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Abstract: Despite their once very wide distribution, cheetahs seem never to have existed in large numbers. Compared to lions, cheetahs appear relatively rarely in the fossil record. One of the main reasons for the cheetah's decline is the decline of gazelles and other hoofed prey. Hunting and habitat loss are killing off most species of gazelles. While crops can actually improve the habitat for gazelles, farmers view them as pests and try to eradicate them.

Other reasons for the decline are that cheetah cubs are very vulnerable of predation and cheetahs also lose prey to larger carnivores in their range.

Some males live in coalitions and some of them remain resident territories that they aggressively defend against other males that leads to a very high rate of adults deaths due to combat between males.

Climate change at the end of the Pleistocene, which brought about massive extinctions, most likely accounts for the extinction of the American cheetah and the disappearance of cheetahs from Europe and parts of Asia.

A problem in zoos is that cheetahs are notoriously reluctant to breed in captivity.



Cheetahs

*Next page: More diurnal in their activity patterns than most other cats, cheetahs rely on vision and vigilance to detect prey as well as predators, and prefer open habitats that offer unobstructed views of their surroundings. (Phoenix Zoo photo by Dick George)
Cover art by Jane W. Gaston.*

I have once seen a cheetah in action, in the scorching midday sun of Kenya's Masai Mara Reserve. The painfully thin but hugely pregnant female stalked a milling herd of nervous Thomson's gazelles with seemingly infinite patience. Then suddenly she took off in a vision-blurring burst of speed, scattering the gazelles and catching her quarry: a fawn, perhaps only a few days old. I was near enough to hear the fawn's desperate bleats, and see the female's exhaustion as she several times released her teethhold on the struggling animal's throat to catch her breath before the fawn finally suffocated.

To my, and, it seemed, the cheetah's surprise, a second fawn appeared just a few feet away. Still wobbly legged and utterly confused, the fawn had woken up to find the shelter of its herd gone. The female cheetah watched the fawn stumble in the grass and made tentative movements toward it. But she too seemed confused, or torn between impulses. Should she stay with her kill or, despite her exhaustion, go after this second fawn? When the fawn sank back into the grass, disappearing from view, the cheetah lost interest. We left the cheetah alone to start her meal.

Compared to the bloody scenes of lions ripping apart a zebra or wild dogs tearing chunks

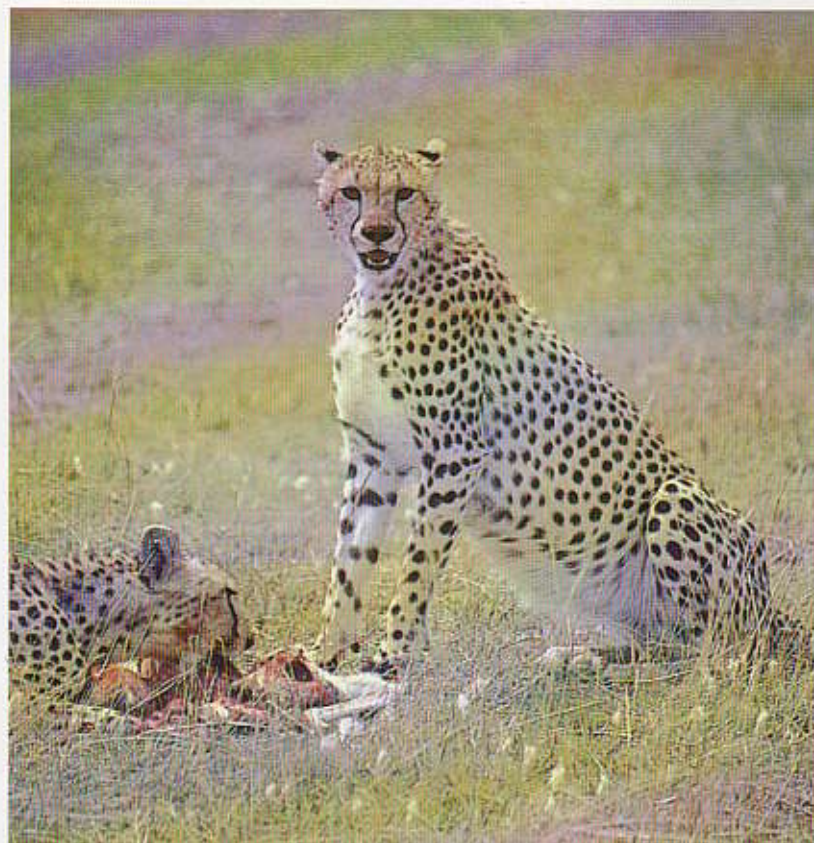
of flesh from the flanks of a still-struggling wildebeest, this act of predation was strangely serene. Twenty minutes after the cheetah separated the fawn from the herd, no blood had been spilled. The details of this one episode reveal a great deal about cheetahs, and about how perilously close to the edge they live.

Whence Cheetahs?

Eminent 19th-century biologist St. George Mivart said that the cheetah differs much more from all other cats than any two other cats differ from one another. The cheetah's paws appear more doglike than catlike: The pads are small and tough and the claws are blunt, only slightly curved, and lack the sheaths that cover the retracted claws of other cats. (The lack of sheaths is why people claim that the cheetah's claws do not retract at all—this is not true.)

Cheetahs also lack the powerful canine teeth possessed by all other cats. While most cats rely on a powerful, piercing, canine bite into the nape to kill prey, a cheetah grasps the throat of its prey until it suffocates—a tactic other big cats employ only when killing prey far larger than themselves. Other features of the cheetah's skull also differ from other cats. And, of course, their speed sets them apart from other felids.

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These cheetahs are feeding on a Thomson's gazelle, the preferred prey of cheetahs living in the Serengeti. In other areas, cheetahs take springbok, impala, or various other gazelle species. (John Cavallo)

As a result, taxonomists have placed the cheetah in a separate genus, *Acinonyx* (from the Greek *akaina*, a thorn, and *onyx*, a claw, which refers to the cheetah's unsheathed claws). *Acinonyx jubatus* is the only living species, and scientists have long been puzzled about its relationship to other cats. Recently, however, studies of the molecular biology of cats, coupled with the discovery of fossil cheetahs in North America, have clarified the cheetah's evolutionary history.

Studies of molecular biology by Stephen O'Brien and his colleagues show that the ancestors of the cheetah, as well as of the puma, split from those of other big cats (clouded and snow leopards, tigers, lions, leopards, and jaguars) about eight million years ago. This means that the cheetah belongs to the big cat, or *Panthera*, lineage, and is more closely related to the big cats (although still rather distantly) than to small cats, such as the wild species from which our domestic cat was derived or the ocelots and margays of Central and South America.

The genetic affinity between pumas and cheetahs supports the hypothesis that cheetahs may actually have originated in North America and then spread into Eurasia and eventually Africa. At least two species of cheetah, *A. (Miracinonyx) studeri* and *A. (M.) trumani*, are known to have lived in western North America. (*Miracinonyx* is a subgenus, indicating the closer relationship between the North American species. The name comes from the Latin *mirus*, which means surprising or amazing, as the discovery of these North American cheetahs was to the scientists who identified them.)

Studer's cheetah was the older and larger of the New World cheetahs, first appearing in the fossil record of about three million years ago, at the beginning of the Pleistocene, although it or another *Acinonyx* probably existed four to five million years ago. Studer's cheetah eventually gave way to the smaller *trumani* species, which survived in North America until the end of the Pleistocene, about 10,000 years ago.

The giant cheetah, *Acinonyx pardinensis*, was a very large cheetah of Eurasia, weighing 210 pounds or more, compared to an average of about 125 pounds for today's *A. jubatus*. This species appears in the fossil record of France about three and a half million years ago. The giant cheetah was widely distributed in Europe, and appears in both India and China. About the size of a lion, this cheetah was probably as superb a runner as the living cheetah, causing paleontologist Bjorn Kurten to remark that the giant cheetah "on the hunt must have been a fabulous sight."

Scientists believe that there was a gradual transition from the giant cheetah to the smaller, living species, which reached its current size in the mid to late Pleistocene. Many mammals, including lions, bears, and rhinos, decreased in size throughout the Pleistocene era. Until the end of the Pleistocene, cheetahs remained widely distributed in Europe and Asia, as well as throughout Africa and the Middle East.

The three fossil species and the living cheetah are all strikingly similar in form and all show adaptations for using high speed to capture prey. In the North American species, however, these adaptations and a few other anatomical features are more primitive, suggesting that the North American cheetahs were ancestral to the Eurasian and African ones.

The most likely path for the movement of cheetahs from North America to Eurasia (and ultimately into Africa) was through the land bridge that connected western Alaska with eastern Siberia during the Pleistocene, forming a vast region known as Beringia. Under the much different climatic conditions of the Pleistocene, this region was a very cold, very dry grassland/savanna. It supported an array of species now more often associated with dry tropical grasslands, including lions, wild horses, hyenas, and, most important from the cheetah's perspective, a variety of antelope and deer that may have served as prey. Some speculate that the great speed of pronghorn antelope, considered the fastest land mammals after cheetahs, may have evolved in response to cheetahs.

Forever Rare

Despite their once very wide distribution, cheetahs seem never to have existed in large numbers. Compared to lions, for instance, cheetahs appear relatively rarely in the fossil record. Even before the collapse of the cheetah's range in this century, 19th-century European explorers and travelers to the Middle East and Africa reported only rare sightings of cheetahs. Norman Myers esti-

Gazelles

One of the main reasons for the cheetah's decline is the decline of gazelles and other hoofed prey in a large part of their former range. Like cheetahs, gazelles once flourished through much of Africa and the Middle East, as well as in parts of Asia. Today, hunting and habitat loss are killing off most species of gazelles in the wild, and populations in zoos are also dwindling.

Gazelles range in size from the dorcas gazelle (*Gazella dorcas*), which weighs as little as 33 pounds, to the dama gazelle (*Gazella dama*), which weighs up to 187 pounds. Slender and long-legged, most gazelles are pale brown with white undersides. Another feature common to these elegant animals is their "stotting" or "pronking" gait—when playing or alarmed, gazelles bounce along stiff-

legged, landing on all fours between bounces.

Because most gazelles live in semidesert steppes, mountainous desert scrub, and other remote, arid habitats, these animals are little known. In fact, even their taxonomy (classification into species) is controversial. Some biologists think there are 11 species in the genus *Gazella*, while others think there are 14 or 16. The number of subspecies is also in dispute. Many species of gazelles are divided into isolated populations by geographical barriers including mountains, the Red Sea, and the Persian Gulf. The form of these isolated populations can vary dramatically over a species' range. Notably, while dorcas gazelles are pale with fairly straight, parallel horns in Morocco, they are smaller and reddish with

lyre-shaped horns in India; populations between these two regions have intermediate characteristics.

Although the taxonomy of gazelles is uncertain, one thing about them is clear: They are in trouble. The numbers and ranges of most gazelles have declined greatly and the World Conservation Union (IUCN) listed all but one species as vulnerable or endangered in 1990. The only abundant species is Thomson's gazelle (*Gazella thomsoni*), a small East African gazelle that, unlike most members of its genus, lives in grassy plains.

Gazelles in arid regions are dying out in part because people are taking over their habitat. People displace gazelles from springs, let domestic sheep and goats overgraze areas where gazelles used to feed, and convert land to agriculture.



Still abundant in East Africa, Thomson's gazelles are the only gazelle species not currently in danger of extinction. (Carol Cofey)



Most widely distributed of the gazelles, the dorcas gazelle suffers from overhunting and habitat loss throughout its range. (Jessie Cohen/NZP Graphics)

While crops can actually improve the habitat for gazelles, farmers view them as pests and try to eradicate them.

Another major reason for the gazelles' recent decline is that sport hunting has increased since World War II, when rifles became more readily available. Gazelles are easily hunted from vehicles, and hunting has decimated populations of dorcas gazelles and slender-horned gazelles (*Gazella leptoceros*) in the western deserts of Egypt. If hunting is limited, however, people and gazelles may be able to coexist. Populations of dorcas gazelles near agricultural settlements in Israel have increased by an average of nine percent annually for 20 years.

In addition to protecting gazelles and their habitats, there is an urgent need for zoo breeding, says Oliver Ryder of the San Diego Zoo's Center for Reproduction of Endangered Species (CRES). "Relying solely on the strategy of protection in the wild is not enough," he says, cautioning that "zoo breeding reinforces—but does not replace—conservation in the wild."

However, zoo gazelle populations are also declining in part due to reduced reproductive fitness. One species that has not reproduced well in zoos is Soemmerring's gazelle (*Gazella soemmerringi*), a pale gazelle that lives in the bush and acacia steppe of northeast Africa. The zoo population of this gazelle has variable numbers of chromosomes, ranging from 34 to 39. Researchers at CRES have found that the variation is due to structural rearrangements of three chromosome pairs. The total amount of genetic material remains the same, but it is now packaged in a different way.

Scientists believe that the chromosomal differences found among Soemmerring's gazelles in zoos account for their poor reproductive record. When egg and sperm are united to form an embryo, the genetic material contributed from the dam and the sire must combine. When animals of differing chromosomal constitutions are bred, the chances of correct genetic combination are reduced, leading to reduced fertility, explains CRES re-

searcher Arlene Kumamoto.

Ryder speculates that the founder stock of the zoo population of Soemmerring's gazelles included either gazelles from different taxa (species and subspecies) or hybrids between taxa. "Maybe people didn't have much experience with what Soemmerring's gazelle look like. Gazelles look a lot alike—they're the mammalian equivalent of little brown birds," he says. Soemmerring's gazelle and Grant's gazelle (*Gazella granti*), for example, are easily confused and their ranges overlap. Thus, before pairing zoo gazelles for breeding, biologists need to know where the animals were captured as well as the number and structure of their chromosomes.

Besides including gazelles that may have been misidentified, the founder stocks of most zoo gazelle populations were very small. There were only four animals in the founder stock of the zoo population of Speke's gazelle (*Gazella spekei*), a pale, little-known gazelle from the bare, stony steppes of the Horn of Africa. While introducing new founder stock is essential to avoid the deleterious genetic effects of inbreeding, getting wild-caught gazelles is difficult. "Many gazelles are from North Africa and the Middle East, where there has been such turmoil and conflict. In addition, U.S. quarantine restrictions and CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) regulations make it difficult to import animals," notes Kumamoto.

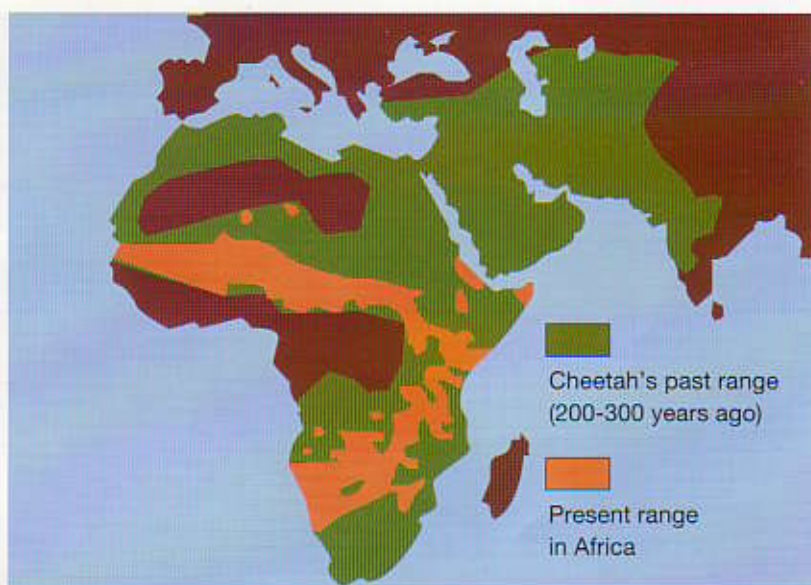
The future for gazelles looks bleak. "Although more attention has been drawn to gazelles recently, their situation is not unique," says Ryder. In other words, gazelles are competing with other threatened and endangered wildlife for limited conservation resources, and there may not be enough to go around.

—Robin Meadows

mates that perhaps no more than 100,000 cheetahs lived in "pristine" Africa south of the Sahara, based on an average of one cheetah per 30 square miles in prey-rich savanna habitats and only one cheetah per 90 to 185 square miles in less productive, more arid environments. Today, even in protected areas such as Tanzania's Serengeti National Park where densities reach one cheetah per about six square miles, cheetah densities are low compared to those of lions and spotted hyenas. And, in only a few places, such as Namibia, where lions and hyenas have been virtually exterminated by farmers, are cheetahs relatively abundant.

As big cats go, cheetahs, with their slight builds and small canines, are fairly ill-equipped to defend themselves against predators. And, throughout their current and historical range, cheetahs have lived among larger or more powerful predators, including lions, hyenas, wild dogs, and leopards. Adult cheetahs are victims of predation, particularly by lions, but cheetah cubs are especially vulnerable. In Serengeti National Park, about 90 percent of all cubs die before they are three months old, and half of these deaths are due to predation.

Cheetahs also lose prey to these larger carnivores in their range. In the Serengeti, for example, cheetahs lose between 10 and 13 percent of their kills. Alerted by the panic of the gazelle herd or by the circling of vultures, lions and hyenas close in on a cheetah's kill and easily drive the timid cheetah away. Cheetahs thus need to eat fast, but they also need to rest and cool off after a chase. The cheetah's blinding speed in pursuit of prey pushes the cat to its physiological limits. Lacking a mechanism for evaporative cooling to



maintain a constant body temperature while running, cheetahs store the large amount of heat produced by a high-speed sprint. This is why cheetahs must catch their prey or abandon the chase after sprinting about 300 yards—after this point, body temperature would rise to lethal levels.

The presence of other predators thus helps keep cheetah numbers low, creating a paradoxical conservation dilemma for managers of protected areas who wish to increase populations of all endangered predators.

Behavioral Ecology

Contributing further to low numbers of cheetahs is the very high rate of adult deaths due to combat be-

Above: Cheetahs disappeared from most of their range during the last 50 years.



Left: By about four months of age, cheetah cubs have lost the black belly fur and light gray, very woolly mantle they are born with. This distinctive natal coat may help camouflage the cubs until they are agile enough to outrun most predators.

(JoGayle Howard)

Cheetahs run using a rotary gallop: The hind legs land first on alternate sides, then no feet touch the ground as the cheetah literally floats through the air. Next, the front legs land on alternate sides, then the cheetah goes into "crossed flight," with all four feet gathered under its body and off the ground.

(Sam Wasser)



tween males, which has only recently been documented. Scientists began systematic studies of cheetahs only about 30 years ago, despite thousands of years of close association between cheetahs and people. The most extensive research has been on cheetahs in Serengeti National Park. These studies were initiated in the 1960s by George Schaller and have been conducted over the past decade by Tim Caro, now of the University of California at Davis, and his colleagues and students. Their work has produced a fascinating picture of the lives of predators in peril.

Female cheetahs are typical solitary cats, living alone or with their young cubs. Interactions with males are rare, confined to brief mating periods of a day or two. Adult females also avoid other females, although the home ranges of females may overlap extensively because the ranges are too large for a female to effectively defend. In the Serengeti, where Thomson's gazelles make up about 90 percent of a female cheetah's diet, females annually range over more than 300 square miles as they follow the gazelles' migrations across the savanna.

About 40 percent of adult males also live alone, but the rest live in all-male groups, or coalitions, of two, three, or sometimes four. Lasting throughout the lifetime of the males—up to eight years in the wild—these coalitions are usually made up of littermates, but about 30 percent of the coalitions include unrelated males. Like females, most males, whether alone or in coalitions, wander over large areas of the Serengeti following migratory gazelles as well as the larger wildebeest preferred by coalitions. But about 30 percent of coalitions remain resident on small, 15-square-mile territo-

ries that they aggressively defend against other males.

In the entire Serengeti, no more than 10 territories are occupied at any one time. The territories contain cover, either vegetation growing in riverbeds or tall, rocky outcrops. Each year during the wet season, when most matings occur, female cheetahs gather in the territories to take advantage of both the cover and the gazelles that also concentrate in this habitat. With as many as 20 or 30 females ranging in these "hot spots," territory-holders enjoy more mating opportunities than wanderers, leading to fierce and often fatal battles between coalitions over ownership of territories. This also explains the value of coalitions—larger groups are better able to secure and defend a territory than smaller groups or singles.

After mating, a female cheetah gives birth 90 to 95 days later to as many as eight, but usually three to five cubs. Born blind and helpless, the cubs remain hidden in a den of thick vegetation for six to eight weeks. This period is fraught with danger for the young cubs. The mother conceals the cubs and is extremely vigilant to avoid attracting predators to the den, but she must also hunt and may have to be away from the den for up to 48 hours to feed herself and acquire the additional energy to support lactation. As noted above, many defenseless cubs are lost to predators, but other causes of death include grassfire, exposure, disease, and sometimes maternal abandonment if prey is scarce and the mother cannot find enough to eat.

Even after cubs begin to follow their mother on hunts they remain vulnerable, largely due to their inexperience at predator detection and recognition. Cubs also lack the speed of adult cheetahs and cannot

run fast enough to escape danger. The antics of cubs may also reduce the female's hunting success, as they "blow her cover" during a stalk—one study showed that between 16 and 21 percent of a female's hunts failed due to cub activity.

Cubs only very slowly learn to be effective hunters, and even after they leave their mother at between 14 and 18 months of age, they are still not very proficient for another year or more. To reduce risks and avoid harassment from other carnivores, all cubs stay together for about six months after leaving their mother. Then, females go off to live alone, while males, if they are fortunate enough to have surviving brothers, stay together to form adult coalitions. But high rates of mortality continue: Half of the males that survive to independence die before reaching adulthood (two and a half to three years of age), largely due to combat with other males over territories.

Rise and Fall

Climate change at the end of the Pleistocene, which brought about massive extinctions, mostly of large mammals, most likely accounts for the extinction of the American cheetah and the disappearance of cheetahs (*A. jubatus*) from Europe and parts of Asia. In much of Europe, for instance, forests replaced the open grasslands that cheetahs and their prey are adapted to. Evidence of a "genetic bottleneck" at the end of the Pleistocene suggests that cheetahs also neared extinction throughout their range in Africa and Central Asia, where grasslands and semideserts remained.

But cheetahs recovered and in historic times ranged wherever dry, open habitat existed in Africa from north to south, in the Middle East and Central Asia, and as far east as central India. Since about the mid-



Above: *The presence of vultures may signal to lions and hyenas that a cheetah's prey is available for the scavenging.* (John Cavallo)

dle of the last century, however, the cheetah's range has rapidly and inexorably declined. Cheetahs were declared extinct in India in 1952, and have not been seen in the vast Arabian Peninsula since 1950. A few might have survived until recently in Central Asia, especially in Iran, but most people believe they are now extinct there. Cheetahs were extremely rare in North Africa by the 1960s and are now gone. A 1970s survey estimated that only 14,000 existed in all of Africa, down from about 28,000 15 years earlier and from a precolonial number of 100,000. Today, cheetahs survive in just a few isolated areas in Africa south of the Sahara.

Cheetahs disappeared from India, Central Asia, the Middle East, North Africa, and the Sahel largely as a result of uncontrolled hunting of both cheetahs and their principal prey—blackbuck in India, and dorcas, dama, and other gazelle species elsewhere (see sidebar on gazelles). The movement of pastoralists, mostly sheep herders, into cheetah habitat also contributed to the decline, primarily because the herders kill the cheetahs that threaten their domestic animals. (Ironically, grazing lands make excellent habitat for cheetahs if people could only learn to live with them.) In sub-Saharan Africa, colonial European ranchers and farmers, and the Africans who are converting pastureland to farmland, have made habitats unsuitable for cheetahs. Trade in cheetah skins, which is now banned in most countries but continues on the black market, also played a role in the cheetah's decline.

Effective protection in reserves and national parks may be sufficient to save many endangered species, at least in the short term. But, as noted above, even protection is a mixed blessing for cheetahs, who are threatened by large numbers of predators. New and creative ways of conserving cheetahs in the wild, coupled with zoo breeding programs to create a back-up, are essential if these elegant creatures are to survive. ♣

Left: *Female cheetahs live alone or with their cubs, but adult males often live in groups of two, three, or four. The males in these groups, called coalitions, are usually brothers.* (Jean B. McConville)



Below: Found only in northern Kenya and parts of Ethiopia and Somalia, Grevy's zebra (*Equus grevyi*) are rare and continue to decline, primarily due to excessive trophy hunting. (Mark Rosenthal)

But the Cheetah Conservation Station is not designed merely to display cheetahs (which will eventually number 10 adults) and their potential prey. At the Station, Zoo scientists will study the behavior, genetics, and reproductive physiology of cheetahs as part of a massive effort to save this endangered species from extinction. What's more, the Station offers visitors a window into this state-of-the-art scientific endeavor as they gain a real understanding of cheetahs through entertaining interactive activities. (My favorite is "What's For Dinner?", in which visitors are invited to weigh themselves, then determine how much of a dent they would put in a cheetah's minimum daily requirement if they were hoofed mammal prey.)

Slender Sprinters

In Tanzanian cave paintings uncovered by paleontologist Mary Leakey, cheetahs can be identified by their small heads, long tails, and lean, muscular bodies. A Zoo visitor comments that one of the male cheetahs looks too thin, but Stuart Wells, biological technician for the Cheetah Conservation Station, responds that he's supposed to look that way.

"Cheetahs are lean and tall and built for speed," he says. "Everything about them is designed to do what they do—run fast. Their legs are long, their spines are flexible, and they run on their toes. Besides that, a deep chest to draw deep breaths for the sprint makes the cheetah's waist look thinner than it is."

All cats have bodies designed for speed. They walk and run with only their toes touching the ground (called digitigrade stance), have flexible spines, and

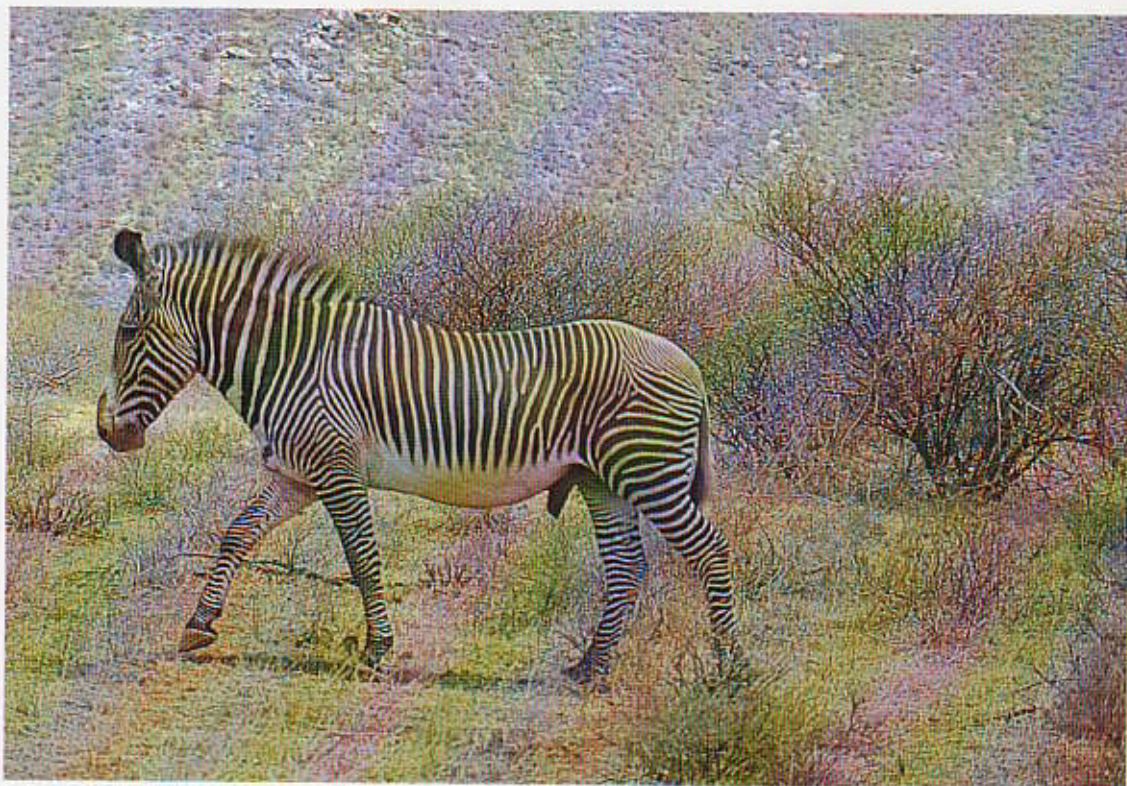
high, mobile shoulders. Cheetahs just carry these features to the extreme. Compared to other cats, their feet and leg bones are straighter, their shoulders and limbs are longer, and their spines are longer and have larger muscles for flexing and stretching. The long tail acts like a rudder to increase maneuverability while sprinting. Cheetahs are also slimmer and lighter than other big cats, weighing only 86 to 143 pounds, compared to as much as 500 pounds for a big male lion.

As a result, a cheetah may reach speeds of nearly 70 miles per hour, faster than one can legally drive on the highway. Even more impressive is how quickly a cheetah accelerates. According to Wells, a cheetah can actually beat a Ferrari GTO off the line. The high-performance sports car needs four seconds to reach 50 miles per hour, while the cheetah hits 50 in less than three seconds. Unlike a car, however, a cheetah can go at top speed for only about 300 yards and then may need 30 minutes or more of rest to recover from the effort.

Cheetahs use this great speed to capture the gazelles and other antelope such as impala and wildebeest that make up their prey. At the Cheetah Conservation Station, children (and brave adults) can run and prowl along a predator/prey trail, imitating a cheetah stalking a gazelle. In addition, daily demonstrations, narrated by trained FONZ volunteers, of a cheetah running along a lure course offer visitors the chance to see how fast cheetahs run—and it has to be seen to be believed!

Under the Skin

For those of us whose experience of observing chee-



The "Hunting Leopard"

The cheetah's first recorded association with humans dates to more than 4,000 years ago. A collared cheetah adorns a silver vase, dated from about 2,300 B.C., that was discovered at Maikop in the Caucasus. A rock painting in Tanzania, in which a cheetah is seen among seven dancing women, may be even older. Other groups including the Scythians, Assyrians, Egyptians, and Indians also left evidence of taming cheetahs. And, Europeans coursed cheetahs during the Renaissance.

Although the cheetah's beauty is indeed remarkable, early humans probably were attracted to the animal's hunting behavior rather than its appearance. They no doubt observed that cheetahs are often chased away from a kill by other predators and scavengers. Noting this, our ancestors probably did the same thing. Finding that cheetahs are docile and trainable, humans eventually put them to work as hunters. This is a fairly typical scenario for the early stages of domestication. However, the cheetah's refusal to breed in captivity may have prevented full domestication.

The Mughal emperors of 16th-century India were without doubt the all-time cheetah aficionados. Although earlier records describe cheetahs being used to hunt, Mughal histories provide an example of the cheetah's esteemed place in society. The Mughal emperor Akbar reportedly trapped cheetahs in pits and trained them for the hunt and for life in the palace, keeping as many as 3,000 cheetahs at one time.

As has been the case throughout history, the Mughal emperors had little luck breeding cheetahs. One cheetah birth occurred in 1613 when an uncollared male cheetah from Akbar's collection mated with a female who later delivered three cubs. Imperial historians viewed this as a "strange" event, and entered it in the record



Bridgeman/Art Resource, N.Y. Not in deposit; PHD 548. George Stubbs, Cheetah with Indian Attendants (#1 detail). Manchester City Art Gallery.

books. No further cheetah births in captivity were reported until 1956, when three cubs were born at the Philadelphia Zoo.

What fascinated Akbar was the hunt. According to one story, as he and his special cheetah hunted, a deer leapt across a 25-yard ravine at the height of "a spear and a half," making a kill unlikely. Chitr Najan, as the cheetah was named, raced after the deer, leaping over the ravine to seize his prey. As a result, he became chief of the cheetahs, and "as a special honour, and as a pleasure to men," Akbar ordered that a drum should be beaten in front of the cheetah.

As recently as 1941, John and Frank Craighead, on assignment for *National Geographic* as guests of an Indian prince, observed trained cheetahs, known as "hunting leopards," hunting blackbuck on the coastal plains of the Indian state of Bhavnagar. The cheetahs were driven to a herd of blackbuck in a sturdy truck. Trainers kept the animals hooded until the truck drew near to the herd. When the trainer removed a cheetah's hood, the animal burst from the vehicle in pursuit of its quarry.

As described by the Craighead brothers, "the cheetah had timed his run, saved his wind, and counted on the spurt...what had appeared like a speeding ripple was now a straight line hurtling toward the buck so fast that it appeared as if only one object were moving. The cheetah was doing close to 70, possibly 80 miles an hour, and looked like a blur of brown against a tan background."

During this chase, the blackbuck dodged the cheetah three times, but the cheetah eventually tripped him up with a well-aimed front paw to the hind leg. The cheetah then sprang and closed his jaws on the buck's neck. At this point, "the trainers rushed in and with a Mohammedan prayer they finished the struggle."

Whether for its awesome speed and hunting skills, or for its aesthetic appeal, the cheetah has long been a favorite of humans. Given the profound nature of the cheetah's present dilemma, it appears that the relationship between humans and cheetahs is of more consequence now than at any other time in history.

—Christopher Stuart

Now home to a pair of four-year-old brothers and two eight-month-old cubs, a male and a female, the Cheetah Conservation Station will eventually include 10 cheetahs. (Jessie Cohen/NZP Graphics)

tahs is limited to a brief glimpse through binoculars, it is amazing that scientists looking through powerful microscopes at a tiny blood sample can perceive the chain of life that makes a cheetah a cheetah. At the CCS, visitors can learn how and why scientists at the National Zoo's NOAHS (New Opportunities in Animal Health Sciences) Center are doing this.

In the early 1980s, NOAHS' Stephen O'Brien, David Wildt, and Mitchell Bush discovered that cheetahs exhibit extraordinarily low levels of genetic diversity—in the wild and in zoos, cheetahs are all virtually identical twins. O'Brien believes that the inbreeding that created this situation began about 10,000 years ago as a result of what is called a "genetic bottleneck." For unknown reasons, the African cheetah population must have crashed and been close to extinction. O'Brien speculates that perhaps only one female and her cubs survived to begin slowly rebuilding the population. But the reduced genetic diversity that resulted from this inbreeding has serious

consequences for the cheetah, producing infertility, high infant mortality, and an inability to combat infectious disease.

Cheetahs are highly susceptible to disease agents. For example, an outbreak of feline infectious peritonitis virus may kill 50 to 60 percent of cheetahs affected, compared to one to five percent of genetically diverse domestic cats.

"You can view a cell like a fortress," says O'Brien. A virus is an army attacking the fortress. With high levels of genetic diversity, or "genetic plasticity" as O'Brien calls it, the army has to overcome many hurdles to take the fortress. When diversity is absent, so too are the multiple hurdles and the cell is easily taken.

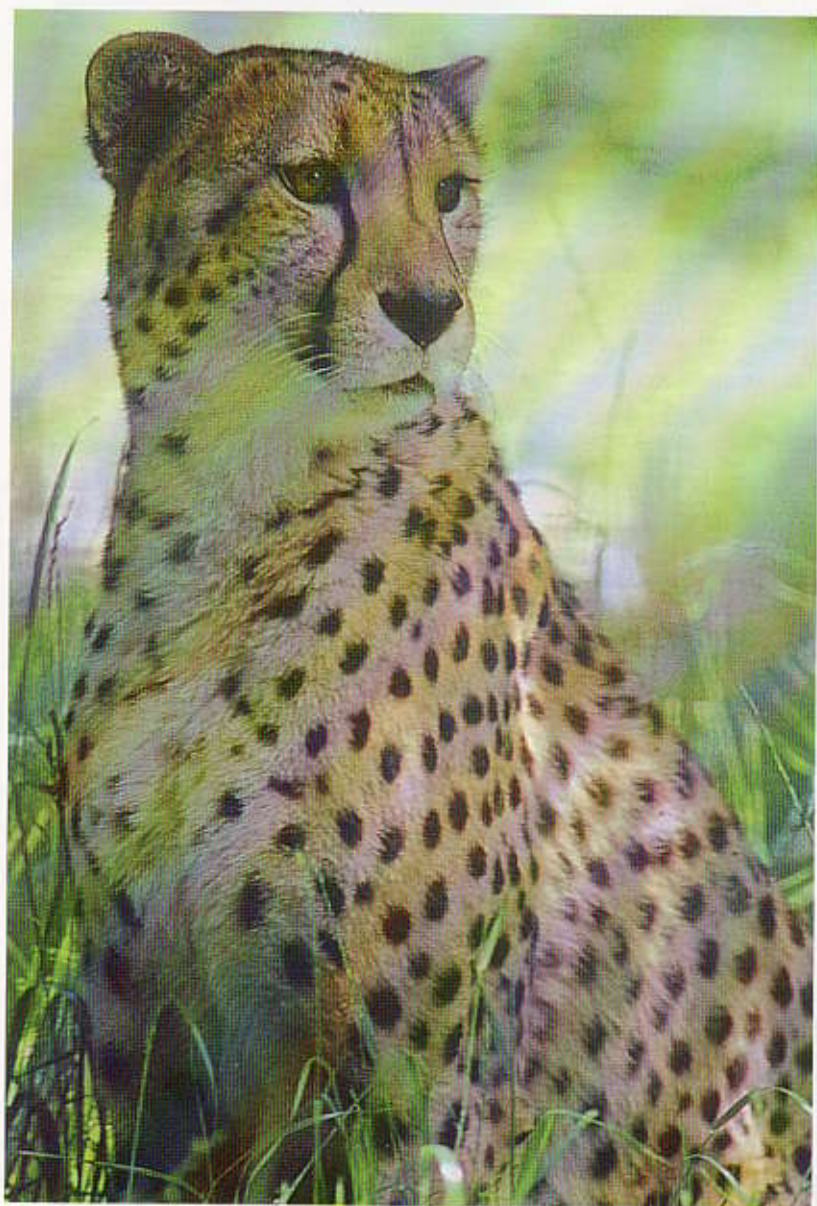
Cheetahs also suffer from infertility, a result of inbreeding's effect on male sperm cells. NOAHS scientists, led by David Wildt, the Zoo's head reproductive physiologist, have examined sperm from both wild and zoo cheetahs. "We were amazed to find that up to 70 percent of cheetah sperm is abnormal," says Wildt. "In most animals, more than 20 percent abnormality is a sign of infertility."

Problems and Solutions

Cheetahs are notoriously reluctant to breed in captivity. Despite concerted efforts, the Mughal Emperor Akbar failed to breed cheetahs. The one breeding recorded among his thousands of cheetahs was the result of an accidental encounter between a male and female. But the cubs died. North American zoos began to experience some success in breeding cheetahs in the early 1960s, and, despite infant mortality rates as high as 37 percent, the North American zoo population reached about 200 animals by the mid-1980s, including cheetahs imported from the wild and from foreign zoos. By 1986, however, the zoo birthrate had declined by 50 percent and, with cheetahs endangered in the wild, the possibilities of importing new cheetahs to supplement the zoo populations were sharply reduced.

Deeply concerned, participants in the Cheetah Species Survival Plan (SSP), one of 56 such plans coordinated by the American Association of Zoological Parks and Aquariums, called for intensive and wide-ranging research on cheetahs to ensure their survival in zoos. To keep track of cheetahs in zoos, NOAHS associate Laurie Marker-Kraus keeps *The Cheetah Studbook*, a world registry now in its third annual edition.

Says Jack Grisham, SSP coordinator and a curator at the Oklahoma City Zoo, "The purpose of the research is to enhance the fecundity, reduce the mortality, and produce a self-sustaining population that can be managed as a back-up to ensure the survival of cheetahs in the wild." NOAHS scientists are leading this research effort, and as a result the Cheetah Conservation Station was selected as an intensive research site.





Cheetahs use a variety of vocalizations to communicate. Some are used only between a mother and her cubs. She uses these to call up lost cubs, to encourage them to follow her, and to tell them to keep still. (Miles Roberts)

Part of this effort includes ongoing research to improve breeding through artificial reproductive technologies. For instance, JoGayle Howard, a Zoo reproductive physiologist and veterinarian, took NOAHS' high-tech "Mobile Lab" (see "Frontiers," *ZooGoer*, July/August 1990) to the Caldwell Zoo in Tyler, Texas, which maintains a large group of cheetahs. Howard successfully artificially inseminated a female cheetah, who gave birth to a cub. Unfortunately, the mother, upset by a storm, accidentally killed her cub, but Howard is now working to repeat her success at other Texas zoos. And soon, work will get underway at the Cheetah Conservation Station.

Howard and other NOAHS scientists are also working on cryopreservation (freezing) of sperm and eggs so these germ cells can be saved for future

artificial reproduction. "The only way we're going to save the cheetah is to learn as much as we can," says Howard. "At the CCS we will be able to do comparative semen cryopreservation studies. Cryopreservation will allow movement of germ cells without our having to take the risks of moving live animals from one location to another."

Other scientists will study behavior, nutrition, and endocrinology at the CCS. Regular, ongoing collection of data on the cheetahs' behavior is a special focus, and Stuart Wells has already trained a cadre of FONZ volunteers to conduct behavioral observations. Studies of how the size and sex composition of cheetah groups affect breeding will be particularly important as Zoo scientists attempt to incorporate Tim Caro's findings on cheetah social behavior in the wild (see pages 15-17) to the zoo management program. No longer is it simply a matter of exhibiting cheetahs "two by two," as was so often done in the past.

"We know so much more than we did even a year ago," says Zoo Curator of Mammals John Seidensticker, who managed the transformation of the old hoofstock area into a full-fledged conservation research site, as well as a fascinating educational exhibit for the public. "The National Zoo is poised to lead the way in producing cheetah young using the latest technologies to assist in natural reproduction and to boost the population using artificial reproduction."

"This is an enormous challenge," Seidensticker adds, "but now we believe many things are possible that were only dreamed of one year ago." ❖

Ruth Stolk is the Executive Director of the National Zoo's NOAHS Center.

Left: The cheetah's distinctive black tear stripe may serve as an antiglare device, like the black marks quarterback Joe Theismann wore under his eyes. Or, the stripe may enhance the facial expressions cheetahs use to convey aggressive or submissive intent to other cheetahs. (John Cavallo)

