Encyclopedia of the World's Zoos

VOLUME 3
R–Z

Editor
CATHARINE E. BELL

Senior Advisor
LESTER E. FISHER

Photo Editor
CATHARINE E. BELL

Associate Photo Editor
LAURA MIZICKO

FD

FITZROY DEARBORN PUBLISHERS
CHICAGO • LONDON

FITZROY DEARBORN PUBLISHERS
919 North Michigan Avenue, Suite 760
Chicago, IL 60611
USA

or

FITZROY DEARBORN PUBLISHERS
310 Regent Street
London W1R 5AJ
UK

British Library and Library of Congress Cataloguing in Publication Data are available.

ISBN 1-57958-174-9

First published in the USA and UK 2001

Typeset by Andrea Rosenberg
Printed by Edwards Brothers, Ann Arbor, Michigan
Cover design by Peter Aristedes, Chicago Advertising and Design, Chicago, Illinois

Cover Illustration: Green tree python at Lincoln Park Zoological Gardens; photo by Todd Rosenberg;
courtesy of and copyright © Todd Rosenberg/Lincoln Park Zoological Society

were released into the wild, but the releases failed as the birds came into contact (in some cases fatally) with electric power lines or areas of human habitation. These findings suggest that species several generations removed from the wild will most certainly fail to survive a return to the wild unless steps are taken to better prepare them for the decisions they must make without the benevolent hand of humans to guide them. The majority of reintroduction efforts have failed, including the notable examples of the roe deer (Israel), the African wild dog (Namibia), the red squirrel (United Kingdom), and the white-headed duck (Hungary). Such failures emphasize the need to revise radically the approaches used to prepare captive-born animals for life in the wild. But it is certain that as demographic trends for many species continue in a downward spiral, the reintroduction of appropriately prepared captive stock will remain as an important option for the future.

Because behavior is the most basic and important property of animal life, it is through the activities that animals display that their nature is revealed. Any circumstance that alters fundamental patterns for good or bad is legitimate grounds for inquiry that provides a compelling rationale for embracing the science of animal behavior.

DONALD G. LINDBURG

See also Behavioral Research Facilities

Further Reading

Hediger, Heini, *Mensch und Tier im Zoo: Tiergarten-Biologie*, Ruschlikon-Zurich: Müller, 1965; as *Man and Animal in the Zoo: Zoo Biology*, translated by Gwynne Vevers and Winwood Reade, New York: Delacorte, 1969; London: Routledge and Kegan Paul, 1970

Kleiman, Devra G., "Behavior Research in Zoos: Past, Present, and Future," *Zoo Biology*, 11(5), 1992

Lindburg, Donald and Helena Fitch-Snyder, "Use of Behavior to Evaluate Reproductive Problems in Captive Mammals," *Zoo Biology*, 13(5), 1994

Wemmer, Chris, Melissa Rodden, and Charles Pickett, "Publication Trends in *Zoo Biology*: A Brief Analysis of the First 15 Years," *Zoo Biology*, 16(1), 1997

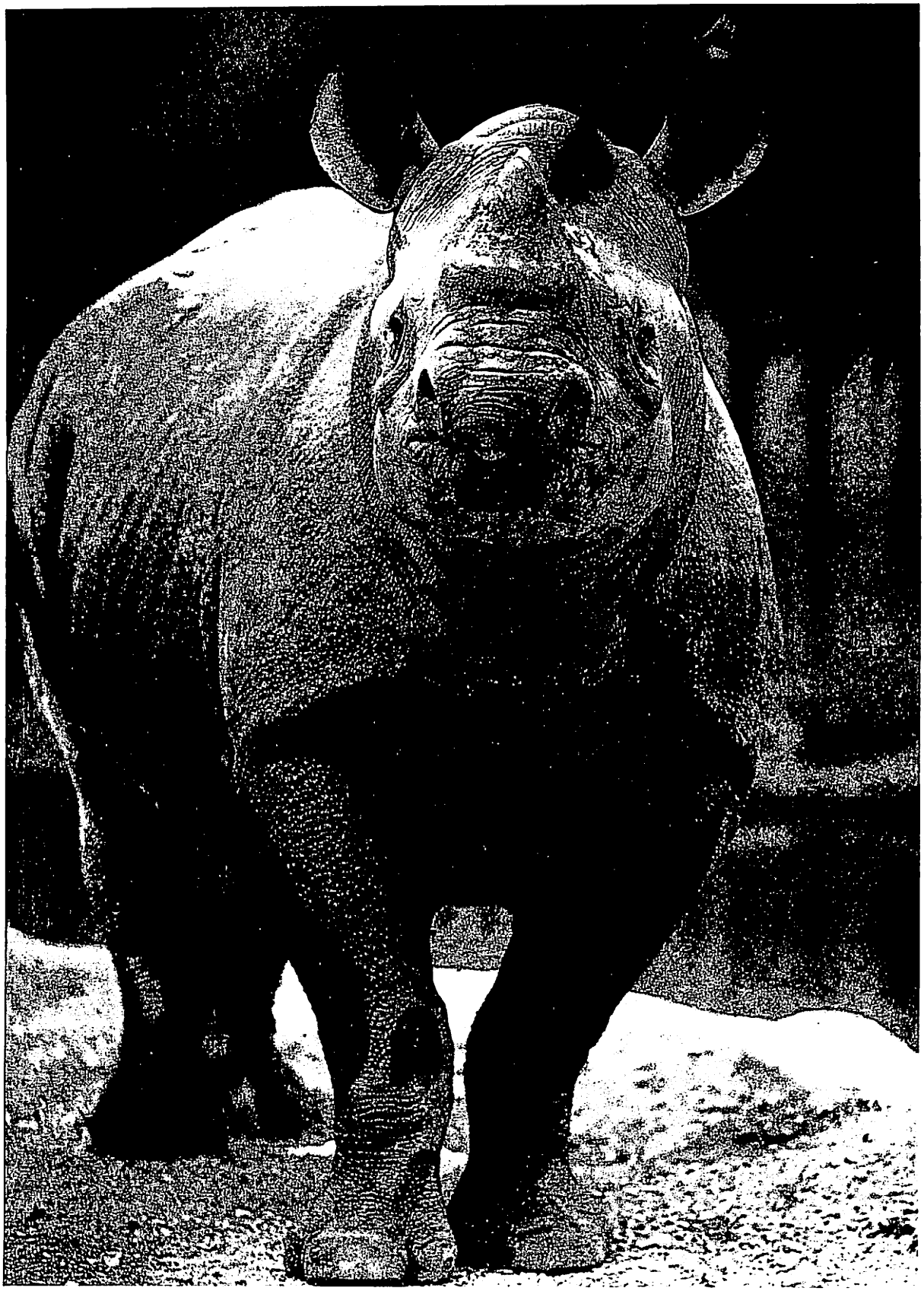
Rhinoceros

Rhinoceroses were formerly numerous, widespread, and ecologically diverse herbivores. The only surviving family, Rhinocerotidae, may be distinguished into several subfamilies, one of them the Rhinocerotinae. This subfamily includes five living species assigned to three different tribes. The tribe Rhinocerotini comprises the Asian one-horned rhinos, the rather primitive Javan rhinoceros (*Rhinoceros sondaicus;* subspecies: *R. s. sondaicus, R. s. inermis, R. s. annamiticus*) and the more advanced Indian rhinoceros (*Rhinoceros unicornis*). The taxonomy of the Indian rhino still needs detailed examination, but a distinction of at least two subspecies found in Nepal and Assam seems to be justified. Besides the single horn, Javan and Indian rhinos are characterized by prominent folds of the skin and the retention of the lower incisors, which have become modified into short tusks used in fighting.

The two-horned African species—the black rhinoceros (*Diceros bicornis*) and the white rhinoceros (*Ceratotherium simum*)—belong to the tribe Dicerotini. According to molecular analysis, the white rhino is the younger species. A separation of both species took place about 2 million to 3.4 million years ago. For the black rhino, seven subspecies are described (*D. b. bicornis, D. b. chobiensis, D. b. brucii, D. b. ladoensis, D. b. longipes, D. b. minor,* and *D. b. michaeli*). In the white rhino, the northern (*C. s. cottoni*), the southern (*C. s. simum*), and two extinct subspecies (*C. germanoafricanum* and *C. s. mauretanicum*) are known. Both the black and white rhino lack incisors and canine teeth. The white rhino uses its broad lips to pluck grass, while the black rhino browses using its prehensile upper lip. For fighting, African rhinos mainly rely on their horns, being longer (up to five feet [1.5 meters]) and sharper than those of their Asian relatives.

The tribe Dicerorhinini is a very ancient lineage represented by the two-horned Sumatran rhinoceros (*Dicerorhinus sumatrensis,* subspecies: *D. s. sumatrensis, D. s. harrissoni,* and *D. s. lasiotis*). Much smaller and hairier than the other species of rhinoceros, the Sumatran rhino shares features with both of the Asian rhinos, since its incisors and canines are present in both jaws, and also with the two-horned African rhinos. Molecular analysis revealed a slightly closer relationship to the African rhinos.

Among rhinos there are browsing and grazing species, which differ in food preference, natural environment, and appearance. Browsers inhabit dense thickets in tropical highland or lowland regions (Sumatran and Javan rhino), as well as forest, scrub, and arid savannas (black rhino). Grazers are found in floodplain grasslands with adjacent woodlands (Indian rhino) and open savannas and bushvelds (white rhino). Forest-dwelling species are lighter and smaller than their relatives living in open habitats. Sumatran rhinos may attain a weight of 0.9 tons (0.81 metric tons) and a height of 5 feet (approximately 1.5 meters). In contrast, field weights of Indian and white rhinos are estimated to be 2.3 to 2.5 tons (2.7 to 2.25 metric tons), respectively; both of these types reach the estimated height of six feet (two meters).



Black rhinoceros at Lincoln Park Zoological Gardens.
Photo by Todd Rosenberg; courtesy of and copyright © Todd Rosenberg/Lincoln Park Zoological Society.

Rhinos devote about 12 to 14 hours a day to foraging. For all species, daily food intake (dry weight) represents 1 to 2 percent of body mass. Rhinos generally prefer to feed on young plants, which are low in fiber and silica content and therefore easy to digest and highly nutritious. The diet of both Asian and African browsers consist of more than 150 plants including forbs, woody shrubs, lichens, and fruits eaten in different amounts and seasons. The range of food plants is more limited in grazers. White rhinos seem to select mainly for grassland types rather than for particular grass species.

In addition to vegetable matter, rhinos also eat naturally occurring salt or saline earth (geophagy), which they excavate by digging with their front horn and feet. Rarely, and mostly in dry seasons, black and Indian rhinos have been observed eating feces of conspecifics or other herbivores (coprophagy). These behaviors mainly occurred in captive and wild subadults, pointing to an increased mineral need during the first years of life. Eating the feces of conspecifics may also serve the calves to establish the microflora of the digestion tract necessary for cellulose degradation.

Depending on food preference, resource density, metabolic requirements, and population densities, individual home ranges may vary greatly in size. Home ranges of 12 to 20 square miles (30 to 50 square kilometers) are reported for Sumatran rhinos, whereas for female white rhinos, home range size may extend from three to six square miles (seven to 16 square kilometers).

In contrast to African rhinos occupying distinct home ranges, Indian rhinos distinguish between "public" and "private" areas connected with "public" and "private" paths. Private paths lead to private grazing and resting areas defended by the resident. Commonly used places such as wallows, water pools, and dung heaps are located in public areas.

Females generally roam overlapping home ranges. Only small core areas, if any areas at all, are defended depending on seasonal conditions, reproductive status, and population density. Female social organization is egalitarian. No intraspecific competition or hierarchies based on agonistic interactions have been observed in the wild. Observations of captive white rhinos reveal a shift from an egalitarian to a rank-related system of resource allocation under limited conditions. Differences were observed between (potentially) reproductive, bold females and shier females which were never or improperly mated or which showed no behavioral signs of estrus. Observations of wild Indian rhinos indicate a difference between females, as more aggressive females occupied "better" areas overlapping with the territories of "strong" (alpha-) males.

The social organization of male rhinos varies greatly. Territoriality and the possible coexistence of alpha- and beta-males is reported for black, white, and Indian rhinos. High population densities may favor the formation of clans in male Indian and black rhinos. Members of these loose communities are of same status and share a territory, which they defend against outsiders.

Little is known about the social organization of Sumatran and Javan rhinos. Both sexes seem to occupy largely overlapping but distinct home ranges. The fact that core areas are defended may explain why territoriality is sometimes described for male Sumatran rhinos.

For individual orientation and intraspecific communication, rhinos do not primarily rely on their visual sense, although the visual capacity does not seem to be too poor compared to other mammals. Rhinos essentially are directed by their olfactory sense, and their hearing also is well developed. Research indicates that rhinos communicate with a variety of auditory and infrasonic sounds.

Exhibit and Collection History

In 1997 approximately 1,050 rhinos were kept in 385 zoos and safariparks participating in international breeding programs. The two African species are most commonly found.

Indian Rhino

Beginning in the 19th century, Indian rhinos frequently were kept in zoos, mostly as single animals. If pairs were housed, partners often were separated, especially during courtship with its frequent fights and chases. Zoologischer Garten Basel (Switzerland) was the first to modify this strategy when in 1951–1952 two Indian rhinos were imported from Kaziranga National Park (Assam, India). Both animals, normally separated, were introduced prior to courtship and remained together until successful matings took place. This change in management proved to be successful. The first Indian rhino conceived in captivity was born in 1956 at the Basel Zoo, the first of ten calves delivered by the female called "Joymothi" (studbook number 7). As of 1999, 27 calves descending from three males and four females have been born at Basel Zoo.

Since the 1950s the species' captive propagation has markedly improved. Captive Indian rhinos now breed in third and fourth generation. Since the establishment of the species' studbook in the early 1970s, the captive population grew by about 90 percent to 130 animals in 1998. Nevertheless, the overrepresentation of certain lineages and high mean kinship are new problems to face. In

Indian rhinoceroses at Zoologischer Garten Basel.
Photo by and copyright © Jörg Hess.

addition to Basel Zoo, several zoological institutions have witnessed significant success in keeping and breeding Indian rhinos, among them San Diego Wild Animal Park (California), Dierenpark Planckendael (Mechelen, Belgium), Bronx Zoo/Wildlife Conservation Park (New York), Whipsnade Wild Animal Park (Dunstable, Bedfordshire, United Kingdom), and Assam State Zoo and Botanical Garden (Gauhati, India).

Javan Rhino

Up until the 19th century, captors attempted to maintain only 21 Javan rhinos (including eight animals kept in Java). Six of them died shortly after capture or during transportation. Three animals were kept in private collections, and, in the late 19th century, four animals were brought to three different zoos: Adelaide, Australia (one animal, 1886–1907); Calcutta, India (two animals, 1877–?, 1887–1892); and London, United Kingdom (one animal, 1874–1885). As of 1999, no Javan rhinos are maintained in any zoo or safaripark.

Sumatran Rhino

From 1872, when the first Sumatran rhino arrived in Hamburg, Germany, up until 1999, a total of 93 animals were kept in zoos. The species has proved to be difficult to maintain, and survival rates have been correspondingly low. Beginning in the early 1980s, 40 Sumatran rhinos were captured for ex situ breeding programs, and 19 of them died. Since that time there have been only four births, all with females who were pregnant when captured. However, there is hope that one of the females at Cincinnati Zoo and Botanical Garden (Ohio), which has been pregnant three times but unable to sustain the pregnancies, will be able to succeed in the near future. Due to the failure of more traditional ex situ breeding methods, emphasis is now on the development of managed-breeding centers in the natural distribution areas.

"Subur," a Sumatran rhinoceros that lived at the Zoologisk Have København (Copenhagen Zoo) 1959–1972.
Photo courtesy of the Zoologisk Have København archives.

Black Rhino

The first black rhino arrived at London Zoo (United Kingdom) in 1868, although the species was not commonly kept until the early 1930s. In 1941 the first birth in captivity occurred at the Chicago Zoological Park (Brookfield Zoo in Illinois). By the 1970s the population increased by about 25 percent due to further imports, advances in the animals' management, and increasing birth rates. In 1998, 242 captive black rhinos—60 percent of them zoo-born animals of sometimes even fourth generation—were assessed worldwide. During the 1990s there was a preponderance of male calves. Such a pattern severely impairs the population's future reproductive capacity. Investigations have been initiated on whether and how management practices can influence the sex ratio of births.

The following institutions have remarkable group size and/or breeding success: Western Plains Zoo (Dubbo, Australia), Tierpark Berlin-Friedrichsfelde (Germany), Zoologicka Zahrada, Dvůr Králové Nad Labem (Czech Republic), and Port Lympne Wild Animal Park (Lympne, United Kingdom).

White Rhino

National Zoological Gardens of South Africa (Pretoria) was the first zoo to keep a southern white rhino when an orphan calf was successfully fostered in 1946. Although this species is comparably easy to keep even in mixed species exhibits with birds or hoofed stock, white rhinos were not frequently found in zoos until the early 1960s. The situation changed during the next decade when about 500 southern white rhinos from South Africa's Umfolozi Game Reserve were transferred to other zoos and safariparks. The two largest groups at that time were established at Whipsnade Wild Animal Park (seven males, 13 females) and at San Diego Wild Animal Park (six males, 14 females), where by 1999, 83 white rhinos were born, ten of them by a female named "Umfolozi" (studbook number 159). Among the other institutions keeping white rhino groups of unusual size and achieving significant breeding success are Zoological Center Tel Aviv Ramat-Gan (Israel), Safari Beekse Bergen (Hilvarenbeek, Netherlands), Dreher Park Zoological Gardens (West Palm Beach, Florida), and Taipei Zoo (Taiwan).

As of 1997 more than 460 births have occurred. However, the white rhino captive population is overaging. In 1999 about 54 percent of the animals were older than 20 years. As is the case with the Indian rhino, certain bloodlines in the white rhino population clearly are overrepresented. For instance, 75 percent of the first zoo-born generation in North America descends from one breeding male.

The situation of the northern white rhino is critical, both in the wild and in captivity. The wild population in Garamba National Park in the Democratic Republic of Congo is severely threatened by poaching and political instability; in 1999 it comprised approximately 25 animals. A total of 19 animals were brought to zoos between 1950 and 1975. Only three of them (two males, one female) ever bred, and no offspring were

White rhino with calf at Allwetterzoo Münster.
Photo by Rudolf Wakonigg; courtesy of Allwetterzoo Münster.

Species	*Common Name*	*Census in the Wild*	*Number of Locations*	*Number of Animals (Males.Females)*
Ceratotherium s. cottoni	northern white rhino	25	3	9 (4.5)
Ceratotherium s. simum	southern white rhino	approximately 8,440	246	649 (307.342)
Diceros bicornis	black rhino	approximately 2,600	75	
				D. b. michaeli
				181 (86.59)
				D. b. minor
				61 (29.32)
Rhinoceros unicornis	Indian rhino	approximately 2,050	50	130 (69.61)
Rhinoceros sondaicus	Javan rhino	less than 70	0	0
Dicerorhinus sumatrenis	Sumatran rhino	less than 400	11	16 (4.12)

Table 1. Rhinoceros Species in the Wild.

produced between 1989 and 2000. In 1992 the only female to that date to breed in captivity died, and hopes for future successful propagation seemed to vanish. However, in the summer of 2000 Dvůr Králové Zoo celebrated the birth of a calf. Its mother, "Nanjin," was the first captive-born northern white rhino in the world to bear young. At the turn of the 21st century, the entire captive population of ten animals was maintained at Dvůr Králové Zoo (seven animals) and San Diego Wild Animal Park (three animals). There are plans to combine some or all captive animals with the same number of wild animals from Garamba National Park in an African environment, which is more conducive to breeding.

Breeding and Husbandry

It is advised to keep at least one male and two female black or Indian rhinos in order to guarantee a certain genetic variability and to replace a proven breeder without loss of time. In white rhinos, a group size of at least one male (preferably two) and three females should be achieved, as the chance of breeding seems to improve if the rhinos have the opportunity to choose among several potential mating partners. The majority of zoos in 1999 maintained singles, pairs, or unisex groups.

In all species, there are overrepresented bloodlines and animals that do not breed at all. Because immaturity or lack of experience may be a reason for breeding failures, the introduction of an inexperienced animal (preferably the female) to a proven breeder is advised. The mismatch of partners caused by a lifelong familiarity (sibling relationship syndrome) may further discourage breeding. Moving animals—preferably the females—to different facilities usually has a postive effect. Females of all species may be housed together. With the exception of white rhinos, males and females must be kept separated, introduced to each other only for mating. There has been discussion in the field concerning whether the temporary separation of sexes is a positive influence on the breeding success of white rhinos. The separation also could help to reduce the female's aggressive behavior toward the male, especially under restrictive exhibit conditions.

Observation of female white or black rhinos kept together permanently indicates that there is a social influence on a female's reproductive capacity, favoring the "bold" and hindering the "shy" (as discussed above). Interchanges of animals therefore should be done not only for genetic reasons but as soon as veterinary examination and/or hormonal analysis does not reveal any pathological findings. In nearly all species of rhinoceros, cysts and benign tumors are described, which likewise occur in young and old females. These pathological changes often result in anestrus or estrus without conception.

In order to shorten the natural breeding-intervals of about three years, mother/calf units were reintroduced to the breeding male shortly after birth (postpartum estrus) or separated as early as after one year, thus stimulating the female's estrus. However, the strategy is no guarantee for improved breeding, and, furthermore, there is no information available on the social development of these subadults.

Inadequate design of enclosures or keeping routines (e.g., separating mating partners overnight for safety reasons) may also inhibit the animal's natural mating behaviors. For all species of rhinoceros, adequate space is a must. Husbandry guidelines recommend an enclosure size of at least two acres (one hectare) for a breeding group of white rhinos. For black and Indian rhinos, several connecting enclosures—each larger than at least 240 square yards (200 square meters)—are advised. At least in white rhinos, there seems to be a correlation of available space and breeding success. Comparing several zoos for the annual number of calves born by a potentially reproductive cow in relation to individuals per unit of area, breeding was found to be more successful in low-density groups.

Daily keeping routines also influence the animal's behavior and activity. Since rhinos devote hours to foraging, changes in feeding style may be an effective tool. A positive influence was observed when food was dispersed in variable distribution and composition. This feeding method not only stimulated the explorative behavior of Indian rhinos but reduced the number of agonistic behaviors in white rhinos. In a short-term observation, changes in the food composition for white rhinos revealed the positive influence of fresh green bulk forage on the animal's general activity. Keeping the animals busy may help to reduce the frequently repeated horn-scoring behavior observed in all species.

Conservation Programs and Partnerships

To improve species management, the Rhino Global Captive Action Plan (GCAP) was initiated in 1992. The GCAP's Global recommendations are conducted by regional breeding programs such as the American Zoo and Aquarium Association's Species Survival Plan (SSP), the European Endangered Species Breeding Programme (EEP), and the Species Survival Committee in Japan (SSCJ). GCAP documents the global and regional numbers of rhinos that are to be achieved for genetic and demographic reasons. For instance, efforts are aimed at reducing the number of captive white rhinos in order to create additional space for the species of rhinos that are less often kept and bred. Interaction between regional breeding programs is facilitated by the Global Species Survival Plan (GASP).

Nonprofit organizations, such as the International Rhino Foundation (IRF) and SOS Rhino, support ex situ and in situ programs directly applicable to rhino conservation. For instance, results of research in hemolytic anemia of captive black rhinos will also serve the conservation of wild animals in which this syndrome is also observed. Data on captive rhinos under different keeping regimes could help to improve the success of species not yet or barely maintained in captivity (comparability of browsing species). Additionally, managed in situ sanctuaries, which also have to deal with small-population management problems, could profit from this experience.

Captivity may not be the most conducive environment in which to breed rhinos; breeding results still are suboptimal, with many unresolved problems. However, as captive management and propagation are constantly improving and as zoological institu-

tions are among the few remaining secure places for rhinos, the world's zoos are making a significant contribution to the strategy of maximizing the future opportunities of this remarkable species.

JUTTA MEISTER

Further Reading

Groves, Colin P., "*Ceratotherium simum*," *Mammalian Species*, 8, 16 June 1972

Hillman-Smith, A.K. Kes and Colin P. Groves, "*Diceros bicornis*," *Mammalian Species*, 455, 2 June 1994

Die Nashörner: Begegnung mit urzeitlichen Kolossen, Fürth, Germany: Filander Verlag, 1997

Owen-Smith, R. Norman, *Megaherbivores: The Influence of Very Large Body Size on Ecology* (Cambridge Studies in Ecology), Cambridge and New York: Cambridge University Press, 1988

Ryder, Oliver A. (editor), *Rhinoceros Biology and Conservation: Proceedings of an International Conference, May 9–11, 1991, San Diego, California, USA*, San Diego, California: Zoological Society of San Diego, 1993

RioZoo

RioZoo is located in one of the premier tropical environments of the world, Rio de Janeiro, Brazil. It is situated on the grounds of the former Brazilian imperial palace in an area of more than 1 million square feet (100,000 square meters). Specializing in Brazilian and rare fauna, it is a member of the International Species Information System (ISIS).

There are approximately 2,500 specimens of more than 300 species at the zoo. Half the specimens are mammals, with birds and reptiles each comprising about one-quarter of the collection. The number of mammal species is nearly double that of bird species, while reptiles are represented by more than two dozen species.

Mammals at the zoo include or have included chimpanzees, orangutans, baboons, and various kinds of monkeys, particularly small types from the equatorial regions of Brazil. The zoo is noted for preserving specimens of Brazilian mammals such as tamarins. There have been breeding projects at the zoo for African animals, including hippopotamuses, rhinoceroses, and zebras. The zoo collection also includes elephants and giraffes, these African species living in a climatological environment similar to that of their origin.

Birds are among the most striking inhabitants of the zoo. There are wading birds such as flamingo, heron, and ibis. Cowbirds, hummingbirds, rufous, and anis fly freely in large, open-air aviaries. There are also king parakeets, ducks, parrots, toucans, and macaws. Together with Petrobras, the Brazilian state oil company, the zoo is engaged in saving the *ararajuba*. This rare macaw is yellow and green, the same colors found in the Brazilian flag.

Among the reptiles at RioZoo are various giant tortoises, iguanas, anaconda, cobras, Amazon and other turtles, and alligators. It should be noted that RioZoo preserves species native to Amazonia, the Pantanal wetlands, and virgin tropical forests that are threatened with extinction in their native habitats.

Rio de Janeiro has had a zoo since the end of the 19th century. The first zoo was founded at the time of the Brazilian Empire by the baron of Drummond, João Batista Viana Drummond, in the Rio de Janeiro neighborhood of Vila Isabel. To supplement the income of the zoo, he created a raffle based on guessing which animal would be selected in a daily drawing. The game, *jogo do bicho*, still exists, although in the 20th century it became a mostly clandestine and illegal gambling operation and was not affiliated with the zoo. Under the dictatorship of Getúlio Dornelles Vargas the zoo was closed in 1940 and reopened five years later.

RioZoo has been run by the RioZoo Foundation since it opened in 1985. The zoo specializes in the preservation of the rich yet threatened realm of Brazilian fauna. It has a staff of veterinarians, biologists, and community educators. In conjunction with two local federal universities, it has conducted research projects in biology, parasitology, infectious disease, hematology, behavior, nutrition, genetics, reproduction, and anesthesiology. Specific projects have included the artificial breeding of black bears, vaccinations for rabies prevention in primates, the assessment of hematological values in spider monkeys, a census of bats and public health in Rio de Janeiro, and programs for increasing ecological awareness. The symbol of the zoo is an anteater.

The education programs at RioZoo include guided tours of the zoo and field trips. There are also courses directed at children during summer vacation and correspondence courses. Loans of some material are made to schools, and there is a program for the physically handicapped. Services offered at the zoo include a gift shop, a restaurant, a cafeteria, and an ice cream parlor, along with a playground, a video viewing studio, and a small theater.

In 1989 RioZoo inaugurated Chico Mendes Park, an area of ecological preservation in the far western part of Rio de Janeiro. A marshland ecosystem of 150 square miles (400 square kilometers), the park preserves the original character of this region, now being developed to accomodate an expanding urban population. The center of the park is Tachas Lagoon, which occupies about a third of the area. Among the species protected at the park are the broad-nosed cayman and the beach butterfly.

EDWARD A. RIEDINGER