Keeper Assessment Of Black Rhinoceros Behavior And Its Role In Exhibit Design.

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Zookeepers play a valuable role in the design of rhinoceros exhibits when they participate in cross-institutional husbandry research, such as the "Methods of Behavioral Assessment" (MBA) Project. The role of keepers in this research is to provide behavioral assessments of the animals in their care that can be compared to assessments of rhinos in other zoos. Ultimately these assessments are used to identify husbandry problems associated with the design of rhino exhibits.

In this summary I will refer only to research on black rhinoceros. The results I present should not to be generalized to other rhinoceros species, because there are probably pronounced differences between species in how they respond to captive environments. Certainly black rhinos are considered the most nervous and stress-susceptible of the 5 rhinoceros species. However, the methods I will present may be used for other species.

For black rhinos in captivity, the birth rate is lower than the death rate and the captive population is not self-sustaining without infusion of wild-caught individuals. Some zoos are very successful breeding them and some are not, and there seems to be no rule of thumb that can be passed from one zoo to another so that all rhinos in the captive population reproduce at an optimal rate. The most common causes of poor breeding results are held to be pair incompatibility, stress-related disease, high mortality or inappropriate management.

One very good reason for differences between zoos in breeding success or mortality, etc. could be related to the facilities in which black rhinos are kept. For black rhinos, as for most zoo animals, there is no proven industry-standard facility, and exhibit design ends up being based on anecdote, tradition, and presumed needs of animals based on its natural history in the wild.

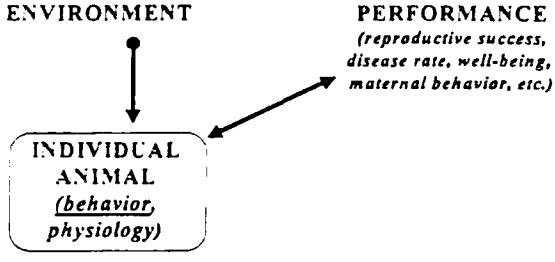
Black rhino facilities vary considerably between zoos. However, the exact impact of facility design on black rhinoceros reproduction is very difficult to ascertain. If one zoo in Texas, for example, does very well breeding black rhinos and another with about the same climate does not, is it because of the space they have, the number of public visitors, the age of the rhinos they have, the density of rhinos, or the character of the individual rhinos? Furthermore, more often than not the failure to breed black rhinos will be attributed to how frequently animals are introduced to each other. While this is doubtlessly a concern for black rhinoceros because of their very aggressive courtship behavior, it is still likely that the facilities in which they are housed influences how humans manage introductions. Facility design may exacerbate, or minimize, the chances of injury during introduction.

Sometimes researchers attempt to compare zoos that successfully breed a species with those that are less or non-successful, and to ferret out statistically the possible advantages of the successful institutions. However, this may not tell us much because most environmental variables are too complexly correlated to single out the most important factor for the difference in breeding success. For example, enclosure size may be related to the maximum distance the animal can be from the public, the type of substrate, the number of trees, how and how often the enclosure is cleaned, and sometimes even with they type of construction of barriers and containment. We would need a VERY large sample size of zoos to statistically separate out the effects on black rhino performance of each and all of the possible things that vary between zoos. This may be impossible to do. For black rhinoceros there are only around 30 zoos in the US with paired animals.

Incorporating behavior into multi-institutional analyses of zoo facilities and performance can help this problem. An institution's performance with a species is affected by facilities and husbandry **via the effects the environment has on the individual animal**. If we want to determine which aspects of the environment are most important for breeding animals or for health or mortality, we *first* need

to do look at the features of zoo rhino facilities that influence the *behavior* of animals living in them.

For the past 6 years a team of behavioral researchers from 12 zoos has been conducting the Methods of Behavioral Assessment Project with the goal of developing simple methods of comparing



the behavior of animals across zoos. The general methods we used to analyze black rhinoceros facilities were as follows: We sent behavior questionnaires to keepers at 19 US zoos for 29.31 black rhino in total. An MBA researcher then visited each zoo to conduct facilities assessments, interview staff about animal management, collect medical and breeding records, and conduct behavior tests with each rhino in the study. The Black Rhinoceros Studbook was used to calculate individual and institutional reproductive success, number of females and reproductive rate, and institutional mortality. Data analysis consisted of two steps: 1) developing behavior profiles for each rhino based on keeper assessments of their behavior and 2) statistical comparison of behavior profiles to environmental variables and to reproductive success.

BEHAVIOR PROFILE DEVELOPMENT

To develop behavior profiles of individual black rhinos we relied on keeper assessments of animal behavior and temperament. Keeper assessments of behavior are valuable and underutilized, for keepers are the people who, on a daily basis, observe how an animal behaves and reacts under a variety of conditions and situations. First of all we asked keepers at each zoo to fill in behavior questionnaires for the animals in the study at their zoo. The questions had quantitative answers; keepers were mostly asked to rate on a 1-5 scale how frequently or intensively an animal performs certain behaviors or demonstrates certain attributes.

Keepers rated animals on the frequency or strength of up to 52 behavior elements. Generally we asked at least 2 keepers at each zoo to independently rate the same animals so we could assess the degree of agreement/disagreement between keepers for each of these 52 elements. By comparing the disagreement between keepers we were able to eliminate most of these variables and retain only the most reliably-rated 15 behavior elements for our behavior profile.

Next, correlations between these 15 elements are examined in order to cluster them into a smaller number of traits. We gave a name to each group of correlated behaviors and a score for each individual on each trait that was the sum of their ratings for each element in the group. So for black

rhinoceros, the final **Behavior Profile** for each individual consisted of scores on 6 traits: *dominant to conspecifics*, *fearful* (timid/shy, anxious, sleeps a lot), *olfactory behavior* (anogenital investigation, urinespraying, urine/feces investigation), *agitated behaviors* (stereotypy, charging/chasing and mouthing), *patrolling* and *friendly to keeper* (allows touching, approaches when called).

Next we validated these behavior profiles based on keeper ratings by comparing them to how the animal actually behaves during a standardized test of behavioral reactivity to a novel object – and a novel conspecific scent. We found significant correspondence between each trait in the Behavior Profile derived from keeper ratings and some aspect of the rhinos' behavior during these behavior tests.

RESULTS

Once we developed and validated these behavior profiles, we could compare them on a cross-institutional level with aspects of black rhinoceros environment and their performance in captivity. Following are the results we have found for black rhinos using behavior to identify aspects of captive environments that influence rhino reproduction and mortality. We analyzed males and females separately.

Enclosure Size

For **males** we found that individuals in larger enclosures were rated as more submissive to other rhinos than males in smaller enclosures, who were rated as more dominant, aggressive and assertive to other rhinos. This was **not the case for females** in the same enclosures.

We also found a strong positive correlation between a zoo's overall reproductive success with black rhino and the total area of its outdoor rhino enclosures. Zoos with large outdoor enclosures over the years have breed more black rhinoceros. From the graph of this relationship (see Carlstead et al, 1999b), a cut-off point for a minimum size of a breeding enclosure for black rhinoceros should be around 4000 sq, meters (43,000 sq. ft, or about one acre).

For males we also found that their dominance scores were negatively correlated with their individual breeding success - the more submissive the male the more offspring he had. So enclosure area does seem to be an important aspect of black rhino facilities – but it has most impact on males, not females.

So all together, the result that enclosure size affects a zoo's breeding record with black rhino is not surprising, but by looking at behavior we are able to propose a mechanism for this effect (that space restriction causes more aggressiveness/assertiveness in males and compromises breeding)

But we can also offer an explanation for exceptions to this rule; for example, that some successful males in small enclosures might by nature have a more submissive character. Husbandry considerations would be to place a more assertive, dominant male at a zoo with larger enclosures.

High, Concrete Enclosure Walls

For **female** black rhinos we found an entirely different environmental influence on breeding success. First of all we found an effect of walled enclosures on female black rhino behavior. The higher the percentage of high concrete walls around a rhino enclosure the higher the females' scores on the group of aroused/agitated behaviors – chasing/charging, stereotypy and mouthing.

We also found that the scores of females for these behaviors were negatively correlated with their individual breeding success. So females in walled enclosures perform more of a type of behavior that is directly negatively linked to their breeding success.

There are some indications in the data that the effect of walls on females is auditory or olfactory, and it points to an area of rhino biology of which we know little. Walls could be amplifying ambient noise, or it could be providing a visual barrier to the source of infrasonic vocalizations from other rhinos. Infrasound would pass through the walls. They could also provide increased substrate for urine-spraying and marking by the various individuals that inhabit an enclosure at different times. The agitated behavior in walled enclosures could also be an indicator of some type of stress. In any case, basic research on the role of auditory and olfactory cues in black rhino communication and reproduction need to be investigated.

Number Of Females At A Zoo

We didn't find a direct link between the percentage of walls and an institution's breeding success with rhinos. This just illustrates how other factors contribute to reproductive success, and how other things might offset the effects of walls. For example, one thing we did find for females is that the rate at which an institution breeds black rhinos is significantly affected by the number of females they have in one area of the zoo. Zoos with more than one female, either with or without a male for each female, had a lower rate of reproduction and a later age of first reproduction for the females. However, with our methodology we couldn't pinpoint behavioral differences between females at zoos with only one female verses those at multi-female zoos. Measuring comprehensive behavioral traits as we did does have limitations; the behavioral differences probably exist but may be very subtle.

Zoo Visitors

We also found some interesting and perhaps disturbing results for black rhino mortality. We measured the degree (%) that black rhino enclosures are surrounded by the public. For male black rhinos their score on fear – timid/shy/anxious/sleeps a lot – was positively correlated with the degree of public access around their enclosure. So for males again, it appears that people having access to a large portion of the perimeter of their enclosure behaviorally affect them in a negative way.

We also found a significant positive correlation between the mortality rate for black rhino at a zoo and the degree to which the public surrounds its enclosures. We feel this strongly suggests that too much exposure to the public around enclosure perimeters is a stressor for black rhinoceros – this should be investigated with cross-institutional assessments of stress hormone levels.

CONCLUSIONS

These results suggest that male and female black rhinos are sensitive to different aspects of their captive environments. Males are sensitive to the amount of space they have and to perceived limitations on that space by people. This makes sense when you think of black rhinos in the wild – the males have larger home ranges and defend larger territories than females.

Females on the other hand seem to be sensitive to the social environment – the number of other females around them, and to sensory restrictions caused by walls. This also makes sense because wild females have overlapping home ranges with males and other females, and are therefore thought to be more tolerant of other rhinos. They would presumably rely on auditory and olfactory communication to space themselves or identify themselves to each other, perhaps more than males would.

Altogether, our results for black rhinoceros are a good basis for concluding how future black rhino exhibits should be designed: large in area (one acre or more), minimum high concrete walls, and minimum exposure to the public along the perimeter. Whether a zoo should have one or two pairs of black rhino might depend on how ideal the enclosures are for each pair; certainly the possible reproduction-suppressing effects of females on each other should be investigated more closely.

References:

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