4. DESIGN OF ENCLOSURES AND HOUSING (G. Guldenschuh)

Enclosure and housing design for Indian rhinos requires careful consideration with varying levels of complexity being dictated by the purpose and composition of the group. Installation of several connectable in- and outdoor enclosures, separation facilities, pools, mud wallows, run-arounds, shelters, visual barriers and so forth will be dependent on if the animals are kept for breeding or exhibition only; or in the future as bachelor groups (see 3.1. Group Size and 3.2. Group Composition).

4.1. OUTDOOR ENCLOSURES

Indian rhinos should only be kept in latitudes where they can stay outdoors for the greater part of the year, at least during daytime.

Since adult Indian rhinos, and especially the males, are pretty territorial, at least two outdoor enclosures are recommended. In Germany and Switzerland, minimal legal outdoor requirements are in the range of 500 m^2 for two animals and another 150 m^2 for every additional individual. (Once weaned, calves have to be considered adults for purposes of determining space requirements. Facilities should be capable of holding offspring for up to 3 years.) Consequently for 1.1 animals at least 650 m^2 useable and accessible surface should be available. A desirable size for 2-3 females with possible offspring lies between 1'000-2'000 m^2. It makes the management of a group of females much easier if part of the outdoor enclosure can be temporarily partitioned off (e.g. for mothers with newborn calves, for a sick individual, for training single animals, etc.). Think big, your group will hopefully grow!

Indian rhinos in the wild spend an average of 70% of the day in the water, feeding and dozing. On land, they primarily walk on soft muddy, sandy or gravelly alluvial substrates. Their feet are highly adapted to this amphibious way of life (see 5.1.2. Causes of Foot Problems in Indian rhinos). Up to 100 % of the mature bulls and more than 50 % of all cows in European and US zoos show serious foot problems; many otherwise healthy bulls have had to be euthanized because of chronic foot infections. Rhino foot problems are mainly due to hard, abrasive substrates; the lack of permanent access to water pools or mud wallows; and improper foot care (see 5.1. Foot Problems).

4.1.1. General Features

Males usually have to be kept separately except for breeding (see 3.3. Introductions and 3.4. Reproduction). Ideally the bull's and the females' enclosures can be connected by two gates for mating.

Animals in separate enclosures should have visual and tactile contact with one another. This will facilitate any kind of introduction.

Olfactory communication is very important among Indian rhinos. Communal dung heaps serve as 'news centers' and they should be respected and even encouraged (they also make the cleaning of the enclosure easier).

Exhibit only facilities should have, at least, an outdoor enclosure and an indoor holding area, both with separation capabilities.

4.1.2. Walls and Fencing

Despite their stockiness, Indian rhinos (especially subadults) can climb and jump over fairly high obstacles. Primary barriers should be a minimum of 1.5 m high.

Solid concrete and rock are the most commonly used materials for walls. The surface of concrete, however, should not be smooth due to the likelihood of the rhinos chafing their horns, causing abnormal wear. Instead shape concrete walls with irregularities: protruding stones, pimples, little crevices, hollows, etc.; rhinos prefer even surfaces for horn chafing. An irregular surface will provide good skin rubbing, and, as a positive side effect, nature-like walls definitely look better.

Both vertical and horizontal fences are possible, but vertical fences have two distinct advantages: In case of an aggression it is much easier for a keeper to get out between vertical bars and the rhinos cannot push their horns under a pipe or cable and uproot the fence. For vertical fences use concrete or wooden posts, or steel pipes; for horizontal fences, steel pipes or steel cables (protected with plastic hoses against horn chafing).

Wooden posts must not be treated with toxic chemicals, such as creosote, as the animals often lick the wood.

All posts, poles, pipes and cables should be spaced no more than 25-30 cm apart. A conflict does exist, however, between the relatively large space needed between two bars to let a keeper get out in case of an emergency and the relatively small size of a newborn calf: It may be necessary to temporarily fix horizontal wooden planks to hold the calf back.

To protect living trees, fence lines, the backsides of pools and so forth, use aprons of heavy rocks, 1.8-2 m wide.

4.1.3. Dry and Wet Moats

Dry moats with vertical walls are not recommended because of the risk of serious injuries should an animal slip, fall or being pushed into the moat.

Much safer are dry moats with a gradual slope, not exceeding 30°, on the animal's side so the rhinos may also use it. The advantage of this type of moat is that the surface of the moat adds to the total enclosure's surface area, the disadvantage being that the animals may lay in the moat for hours, staying out of the sight of the visitors. The floor space in such a moat should be a minimum of 1.5 m across. This area has to be well drained; otherwise you will create an unintentional mud wallow out of sight of the public. The surface substrate of the moat's slope must provide stable footing even under wet conditions, suitable materials being gravel, sand, marl, etc.

Deep, vertical wet moats are not recommended due to the danger of drowning, especially if young calves are kept on the enclosure.

Considering the importance to the animals for constant access to water and the limited available space in average zoos, spacious wet moats (see also 4.1.7. Mud Wallows and Pools) used as primary barriers are an attractive solution from the point of view of blending animal health and well-being with close but safe visitor proximity.

The wall on the public's side should be overhanging, with the distance between the bottom of the moat and the upper rim being not less than 2.2 m and a minimal water depth of 2.0 m. As a secondary barrier you might consider a rim of heavy rocks with uneven, sharp and pointed surfaces to discourage any attempt to climb out of the enclosure. In new-to-build, pool-like wet moats the installation of solar panels to warm up the water would prolong the length of time the animals would spend in the water per day and over the season.

4.1.4. Gates and Doors

Enclosure gates are an exhibit's weakest points. Adequate hinge and lock strengths are very important, with sliding gates being optimal as they may be only partially opened. Gates should be a minimum of 1.5 m wide and 2.2 m high (the tallest living bull in Europe measuring 1.94 m on his hindquarter <von Houwald, 2001>). If a gate uses a bottom track, care should be taken in the design of the track to prevent injuring the animal's feet as they run through gates, for instance during introductions. There should be no gap between the floor and the gate to avoid that hooves can get caught.

Doors connecting indoor housings with outdoor enclosures are usually of wood reinforced with steel; especially the bottom part of a door should be reinforced with steel plates to minimize possible damage. If the animals have permanent access to the door, it might be necessary to cover smooth surfaces with vertically fixed rounded timbers spaced 30 to 40 cm apart, in order to prevent the abrading of the horn. If this is not possible, keep them from the door with a hot wire.

In general, gates between outdoor enclosures are made of heavy galvanized steel pipes. Space between bars should be in the 25-30 cm range to allow keepers to pass through to the other side in case of an emergency.

All gates have to be usable without entering rhino space. Outdoor facilities must have at least one entrance / exit for heavy trucks and maintenance machinery.

4.1.5. Substrate

Because of the frequency of foot problems, a not too dry surface with give that still provides adequate footing is recommended (see 5.1.2. Causes of Foot Problems in Indian Rhinos). Various natural materials such as thick alluvial sand (rounded, not broken), wood or bark chips, mulch or clay are acceptable. Concrete, sharp sand, compressed marl or solid rock are bad for the animals' feet. Concrete and rock should only be utilized in the small locations used as feeding stations; Indian rhinos tend to ingest sand and pebbles which can cause serious health problems, like sand impactions and obstructions of the intestines. Use different kinds of substrates without mixing them, because their quality might change over the seasons (e.g. the influence of humidity and temperature, but also the importance of quickly warming up in the sun and the ability to store heat or to provide sure footing during cold periods).

4.1.6. Drinking Water and Feeding Areas

In hot climates, a single rhino may drink between 100-200 liters per day. Fresh drinking water should always be available and changed daily, or be supplied by an automatic-fill or continuous-flow device. Non-automatic troughs need to be of an appropriate size. Regular cleaning is necessary to avoid algae and bacteria growth. Watering devices should be solidly and smoothly constructed to prevent problems like horn cracks due to trapped horns and foot injuries caused from climbing and slipping, etc.

Provide, at least, as many feeding areas as there are animals on an enclosure. Always give food on concrete surfaces, rocks or on racks to avoid the ingestion of sand or pebbles. At least part of the feeding areas should be sheltered against rain so hay or straw will stay dry (Indian rhinos love rain, but they don't like wet straw or hay).

4.1.7. Mud Wallows and Pools

Mud wallows are highly recommended, in hot climates even a must. They should be sized to provide plenty of space for each animal on the exhibit. Wallows contribute to skin and foot health, thermoregulation and behavioral enrichment (and they are a real attraction for the visitors, especially when there are calves present). Real mud wallows (without a concrete foundation) have to be dredged out at least once a year to prevent contamination. And, because only few bacteria resist direct sunlight, exposure to the sun helps keep a mud wallow healthy. Still, in very hot climates, a shaded configuration is preferable. Given a start with a water hose, rhinos often create their own wallow.

For the Indian rhino, pools are an absolute must. Depending on the number of animals on an enclosure, the pools should have a minimal size of 30-40 m^2 with a depth between 0.9 in the shallow and 2 m or more in the deep parts. When a calf is on the enclosure, pools should be drained to 0,45 m or less in depth. Ramps are better than steps for access. Slopes should be no steeper than 15°-20°. If steps are used, they should have a 20-25 cm rise with a 40-60 cm step depth. Multiple entries into the pool are essential to prevent 'dead-ends'. Design of pools should accommodate cleaning by keepers. Pool substrate should be smooth, but not slippery. Abrasive surfaces flatten water-softened nails, causing hard-to-heal hairline cracks that may extend to the coronary band of the lateral nails (see 5.1.1.2 Cracks in the horn wall). Good results were achieved with two component rubber coatings like Relatex® or Horsefriends®.

4.1.8. Shelter and Visual Barriers

The rhinos must always have the opportunity to get out of the sun and in cooler climates, also, out of the rain. Adequate shelter, natural or constructed, is indispensable. In parts of the enclosure wind protection should be provided, unless the topography of the enclosure ensures that the animals can always find protected spots.

Visual barriers like boulders, deadfall, bushes and dirt mounds are important to defuse potentially aggressive situations. They should be large and high enough to allow an animal to pass from a pursuer's sight.

Critical enclosure design characteristics are visual barriers and escape routes, for the hiding by and preventing the cornering of pursued animals. Although gates can be used as escape routes, any kind of dead-end must be avoided. 'Run-arounds' like rubbing rocks, feeding mounds or water ponds with partially impassable embankments need to be incorporated into the design. If the enclosure is big enough, a hilly layout is advantageous as it allows animals to get out of sight of their co-inhabitants naturally.

4.1.9. Additional Furnishings

Several scratching posts or suitable natural or artificial rocks should be provided. Deadfall or logs buried upright in concrete sewer culverts and fixed with gravel, produce easily replaceable and natural-looking rubbing posts.

At least one feeding station should be equipped with a mineral salt lick.

4.2. STANDARD INDOOR HOUSING

The following recommendations are for institutions in temperate climates with a distinct winter season; indoor housing is imperative for climate zones where the temperature may drop to under 15° C for days in a row. In subtropical climates, where even in winter the animals can spend some hours on the outdoor enclosure and have daily access to a pool and / or a mud wallow, the requirements for the housing facilities are less stringent. The recommendations regarding the substrate remain the same.

Undoubtedly, near future developments in Indian rhino husbandry will lead to a new concept of Indian rhino housing; with it becoming more similar to modern elephant housing in which groups of females are in a free-roaming in-house situation, with the possibility of single boxes for overnight. The following recommendations are for already existing or to-be-rebuilt facilities (standard facilities). Under 4.3. you will find recommendations for built-new housings (future facilities).

4.2.1. General Features in Standard Facilities

The minimum space recommendation for each animal is 25 m^2, each stall wall being at least 5 m long. If an animal is to spend an extended period of time indoors (hard, long winters), more space is required. Every animal needs a stall of its own and one additional off-exhibit stall should be at the manager's disposal. An additional 50 % of adult space should be provided when a calf is present.

Separate the single stalls with solid walls (concrete or wood) to avoid visual contact between the individuals. These walls should be no less than 2 m high. A minimum shed height of 3.5 m leaves at least 1.5 m open-space for acoustic and olfactory communication.

For training and medical purposes, the construction of the facility should allow safe access to the animals from the front (commands) and the side (manipulation).

To prevent the chafing of horns on concrete walls and other flat surfaces, rounded timbers should be vertically mounted, spaced 20 to 30 cm apart. All mounting nuts and screws must be countersunk to prevent injuries. Although less common, horn chafing may also occur along wall edges.

Corridors used by the animals to go to the outdoor enclosure or the indoor pool should be no wider than 1.6-1.8 m to keep, at least, adult animals from turning around. One side of the corridor must be of vertical pipes or bars giving the keeper an emergency exit route. Long corridors should have pipe or bar doors that can be closed after the animal has passed.

Sliding or hinged steel pipe doors are recommended for between the stalls and traffic corridors (see 4.1.4. Gates and Doors). The pipe door of a cow-calf stall must be equipped with a heavy but easy to fix, smooth wooden panel that covers the lower inside part of the door and keeps newborn calves from walking out between the pipes. For the off-exhibit separation stall, a similar panel should be ready for covering the inside of the whole door to keep an agitated animal from hurting itself between the pipes.

In stables open to the public, a fence or a dry moat can be the primary barrier (see 4.1.2. Walls and Fencing and 4.1.3. Wet and Dry Moats). Vertical moats should be made safe with an additional steel cable-fence or with a rock apron and must have exits on both sides, especially if the bottom is too narrow for an animal to turn around. When animals have access into a sloped moat, it is important to keep enough distance between visitors and rhinos to make public feeding difficult.

Maintaining indoor temperatures at between 18-20° C, with calves between 22-24° C, is recommended. Humidity should be kept at no less than 60%. At Dvur Králové Safaripark (Czech Republic), where winters are pretty long, they keep the indoor temperatures between 15-17 ° C, trying to avoid too large differences between indoor and outdoor temperatures. So far no animal ever showed rhinitis or respiratory problems (Kristina Tomášová, pers. com.).

Adequate ventilation, with 4-6 air exchanges per hour, must be provided. Ammonium fumes should be drawn off near the floor, but without causing a draught. Floor heating, if used, should cover only 30-40 % of every stall, thus allowing the animals to choose their most comfortable temperature range.

Equip all indoor stalls with solid troughs. Self-operating water sources are not recommended indoors because individual stalls without automatic-fill devices allow for easy control of the water consumption of every animal. Troughs must be easy to clean and refill. The water should be at room temperature.

It is very practical for one stall to be equipped with a door, against which a crate can be placed, without blocking any passageways: an animal to be transported in winter can be trained to feed in the container.

In temperate climates, provide Indian rhinos with an indoor pool of at least 30 m^2, ramp or steps included (see 4.1.7. Mud Wallows and Pools). The water temperature should not drop below 18-20° C, the optimal temperature being 22-24° C.

Since rhinos have very sensitive hearing, houses should be acoustically muffled to deaden loud noises from the visitor's area.

4.2.2. Separation Capabilities in Standard Facilities

Facilities should have an off-exhibit stall of approximately 45 m^2 to isolate cows with newborn calves or to quarantine sick animals. Both of the following options should be available for the door, open steel pipes for visual and maybe even tactile contact and, if needed, a smooth, solid surfaced panel mounted on the inside of the steel pipes to keep an agitated animal from hurting itself.

4.2.3. Substrate and Bedding in Standard Facilities

Ideal stable floors for Indian rhinos have 'give'; and are non-abrasive, non-slippery, well draining while holding some humidity, and should be easy to clean. Polyurethane floor coverings like Tartan have most of these desirable characteristics but have a tendency to crack and peel off under the ongoing impact of a two- or three-ton animal standing up or lying down. Better results were achieved with two component rubber coatings like Relatex® or Horsefriends®. Hoofed-stock rubber matting works, but some animals may play with it and chew it to shreds. In addition, rubber matting is very heavy and, therefore, difficult to move for cleaning under. The best results you will get when you glue them directly to the floor. Stable tiles like Stallit or brushed or broom-finished concrete floors have a rough surface, getting even more abrasive when they get corroded by power washing machines or by fruit acid (food on the floor). When rhinos are recumbent, rough floor covers cause a thinning of their lateral nails that lead to hard-to-heal cracks; the injuries gape apart with every step due to the animal's heavy body weight. Additional straw or hay bedding is recommended to avoid foot problems. The floor should slightly slope into a drain.

4.2.4. Special Features

Video cameras may be helpful for observing the animals during introductions. They are recommended in the cow-calf stall to observe mothers in labor without disturbing them (see 3.4.4. Pregnancy and Parturition).

Access to a scale is desirable and strongly recommended, best positioned in a race-way doubling as a restraint chute.

All service doors and corridors should be big enough to allow access to little trucks or big forklifts (maintenance and removal of dead animals). Heavy steel rings on the ceiling for block and tackle or even crabs may be helpful during medical emergencies.

4.3. FUTURE INDOOR HOUSING

Facilities in temperate zones planning new housing for Indian rhinos, should consider building a hall where the animals can roam freely, at least during the day.

4.3.1. General Features in Future Facilities

Such a hall should comprise a large indoor enclosure for the cows and their offspring and a smaller enclosure for the bull. Each animal older than 3 years should have a stall of its own, with a cow's measuring 25-30 m^2 and a bull's 30-40 m^2. Further, the bull's stall should be accessible from both the bull's and cows' enclosures. In case a mother with a newborn calf or a sick animal occupies his stall, the bull can sleep in his enclosure.

A corridor between the outdoor and indoor enclosures would aid in the leading of animals into their individual stalls and would also be useful for the placement of a scale and a restraint chute. This walkway may be part of the house or a simple fence construction, depending on the climatic conditions. The restraint chute should be accessible from all sides.

The single stalls would ideally open on one side to the indoor, and on the other to the outdoor enclosure. In addition, there must be a great gate from each indoor enclosure to its associated outdoor enclosure, big enough to allow trucks access to the indoor areas (e.g. to exchange the substrate).

Both indoor enclosures have to be equipped with a pool and, if possible, a mud wallow. To save space, use the pool as a barrier to the visitors' area. To save energy, heat the pools with sun collectors, the water temperature should be in the range of 22-24° C or even warmer (see also 4.1.7. Mud Wallows and Pools).

4.3.2. Separation Capabilities in Future Facilities

Ideally the cows' and bull's indoor enclosures would be connectable with two gates for mating during cold seasons. The bull's stable might serve as a second connecting passage (avoid dead-end situations).

The cows' enclosure has to be temporarily dividable with bars, posts, pipes or cables (see 4.1.2. Walls and Fencing) for births, medical treatments and introductions. Even with this separation in place, at-will access to the pool from each side of a divided enclosure should be ensured.

4.3.3. Substrate and Bedding in Future Facilities

It is advisable - out of practical reasons - to use a rubber coating next to the water, the mud wallow, the exit to the outdoor enclosure and the stalls (see 4.2.3. Substrate and Bedding in Standard Facilities). The remaining area should be constructed as a well-drained hollow, which can be covered with a 60-100 cm deep layer of bark or wood chips.

Depending on the climatic conditions of the facility, the installation of a sprinkler system might be advisable to keep the substrate moist.

4.4. PHYSICAL RESTRAINT DESIGNS

Numerous papers have been published about the design of rhino chutes (Schaffer, 1993; Eyres et al., 1995; Schaffer et al., 1998).

Use of a restraint is facilitated when the restraint area is an active component of daily rhino management, e.g. if the rhinos must pass through it to exit into the yard from the barn. Part of the feed can be offered in the chute area. Finally, more extensive conditioning in habituating rhinos to physical restraint can be particularly effective. Such a program should be attempted prior to detaining a rhino in a chute for an exam.

Indian rhinos have no specific chute requirements. Fouraker & Wagener, 1996, describe in length different types of chutes with all the necessary construction details.