Page J. 1987. Outdoing Akbar the Great. Zoogoer. 19-21.

Keywords: Acinonyx jubatus/artificial insemination/bottleneck/captive breeding/cheetah/extinction/fossil records/genetic analysis/inbreeding/research

Abstract: The cheetah is one of the most inbred species ever studied. They suffer from a very high infant mortality and captive breeding efforts have been largely ineffective since 1956. At the time biomedical intervention into reproductive processes of exotic animals are made. The work includes genetic analysis, hormone and semen analyses, artificial insemination, and other techniques. Alarming results were found in genetic analysis. Tested animals were virtually identical genetically. Fossil records showed that several species of cheetahs existed worldwide until the Ice Age, 10-12'000 years age, when some series of events brought about a massive extinction of mammals. There is little hope since other animals have survived such bottlenecks.

Outdoing Akbar the Great

Jake Page

Akbar the Great was in a royal snit. A potentate in India in the 16th Century, he numbered among his many possessions 1,000 cheetahs, traditional symbols of royalty and wealth. But they would not breed.

In desperation, Akbar ordered that the palace gardens be opened to the cheetahs but, even with the run of the place, the animals produced only a single litter—the last cheetahs ever born in captivity until a pair in the Philadelphia Zoo had a litter in 1956.

It is easy to see why Akbar and countless other kings going back to Egyptian times like to have cheetahs around. Nothing quite compares to the sight of these elegant hunters padding along in a high-shouldered, head-lowered walk or suddenly erupting, as if spring-loaded, into a sprint that exceeds the new U.S. speed limit.

Outdoing even the lion in its rate of successful kills, the cheetah is the most effective predator in its grassy plains habitat. There are trade-offs, however. After the chase, the cheetah is exhausted and may have to wait half an hour to regain its strength. Often, in that interval, the animal is robbed of its bounty by lions or hyenas.

But over the last decade or so, it has become clear that the cheetah faces problems far more serious than pilfering. In some game parks, cheetahs suffer from a rate of infant mortality as high as 70 percent. Captive breeding efforts have been largely ineffective; since 1956, less than 15 percent of wild-caught cheetahs have bred in captivity, and 30 percent of the resulting cubs have died.

One of the most successful captive breeding programs was established in 1971 by the National Zoological Gardens of South Africa, near Pretoria. But even there, success rates were low and in 1981 the director, Frank Brand, invited researchers from the National Zoo to look into the matter.

At the time, NZP reproductive specialist David Wildt, chief veterinarian Mitchell Bush, and Stephen O'Brien of the National Cancer Institute had been collaborating in a new area—biomedical intervention into reproductive processes of exotic animals. Their work included genetic analysis, hormone and semen analyses, artificial insemination, and other techniques. Genetic screening, for example, was already becoming a significant tool in the zoo community's Species Survival Programs, in which captive populations of certain endangered species are managed with special attention to genealogy and the promotion of genetic variability.

Inbreeding

When the three researchers went to Pretoria, they were well aware that low fecundity and high infant mortality are telltale signs of inbreeding. Nonetheless, they were stunned by the results of their cheetah investigations. First, they found that cheetah sperm concentrations were only about 10 percent those of domestic cats; also about 70 percent of sperm were seriously deformed. (In a bull, 20 percent deformity of sperm means—for all

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practical purposes—sterility.)

The researchers also collected blood samples and analyzed them by electrophoresis, a standard test for genetic variability. In this technique, various key blood proteins are isolated and put in a gel. When subjected to an electric field, the proteins move through the gel, identical proteins moving precisely the same distance. The results were astonishing. What emerged was a picture of one of the most inbred wild animals ever studied. The 50 animals tested were virtually identical genetically. There was less variability among their proteins than exists among some strains of laboratory mice that have been deliberately inbred for generations.

Even worse, the researchers found that the region of the genes that is responsible for the cheetah's immune response was similarly lacking in variability. While cheetahs would reject skin grafts from domestic cats in the usual period of 10 to 12 days, they accepted skin grafts from one another almost as if they were the same animal: Such skin grafts would persist for two or three months before the cheetahs' sluggish immune systems rejected them.

Its poor immune response places the cheetah at risk for viral attacks, which seem to come along in new forms all the time: Indeed, in 1982, two evidently healthy cheetahs arrived on loan to the Wildlife Safari Park in Oregon where a cheetah breeding program was meeting with rare success. But the new cheetahs developed a viral disease and died. The disease, called feline infectious peritonitis, can be rampant in groups of domestic cats, but it usually kills only about 10 percent of the group. In Oregon—and later in other cheetah parks—one half of the cheetahs died of the disease.

How had all this come about? Were cheetahs naturally incestuous? On the contrary, animal behaviorists had found that cheetahs do not remain with their offspring once they are grown. Males are usually territorial and females wander through numerous territories.

Bottlenecks

The fossil record shows that several species of cheetahs existed worldwide until the Ice Age, 10-12,000 years ago, when some series of events brought about a massive extinction of mammals. Soon the current cheetah species (*Acinonyx jubatus*) was the only one, and its range was restricted to parts of Africa. Perhaps this catastrophe caused a severe population "bottleneck"—a situation where only a handful of cheetahs remained, and generations of inbreeding resulted. Indeed, researchers speculate that there may well have been more than one bottleneck in the cheetah's history.

There are a few reeds of hope. Other animals have survived such bottlenecks. The northern elephant seal was hunted to near extinction; in 1922, when protective legislation was passed, only 20 animals remained. Today, off the coasts of California and Mexico there are tens of thousands.

In all, there are probably some 20,000 cheetahs, including a subspecies in the eastern part of Africa that seems to be slightly less inbred than those in the south. Cross-breeding the two subspecies might prove beneficial; but, as noted, captive breeding has been an extreme disappointment in the past.

Perhaps the best hope for scientists working with captive cheetahs is to be found in a room at the National Institutes of Health Animal Center in Poolesville, Maryland. There a litter of domestic kittens cavorts. They are the first "test-tube" kittens in the world, the result of a biomedical technology that has been used for years in the livestock industry and recently among humans. Now its application to exotic animals may hold out a life-line for the cheetah and other animals threatened by a loss of genetic diversity.

The kittens are the first carnivores to be born by *in vitro* fertilization (IVF), a Ph.D. project of Karen Goodrowe, a FONZ trainee and one of Dr. Wildt's graduate students. The NZP scientists are hopeful that "cheetahs will one day respond to such treatment." But first there is much to be learned about hormonal aspects, gestation periods, and so forth. Late in 1986, Wildt and Goodrowe successfully fertilized the eggs of leopard cats by IVF, and the next step will be to implant those eggs in surrogate domestic cat mothers. Through such painstaking steps, the researchers hope to progress one day to "test-tube" cheetahs.

Negotiations are presently underway with the nation of Namibia to bring 25 cheetahs—perhaps 50—to this country. Here they will be distributed among various zoos that house the 200-odd cheetahs already in the country. This entire population is managed under a Species Survival Plan (SSP) administered by Ingrid Schmidt of the Albuquerque Zoo. The Namibian animals are, Schmidt says a bit wistfully, a small "salvage" operation. Namibian farmers shoot some 700 cheetahs a year and the plan is to have government agents trap some of the "pest" cheetahs for export.

Schmidt is extremely hopeful about the possibilities of artificial reproductive methods for cheetahs, but reaffirms that there is a great deal to be learned.

Meanwhile, as the cheetah SSP gains momentum, Wildt and his team plan to visit Namibia this fall. There they will evaluate the reproductive potential of each animal and perform genetic tests to find animals with the most promising genetic make-up, in the hopes that successful captive breeding by whatever means will lead to a strain of genetically healthy animals and, as they have written, "help the world's fastest animal to win its race for survival." □