, crack formation or other pathological findings were visible on the side or front hooves nor on the pads themselves. The horn of the horn wall had a shiny appearance.



Histology revealed that the horn of the pad consists of very fine horn tubules and weak intertubular horn cells. In contrast, the horn of the adjacent sole consists of very strong horn tubules, which are arranged in groups. These groups are well visible as a dark rim (the area of the sole adjacent to the pad) and give that structure its great strength.
From the histological point of view, the transitional area between pad and central sole is an area of minor resistance, as two very different horn structures are aligned directly next to each other.

Anatomic investigation showed that the epidermis of the pad is very thin. The maximum height ranges around 1cm.

When comparing wild and captive animals it becomes evident that **wild** Indian rhinos have naturally very strong pads, elevated soles, and long horn walls. They are **'sole-walkers'** as their main weight is carried by the strong horn structures of the soles and hoof walls. The soles are concave and expand during locomotion phases. Almost no weight is put on the front part of the pad.

In **captive** animals the situation looks different. Their footing surface is flat and abraded. They have turned under the current captive situation into **'pad-walkers'**, carrying their main weight on the pad. The front part of the pad is not protected by an elevated structure of the soles and has to bear the massive weight of the animal. Once the pad and sole structures become abraded they are prone to any further impact, such as the high weight, sudden sharp turns, lack of moisture, etc. Those factors finally lead to the development of cracks in those predisposed areas.

5.1.3. Therapy

5.1.3.1. Cracks between the Sole and the Pad

Severely affected animals are very difficult to treat and treatment schemes remained so far palliative. The granulation tissue needs severe débridement. The cracks need to be cleaned and pared out in a way that most strain is taken off that area, when the animal puts its foot down again. These are all attempts to allow the tissue to regenerate. In general this it not possible. The soles are so flat that even with thorough cutting the cracks can't heal properly. Each time the animal will put down its foot the tissue will crack again. In a report by Atkinson (2001), on a long-term treatment scheme, it is mentioned that it was not possible to improve the healing process to 100%. Unsuccessful treatment in severely affected animals led in some zoos to euthanasia. Despite the relatively young age of many animals affected, chronic cases are always associated with a poor prognosis for recovery.

Some zoos manage to keep the problem under control by regularly (every 3 weeks) cutting the small cracks as well as granulation tissue away. This is helpful in milder cases. In general the problem is not resolved, but delayed. Animals can become well trained to tolerate minor manipulations.

In severe cases frequent anaesthesia needs to be performed and it may be the only way to adequately control the problem (Schaftenaar, pers. com., 2000; Atkinson, 2001). It is important to realize that treatment schemes have to be performed quite regularly, even if this means anaesthesia every 6 – 8 weeks. The horn growth is rather quick (about 1cm per month).

Most zoo animals show elongated central hooves in their hind feet. In untrained animals cutting of the horn wall and sole is only possible under anaesthesia. The cutting is often delayed until the horn wall and sole have formed a rather long hoof. At this point interference becomes more than necessary and the long horn walls need to be cut. When doing this, the weight-bearing border becomes well visible as a black line. Under physiological conditions, this black line should always touch the ground. In those cases, where the horn wall looks very long, the weight-bearing border does not touch the footing surface anymore after cutting. The white material underneath is horn of the sole, which is rather weak. In the course of time this horn will wear off, adding to the process of flat soles and feet. It is important NOT to cut the hoof wall too late. If necessary, one should try to cut also some horn of the middle part of the sole away, in order to give it a concave shape. This gives the horn shoe more elasticity.

In Basel Zoo, there are at the moment some investigations underway to find a method of elevating the soles, in order to copy the natural structures of the foot. Previously, wooden blocks have been applied beneath the soles. This has not proven successful on the long run. When using blocks, one has to make sure that all three blocks remain on a foot. As soon as one block drops of, it either has to be replaced immediately or the others need to be taken off at once. Otherwise the animal will put the weight on the pad, adding in the formation of cracks. Applying blocks might be done without anaesthesia but again the animal has to be well trained and there is always a great risk that the animal will get up before the treatment is completed.

5.1.3.2. Vertical Cracks in the Horn Wall

Therapy of vertical cracks should consist of cutting them open by means of a ‘V-shaped’ cut, a technique adapted from hoof care in horses. Close attention needs to be paid to the living tissue.

Therapy of a 'loose wall' or sole abscess requires in most cases sedation of the animal as they are very painful and need aggressive treatment.

Abscesses on the coronary band need to be opened, so does the track below (coming from the sole). It is very important, to find and treat those tracks, otherwise the abscesses will reappear.

Horizontal cracks seem to grow out alone but need monitoring.

5.1.3.3. Abraded Horn Wall

There is no treatment scheme for abraded horn walls. However, one should keep in mind that the thin horn layer of the horn wall (if it is already white instead of black) is VERY sensible. This is important to know, when applying blocks on those hooves by using material that becomes very hot.

5.1.3.4. Ulcers and Lesions of the Pad

These need débridement, cleaning with antiseptical lotions, and application of anti-bacterial and antifungal crèmes.

In general those localised lesions will heal well if they are cut open (funnel-shaped) and monitored regularly. Those injuries result in general from penetration of foreign material such as rocks, flint stones, thorns, etc. They do not seem to correlate with the other pathological changes of the feet.

5.1.4. Prevention

Above mentioned alterations appear due to highly abraded horn structures of the pad, sole, and horn wall. As mentioned, treatment schemes are only palliative and in order to prevent foot problems in Indian rhinos, serious thoughts need to be given to the husbandry conditions in zoological gardens.

The outdoor enclosure should consist of moist, non-abrasive flooring substrates. This can be wood chips (some bark might be eaten), grass, (rounded) sand, earth, mud. A good drainage system helps to avoid that the outdoor enclosure will look like a huge mud wallow in the course of time. It often helps to observe where animals like to spend most of the time. Knowing this, one can use different substrates according to the needs of the animals (mud to cool down, sand to warm up, wood chips to walk on, etc.)

As wild rhinos spend up to 70% of their time in the water, captive animals should have free access to a pool / lake throughout the year. As most animals do not like to go into the water if it is too cold (below 15-18° C) one should consider additional heating systems (solar, etc.) in case it is needed. Animals should not be allowed to go into the water if the outdoor temperature is below 10° C.

In some indoor enclosures a 2 component rubber flooring material has proved successful in the last years. Other materials, mentioned beforehand, are prone to fast degeneration. Despite the fact that this material does not completely withstand the tearing forces of the feet when lying down, it is momentarily recommended as the best solution.

It is easily applied, and broken parts are easily replaced.

Other institutions worked with card box chips, straw, wood chips, etc. With regard to the constructions of most facilities, it is difficult to apply wood chips to the given situation without remodelling the facility. In those cases, rubber seems the better choice. For those institutions that think about building new facilities one should keep the option of wood chips in mind. They have proved very useful in many enclosures.

Each animal should have access to an indoor pool during the day, especially during the winter months, where most animals might have to stay inside for several months.

5.2. SKIN PROBLEMS

5.2.1. Exsudative Dermatitis

Clinical signs

The skin along the medial surface of the hind legs, along the caudal part of the abdomen, and along the edges of the ears looks reddened and show signs of inflammation (it is generally not seen between the skin folds). Pruritus and smelling exudates are often found.

Diagnostic

In several cases microbiology revealed a with mixed infection with:

- ß-haemolytic Streptococci
- Staphylococci without haemolysis
- Malassezia pachydermatis has been reported in rhinos, but seems to occur rarely

One report documented the resemblance of ß-haemolytic streptococci and *S.* dysgalactia by means of biochemical and DNA sequencing tests (Völlm et al., 2000).

Treatment

The following treatment scheme seemed temporarily successful: Bactrim forte®, with a total dose of 4.8 g Sulfamethoxazole + 0.96 g Trimethoprim TMP (containing per tablet: 800 mg Sulfathoxazole + 160 mg Trimethoprim TMP) for 4 days. The skin lesions were treated with Excipcial U Hydrolotion® (emollient in 4% Urea: 1% Chlorhexidine + 2% Clotrimazole + 0.15 % Betamethasone) and a watery inorganic iodine solution (Iodi solutio glycolica, Formularium Helveticum 1.2) (Völlm et al., 2000).

The daily washing with Betadine® soap and spraying with Betadine® solution did not lead to full improvement and stop of pruritus.

In other institutions the recommended dosage for Bactrim forte® is ten times higher than the dose mentioned above (2 mg/kg), i.e. 20 mg/kg. This is given orally, for 5-7 days (Atkinson, pers. com., 2001).

Prevention

The reddening of the skin seems to occur often during the summertime (Göltenboth, 1995), but has also been reported during winter months (Völlm et al., 2000). It is possible that this problem results from too much heat (sweat), increased resting periods, and not enough access to water and / or mud.

Prevention should consist of close monitoring, daily spraying and / or washing of the animal with water and / or the possibility of free access to water and / or mud.

5.2.2. Pustular Dermatitis

Clinical Signs

Multiple pisiform to thumbnail size, seropurulent pustules, which cover most parts of the body. The animal can show signs of apathy and anorexia, but this stage usually appears only in connection with the spreading of the lesion in size and quantity. In most cases the general state of health is not affected.

Diagnostic

Microbiological tests reveal the presence of:

- Staphylococci without haemolysis
- Streptococci with haemolysis
- Other non-specific polybacterial microbial flora (Rietschel, 2000)
- Poxviruses were excluded
- Presumption of herpes, but so far no certain proof exists (Göltenboth, 1995)

Treatment

Depending on the severity, scrubbing with Betadine® shampoo (shampoo works better than lotion, Schaftenaar, pers. com., 2000) for several weeks will help or

Penicillin-streptomycin, corticosteroids, washing with soap-, rivanol- and entozoon-solutions as well as a cover with a sulfonamide-cod liver oil ointment can help the healing process (Rietschel, 2000).

Prevention

It seems likely that insects may be the vector to transmit these common bacteria in indoor / outdoor enclosures. In how far it becomes necessary to use insecticides on the rhinos depends to a great extent on the situation itself.

Other reports mention that flies were not observed to be of any importance.

So far no information exist about the epidemiology and its prevention.

5.3. HORN PROBLEMS

5.3.1. Abrasion / Fracture of the Horn

Almost every zoological garden faces the problem that an animal rubs its horn until it is almost gone (esp. the males), or tries and succeeds in breaking it off.

The former is often associated with stereotypic behaviour and can lead to the demolition of the whole horn (Widuch, 1999). The latter seems to be the result of a trauma. Regarding to literature (Silbermann & Fulton, 1979) horns are easily broken off.

Treatment

Horn will re-grow without any difficulties if the wound is cleaned, disinfected, and all necrotic / broken tissue parts removed. Hygiene is important to avoid maggots to invade the wound, which seems to be a common problem during summer months (Göltenboth, 1995).

Prevention

Stereotypic behaviour is difficult to change and stop. A behavioural enrichment programs is required in order to prevent it from developing at all. To avoid rubbing of the horn (circling / banging the head in front of doors, walls) it has proved helpful to install an electric fence along / in front of the objects of choice. This is only an option for the outdoor enclosure. It is interesting to notice that they tend to rub their horn only against flat surfaces. In indoor enclosures rounded timbers along the wall (see chapter 4.2.1 General features) should be the first choice.

It is important to keep in mind that the animals do need some structures to groom their horn. This is a natural behaviour (Laurie, 1997). Tree trunks for example give rhinos a good possibility to rub body and horn.

5.4. OTHER HEALTH PROBLEMS

The following health problems have been reported but do not seem to be a common problem in this species.

5.4.1. Joints / Bones

Arthritis seems to affect Indian rhinos at old age or due to traumatic impacts (Silbermann and Fulton, 1979). It is interesting to notice that this species seems to be less affected by this problem than elephants or other rhino species.

Osteomyelitis on the second (PII) and third phalanx (PIII) in a front foot has been diagnosed in an old female. *Streptococci equisimilis* were cultured. This infection followed probably a traumatic impact on the front foot (Flach, pers. com., 2000).

Czupalla and Strauss (1997) reported on a case of multiple fractures of thoracic vertebrae in an adult male rhino. This occurred after the animal fell into a moat.

5.4.2. Digestive Tract

5.4.2.1. Teeth

Young animals may encounter difficulties during tooth replacement (Silbermann & Fulton, 1979). The first generation may remain over the next one and this leads to impairment while eating.

Old animals often chew irregularly on their teeth or the teeth have been worn to such an extent that they cannot digest their food.

The symptoms and the treatment are similar to that in equines.

5.4.2.2. Oesophagus

Large food items can lead to the obstruction of the oesophagus with all its known symptoms. Diagnose is only verified when access is possible during sedation (Rietschel, 2000).

5.4.2.3. Stomach

Indian Rhinos may easily be stressed by minor events, undetected things, noises, etc. In several necropsy reports it has been noticed that ulcers developed in the stomach. Those were thought to be associated with stress situations (Göltenboth, 1986).

It is important not only to notice a change of behaviour but also to improve any condition, which might stress the animal. This aspect should be considered when it comes to translocation, introduction of new animals, presence of construction sites, changes in the diet, etc.

Perphenazine has proved very successful in one case to reduce stress (Rietschel, 1998) and it seems to be a good alternative in order to get animals used to an unknown situation.

5.4.2.4. Small and Large Intestines

Several cases of impaction of the colon are reported in the literature (Jones, 1979; Silbermann & Fulton, 1979; Göltenboth, 1995). The ingestion of sand seems to be the main reason for it. The feeding place should be made of concrete and preferably elevated.

Observation of the animals after introducing new material seems the only way to prevent this problem.

Torsions of the colon as well as the small intestine have also been reported. The causes are often not known. In one case it has been associated with mating (Silbermann & Fulton, 1979).

5.4.3. Lungs

Nasal discharge, coughing, elevated breathing, and apathy are common symptoms associated with lung disorders. Since diagnostic work is difficult, first aid therapy often consists of a broad-spectrum antibiotic.

In the seventies, the animals at Basel Zoo suffered from 'Farmers lung' (*Micropolyspora faeni* - chronic interstitial pneumonia), which was associated with the hay. To eliminate the problem the hay was replaced with good quality straw. Since that time, straw is given to the animals after careful preparation (shaking and cutting). Moistening also prevents spores from spreading (Rüedi & Müller, 1975).

5.4.4. Cardiovascular

Sarcoma in the heart and lungs resulted in a sudden death of a Indian rhino (Silbermann & Fulton, 1979). Cardiovascular shock has been reported in an animal during anaesthesia, which suffered from severe foot problems and seemed to be very stressed (Flach, pers. com., 2000). An other animal became recumbent due to severe foot lesions and was not able to get up. He died of cardiovascular shock.

5.4.5. Urinary Tract

One report exists about a suspected case of urinary infection (Göltenboth, 1995).

5.5. BACTERIAL INFECTIONS

5.5.1. Salmonella

Salmonella infantis was associated with the death of a young animal, which suffered several days from diarrhoea and did not respond to antibacterial treatment (Silbermann & Fulton, 1979). In young animals (and esp. wild caught ones), stress associated with transport and the loss of the mother, seems to impair the immune system to such an extent that they become very susceptible to bacterial infection, such as *S. infantis* (Strauss & Wisser, 1995).

Salmonella thyphimurium and *enteritidis* caused the death of adult animals.

Therapy should consist of high dosages of antibiotics (resistance test) and the replacement of fluids. If the animal refuses to drink, the ear vein has proved to be a very helpful place for infusion. The use of an enema is recommended.

5.5.2. Tetanus

This species is likely to be susceptible to tetanus. However, no reports exist. One should consider this aspect when dealing with large wounds or during foot care.

5.5.3. Tuberculosis

Indian rhinos are susceptible to *Mycobacterium bovis* and *tuberculosis* (Silbermann & Fulton, 1979). Since the last 20 years there have been no reports on tuberculosis infections in European collections regarding this species.

5.6. VIRAL INFECTIONS

5.6.1. Herpes

The presence of a Herpes virus in connection with skin problems is still presumptive (Göltenboth, 1995).

5.7. ENDOPARASITES

Anoplocephala gigantea seems to occur quite often in this species. Proglottids in the faeces are easily diagnosed.

Treatment consist of 7,5 mg/kg BW Fenbendazole (Panacur®) or 1 mg/kg BW Praziquantel (Droncit®) p.o. three times in monthly intervals (Göltenboth, 1995; Rietschel, 2000).

5.8. MEDICAL ASPECTS OF REPRODUCTION (F. von Houwald / R. Hermes)

Despite the fact that the captive population is slowly growing it is interesting to notice that some females have never bred successfully in captivity.

5.8.1. Female Reproductive Disorders

Female Indian rhinos become sexually mature at the age of 3 - 4 (5) and have an average cycle length of 44 (34 - 48) days. A common problem in zoos is that the female does not show any overt signs of oestrus (see 3.4.2. Oestrus and Courtship) and / or is not willing to tolerate the male for mating. There are numerous reports in the literature concerning females, who gave birth once or even more often and then never again.

5.8.1.1. Leiomyomata

The most prominent alteration in the female genital tract, which is held responsible as one reason for a reduced rate of reproduction are leiomyomata, benign muscle tumours located in the uterus, cervix, and vagina (Montali et al., 1982; Göltenboth, 1995; Hermes, pers. com., 2001). None of the females affected by these tumours became pregnant as leiomyomata are believed to hinder the sperm transportation, the supply of an embryo with nutrients, and the implantation of an embryo in the uterus. Tumours have mainly been identified during post mortems. The development of leiomyomata in the female genital tract is reported from many other species including humans. It is thought that their occurrence is linked to a permanent oestrogen influence on the genital tract and especially on the uterus originating from an continuous oestrous cycle activity without conception. Advancing age in combination with regular oestrous cycle are thought as reason for the progressive development of these tumours reaching up to 50 kg in rhinos. The pathological mechanisms have not

been elucidated up until now and the whole field still needs more research. Recent advances in diagnostic ultrasound in different rhino species facilitated *in vivo*

diagnosis of these tumours by the performance of reproductive ultrasound examination. The reproductive assessment of all genital organs by ultrasound was used to determine potentially present pathological alterations and to evaluate the remaining breeding potential of a female. Uterine tumours were found in females with regular oestrous cycle as well as in females in which the cycle activity had ceased. Close housing of the male next to the females has been discussed to play a potential role as well (Göltenboth, 1995).

5.8.1.2. Endometritis

Endometritis has occurred in Indian rhinos and was treated successfully with antibiotics and flushing of the genital tract with a disinfectant (Rietschel, 1992). In some cases endometritis was linked to abnormal oestrus cycles and abortion (Göltenboth, 1995).

5.8.1.3. Ovary cysts

Ovary cysts have been reported to occur in Indian rhinos (Hermes, pers. com., 2001). The causes for their occurrence remain still presumptive and it is likely that they stand in close correlation with a hormonal imbalance. In the wild, Indian rhinos cycle maybe 15 times during their whole life. The rest of the time they are either pregnant or are lactating. The wild population cycles therefore every second year, before conceiving again. Under captive conditions most females cycle much more often before they get pregnant. They also become sexually mature at an earlier age than wild Indian rhinos. At the moment research projects are investigating the question in how far cysts and tumours might be related to a hormonal imbalance of the genital tract (Hildebrandt, pers. com., 2001).

Modern reproductive management of rhinoceros in captivity implies the transportation of potential breeders. The described reproductive disorders in female rhinos emphasize a critical need for enhanced reproductive assessment in animals with missing breeding success. This becomes especially important before translocation to other facilities.

5.8.2. Male reproductive disorders

Males tend to have fewer organic disorders than females. A young bull, coming to the zoo at the age of 3 was kept with two females. He did not become sexually active by the age of 7. There is the impression that he regarded the females more like mother / sister than as a potential mate. In how far bulls should not be kept in the proximity of females after weaning is difficult to assess and depends to a high degree on the facilities. If male rhinos tend to show a more docile behaviour and do not reproduce at a certain age after being kept together with females, this might have an effect on husbandry and breeding aspects. This field needs further evaluation.

In contrast to the research undertaken in White and Black rhinos regarding sperm quality and success of breeding (Hermes, 2001) only little research has been per-

formed on the Indian rhino. In the White rhino e.g. it was reported that more than two males housed in one facility induced a status of subfertility in all but one dominant breeding male. Female dominance behaviour over males also reduced sperm production and sperm quality. Some questions such as sperm quality of bulls kept in bachelor groups, might be of great interest for the Indian rhino too. Especially if some facilities would be able in the future to hold a group of young bulls until they become sexually mature.

5.9. SEDATION / ANAESTHESIA

Many zoo rhinos, which are used to humans, are kind and good-natured. They tolerate minor manipulations and will lie down when being rubbed between the legs, stomach, mammary gland, or preputium. Nevertheless, one should always keep in mind that they can be up on their feet within seconds. Chute training can and should be used for minor manipulations such as blood sampling, etc. The following dosages are meant to serve as guidelines. The character of each individual should be considered prior to any procedure. The safety of personnel should be given very high priority, not only due to the nature of the animal but also due to the potential agents used in chemical restraint procedures.

5.9.1. Light Sedation / Tranquillisation

Light sedation is indicated for minor manipulations (blood sampling in untrained animals, translocation, etc.). There are different drugs on the market, which vary with regard to onset and duration of the sedative effect. The choice of drug depends therefore on when and how long a tranquillising effect is desired.

These drugs have been used on a variety of occasions: To reduce anxiety, aggression and capture / transport related stress (Atkinson, pers. com., 2001). The experience with these drugs has shown that they proved highly effective in transports and pre-transport related training. During transportation most animals remained calm, were eating and fewer problems occurred when reaching a new zoo / enclosure / environment, than those which were crated and transported without any drugs. Especially for long distance transportations some of these drugs should be given serious considerations. All drugs have side effects, which are often associated with over dosage. More detailed information on tranquillisation can be obtained from Mark Atkinson, The Wilds, Ohio, USA.

<u>The following drugs are recommended</u>:

Diazepam (Valium®)
0.5-1.0 mg/kg BW per os (Göltenboth, 1995), lasting for 60-90 min.

Azaperone (Stresnil®)
0.05-0.1 mg/kg IM. (Atkinson, pers. com., 2001), 100-200 mg total dose for an adult IR. Will last for 2-3 hours.

Acepromazine (Vetranquil®, Aceprom®, Combistress®, Neurotranq®)
0.5-1.0 mg/kg BW per os (Göltenboth, 1995), lasting for 4-8 hours.

Detomidine HCL (Domosedan®)
8 – 14 mg IM total dose for adult White Rhino alone or in combination with Buthorphanol (Butomidor®, Turbogesic®) 8-14 mg IM total dose. Onset IM 20 minutes, duration 1-2 hours. Can also be used IV at a reduced dosage of 4-6 mg Detomidine plus 4-6 mg Buthorphanol. (Used by Walzer in approx. 60 minor procedures). Can be used as an adjunct in Ethorphine anaesthesia (see below).

Haloperidol USP (Serenace®, Haldol®)
0.05-0.1 mg/kg per os (Atkinson, pers. com., 2001) (max. 200 mg for an adult male IR), lasts up to 16 hours.

Zuclopenthixol acetate (Clopixol-Acuphase®)
up to 300 mg for an adult rhino (Atkinson, pers. com., 2001). Onset of action 1 hour after administration, tranquillisation effect will last for 72 hours.

Perphenazine enanthate (Trilafon LA®, Decentan®)
Average dosage for an adult IR: approx. 200-300 mg (50-150 mg in juveniles and sub-adults). The effects are seen 10-16 hours after deep IM injection, peak effect is usually reached after approx. 72 hours. Duration of this form is described as being up to 7 days (Atkinson, pers. com., 2001).
500 mg (2.800 kg bull) s.c. (behind the ear) were used by Rietschel (1998).

5.9.2. Anaesthesia

General comments
Monitoring of anaesthesia is essential in rhinos. In procedures in which the animal is recumbent, ventilation / perfusion mismatches will occur. Initial respiratory acidosis can furthermore be aggravated through a metabolic component. Minimum monitoring requires the use of a dedicated person and a pulsoxymeter. Ideally sequential arterial blood gas analysis should be performed.

Make sure that both nostril airways are free and off the floor – provide additional oxygen through a nasal tube.

Etorphine-acepromazine (Large Animal Immobilon®)
is the 'drug of choice' for anaesthesia in rhinos and is often used in combination with detomidine (Domosedan®), butorphanol (Turbugesic®), ketamine (Ketaset®, Narketan®, Vetalar®), and xylazine (Rompun®, Xylazine Injectable®). As pre-medication some of the drugs mentioned under 5.9.1. have been used as well.

Others prefer the combination of etorphine, ketamine, and detomidine (Atkinson, 2001). The combination of butorphanol, detomidine, and etorphine was successfully used in White rhinos (Walzer et al., 2000).

There are numerous approaches for anaesthesia in Indian rhinos. The three most common ones are listed here:

APPROACH 1:

Dosages
Some zoos use Large Animal Immobilon® alone (dosages see below) and top up either with ketamine or LA Immobilon® during anaesthesia (Göltenboth, 1995).

LA Immobilon® (per ml: 2.45 mg etorphine HCL and 10 mg acepromazine) 1.2-1.6 ml (2.94 mg-3.92 mg) for an **adult** animal.

In some cases the dosage of LA Immobilon® increased to1.8-2.0 ml (4.32 mg-4.9 mg) for females and 2.5-3 ml (6.13 mg-7.35 mg) for males with the frequency of sedation (Flach, pers. com., 2000).This high dosage can be avoided by combining LA Immobilon® either with a previous dosage of perphenazine (see above) or with ketamine / xylazine or xylazine alone. Stress symptoms were significantly reduced and the combination led to a good anaesthesia.

A 10-year-old Indian rhino female, being eight months pregnant, was safely anaesthetised by using 1.5 ml LA Immobilon® (Schaftenaar, pers. com., 2000).

Ketamine/Xylazine	30-50 mg (each)
Xylazine	50 mg
Perphenazine	500 (300) mg per adult animal, given three to five days prior to anaesthesia, s.c.

Reversal
Diprenorphine (Revivon LA® per ml: 3.26 mg diprenorphine HCL). This drug has agonistic and antagonistic properties. 1 ½ -2 the amount of LA Immobilon® half IV, half IM.
NB! Beware the agonistic properties especially in White rhinos.

APPROACH 2:

Dosages
The combination of etorphine, detomidine, and ketamine had been used successfully in over 24 anaesthetic procedures of an adult male Indian rhino (6-8 weeks interval), (Atkinson, 2001).

Etorphine (M99®)	3.7 mg in combination with
Detomidine	14 mg and
Ketamine	400 mg

All drugs were given together IM. During anaesthesia, ketamine was used (100-250 mg IV) for maintaining a good sedation.

Reversal
Naltrexone (Trexonil®, Trexan®)
It is a pure opioid antagonist, which avoids the problems associated with 'renarcotization' (150-300 mg divided IV / IM).

APPROACH 3:

In White rhinos, the following combination was successfully used in over 80 procedures (Walzer et al., 2000).

Dosages
Butorphanol 10-15 mg per adult animal and
Detomidine 10-15 mg per adult animal

Wait 15-20 minutes, then apply
LA Immobilon® 0.8-1.4 ml

Dosages depend highly on age, state of health, and nature of the animal. In safari park - large enclosure situations - 200 mg ketamine is additionally added to reduce the 'pacing effect' of the etorphine. Animals remain 'glued' to the ground.

Reversal
250 mg **naltrexone** (Trexonil®) and 20 mg **atipamezole** (Antisedan®), given combined IV. Omit the use of atipamezole if you want slight sedation due to alpha-2 agonist post procedure.

Important considerations before and during anaesthesia

- No stressed, nervous animal should be sedated. The risk of fractured bones, pulled tendons or broken horns is high.
- Stressed animals also need a higher dosage for full anaesthesia. This might increase the risks. (One 6-year old rhino died under anaesthesia of heart failure. He had been sedated with LA Immobilon® on several occasions before, due to severe foot problems. He needed increasing doses for induction due to aggression, possibly associated with the pain from the foot lesions. In addition he was topped up as well during anaesthesia (Flach, pers. com., 2000).
- Rhinos tend to push their head between bars when going down. This can be avoided by using appropriate covers of heavy wooden panels. Enough staff should also be available. (The staff has to be experienced, informed about how to proceed and has to be aware of the risks!) The use of adjuncts to the etorphine anaesthesia also reduces the 'head press' effect.
- No slippery substrates should be on the floor for sedation. The animals tend to slip when going down. Rubber mattresses, which cover the whole ground are ideal, sand might prove helpful as well. Straw bales should be available to cover hard edges etc.
- No food for at least one day (esp. hay, straw) ? minimises the risk of regurgitation.

- Helpful tools:
  Straw bales (to assist in comfort when the animal goes down).
  Ropes (to pull / hold the animal in case this is needed).
  Non-translucent blankets (to cover the eyes as soon as the animal lays down).
  Water (to cool the animal under sedation if needed. Immobilisation on hot days should generally be avoided).
- Ear plugs to reduce the effect of noise
- Oxygen (essential in order to ensure adequate supply, especially if the head lies in an awkward position), emergency case (Doxapram®, 10 mg Nalorphine, naloxon, antidote), pulsoxymeter (clip on the tongue, ear or vulva).
- Make sure you have the human antidote naloxon (Narcanti®) ready **before** drawing up etorphine.
- Injection site: muscles of the neck, between the folds, or the medial side of the leg. Use adequate needle length, at least 55 mm.
- After injecting etorphine, it takes on average 10 minutes for the animal to become recumbent.
- Ensure intravenous access (ear veins). Eye ointment should be applied before covering the eyes with a blanket.
- Close monitoring of heart and breathing rate. Average parameter under anaesthesia are:
  - Heart rate: (50) 65-90 / min
  - Respiratory rate: 6-10 / min
  - $Sa0_2$ - mean: 77-89 % (very optimistic at least in White rhinos)
- For surgical work on the feet, straw bales should be available to put the legs on. Hard material should not be used as it might lead to temporary nerve damage as a result of prolonged compression of the neural tissues.
- Duration of anaesthesia should not exceed 1 ½ hours but this it not a general rule! Decision should always be based on monitoring! The first 20 minutes seem to be the most critical ones. In longer procedures ensure that the area underneath the animal is padded with straw / hay, etc.
- Reversal takes about 1-2 minutes (it is possible that the animal becomes 'renarcotized' during the following hours if not enough Revivon® has been applied, esp. when the animal had to be topped up with Immobilon®). By using naltrexone, a pure antagonist, one can avoid the risk associated with 'renarcotization'.

Size and weight

Male:	front: 166-187 cm; hindquarter: 175-194 cm
Weight adult:	2000-2800 kg (max. recorded 3600 kg)
Female:	front: 154-166 cm; hindquarter: 159-170 cm
Weight adult:	1600-2300 kg