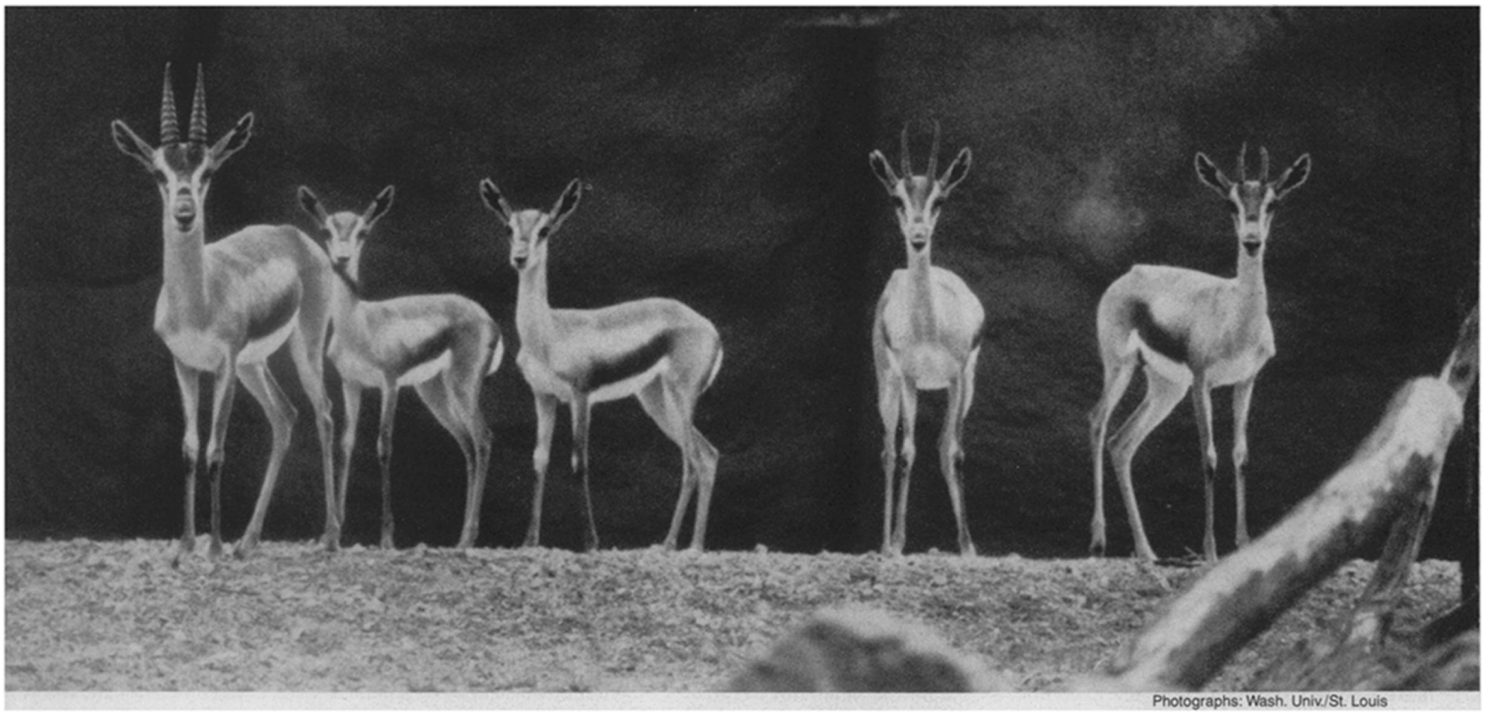

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SPEKE'S GAZELLE: Success of a Last Resort

Carefully planned inbreeding saves a captive population

Second in a two-part series

By JULIE ANN MILLER

By skillfully defying the incest taboo, a novel breeding program designed by a geneticist and a zoo curator has saved a herd of rare African antelope from extinction. They devised the program for a captive antelope population, which began 15 years ago with only four "founding" animals. The plan may soon be applied to other zoo species with too few members to be candidates for other genetic management plans (SN: 10/13/84, p. 232).

It was "an act of desperation," says geneticist Alan Templeton of Washington University in St. Louis. Most breeding plans call for a population of about 250 animals descended from a minimum of 10 to 20 founders. But according to population genetics' "Adam and Eve" effect, even two unrelated animals are likely to contain most of a species' genetic variation. Thus four unrelated animals should be sufficient for maintaining the species, if only their genes can be preserved. Templeton and Bruce Read of the St. Louis Zoo have invoked inbreeding in a program to preserve those genes.

Whenever there is a large enough founding population, other programs not based so heavily on inbreeding are probably preferable. "However, these [other] breeding options quite often do not exist, and our program offers a chance for the survival of the species (and even for ultimate reintroduction [to the wild]) that otherwise would not exist," say Templeton and Read in a recent book for wild animal and plant population managers. They recommend the plan for populations of less than 25 animals.

A breeding pair of Speke's gazelles and two additional females were imported to the United States in 1969. From these four specimens — Greenie, Lisa, Chicago and Iodine — descend all the Speke's gazelles known to be in zoos today.

It appears that no additional wild-born Speke's gazelles can be obtained to bolster the zoo collection. Their homeland, an inhospitable plateau on the Somalia-Ethiopia border, has been torn by 20 years of warfare, compounded by drought and vast migrations of displaced people. Nobody knows the status of the animal in the wild, but it is considered to be endangered, if not extinct. There have been no reported sightings of a wild Speke's gazelle since 1973.

The Speke's gazelle stands less than 3 feet high and weighs 20 to 30 pounds. Its most remarkable characteristic is its nose, which has folds of skin that inflate for a second or so when the animal snorts an alarm signal.

For the first seven years of captivity, Greenie was the sole breeding male. He mated with the imported females, as well as with his daughters and granddaughters. Later captive-born males were bred to the captive-born females. But because all the captive-born animals have Greenie as an ancestor, the offspring of all their matings are inbred.

Zoo curators began looking for a new strategy when it became clear that the inbreeding was severely deleterious. As in other animals, it produced high miscarriage and infant death rates and low birth weights — all signs of the condition called inbreeding depression. In 1979, only one in five newborn Speke's gazelles survived the first year.

"We faced an unfortunate but all-too-common situation with the Speke's

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gazelle," say Templeton and Read. "On the one hand, the small founder size meant that inbreeding could not be avoided. On the other hand, inbreeding had induced a severe inbreeding depression that seriously endangered long-term maintenance."

So they put into practice a theory developed by Templeton in his work on fruit flies in Hawaii: It should be possible to adapt a population to survive inbreeding, just as a population can adapt to survive stressful physical conditions, such as cold or heat.

In natural populations many animals and plants regularly inbreed with little or no detriment. This has been observed even among human populations. The Tamils of India, for example, regularly have a large proportion of marriages between relatives, yet seem to suffer no inbreeding depression.

Inbreeding depression is the result of the pairing of genes that are lethal in a double dose but not deleterious in a single dose. Most members of a population that is not inbred carry single copies of several such genes. Both humans and Speke's gazelles average about eight single copies of such recessive lethal genes. With random mating, the deleterious genes seldom are paired. But matings of close relatives tend to bring together genes from the same ancestor and therefore make it likely that two copies of a deleterious gene will come together.

Relief from inbreeding depression could come from deliberate inbreeding, Templeton proposed. As individuals carrying a pair of recessive genes die, the gene becomes less frequent in the population. (In contrast, in a non-inbred population, where the gene is usually present in only one silent copy, there is little pressure to eliminate it.) Once the eight or so recessive lethal genes have been eliminated, inbreeding no longer is detrimental to the population.

The first step in getting the Speke's gazelle to adjust to inbreeding was to enlarge the population as much as possible, so that the deaths inevitable during adaptation to inbreeding would not wipe out the herd. By 1980, the herd had increased to include 19 animals.

Next a program was begun in which each breeding decision was based on three factors. The first was an attempt to equalize the genetic contribution to the present herd from each of the four founding gazelles. This contribution could be calculated because the total pedigree of the herd is known. In 1980 Greenie had had the biggest impact on the herd's gene pool, followed by Lisa, Chicago and Iodine. The pedigree showed that Chicago and Iodine had had far less genetic input than the others, and about 40 percent of Iodine's genes had already been irrevocably lost.

This inequality of genetic legacy is the result of events occurring before zoo managers recognized the importance of preserving genetic diversity. In 1969 when the animals were imported, Chicago went to Lincoln Park Zoo in Chicago and Greenie, Lisa and Iodine went to the St. Louis Zoo. (Chicago was moved to St. Louis in 1972.) Greenie and Lisa were breeding well, so there seemed to be no reason to go to the extra trouble of breeding Iodine. In addition, the zookeeper in attendance "didn't like the looks of her," Templeton says.

Therefore, the first rule in the Speke's gazelle breeding plan was to give preference to males and females bearing genes of Iodine and Chicago. This rule succeeded in rapidly increasing these animals' contribution to the gene pool. Iodine's genes, for example, had represented less than 10 percent of the total gene pool in 1979, whereas now her contribution is almost 20 percent.

The second rule was to break the inbreeding taboo in order to breed preferentially those animals that could do well even though they were inbred. Therefore, among healthy animals bearing genes of Iodine and Chicago, the scientists gave preference to those that were already inbred. Now inbreeding depression has been virtually eliminated, they say.

To decide with whom each chosen animal should mate, the rule was to increase the individual genetic variability in potential offspring. Matings were designed between animals with different founders in their ancestry. Such "disassortative mating" preserves large amounts of genetic variability in a small population. It also somewhat ameliorates the detrimental effects of inbreeding and increases the opportunites for new gene combinations to arise.

The goal of this last rule is to have each individual gazelle carry genes from all four founders. In 1979 only one male (5 percent of the population) met that criterion. Today 91 percent of the gazelles have all four founders in their ancestry.

Templeton uses recombinant DNA technology on blood samples of each newborn gazelle to monitor the genetic variation. "We have been able to radically alter the individual genetic makeup of this herd in a very short period of time," the researchers say.

"Barring major mishap, we can now say that long-term survival of the Speke's is guaranteed," Read says. After three to five generations of breeding captive gazelles, there are now 33 Speke's gazelles in the United States.

"Today the gazelle program is in a new phase," Templeton explains. "We are now getting other zoos to establish subherds." Separate subherds guard against loss of the species through an accident at one zoo and also against the unavoidable chance loss of specific genes. Even though an individual subherd loses some genes by chance, it is unlikely that all the subherds would lose the same genes. If the animals were ever to be released into a natural environment, the subherds first would be bred together to give the animals the resource of the greatest possible genetic variability.

Speke's gazelle at St. Louis Zoo inflates its nose while sounding an alarm.

"Our success with the Speke's gazelle demonstrates that small founder populations with no hope of additional wild collections should not be neglected; rather, these populations can be successfully maintained despite an initial inbreeding depression," Templeton and Read say.

Even though their managed breeding program has been remarkably successful, the researchers were recently delighted to learn of an unexpected potential source of the gazelles. In response to a wire service story last April on the work of Templeton and Read, a veterinarian who works for an Arab sheik contacted them saying he had a herd of Speke's gazelles derived from gift animals from the king of Somalia. Templeton says, "We do now have the option of increasing the gene pool [of the American zoo herd] somewhat."

Various zoos are considering applying Templeton's once-controversial inbreeding program to other diminished populations — for example, the Aruban rattlesnake, which is extinct in the wild, with all captive specimens derived from only three founder snakes.

In addition, some zoos are including a low level of deliberate inbreeding in their management of larger populations of animals. A low, continual level of half-sibling or cousin matings appears to increase the general vigor of the population by helping to eliminate genes that are lethal when they are received from both parents.

Inbreeding is likely to occur not just in small captive populations, but also when captive-bred animals are released into the wild, Russell Lande of the University of Chicago says. The released population, facing the rigors of the natural environment, may decline so extensively that it is forced into inbreeding.

Jonathan Ballou, population manager of the National Zoo in Washington, D.C., comments on Templeton's breeding plan, "For species that are really down in number — and a lot of them are — this is very important. Now we know we don't need to give up. We can inbreed cautiously and still preserve the species." □