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Abstract: During a decade studying cheetahs, Caro became increasingly alarmed over the vulnerability of this endangered species. It's not enough for biologists to observe, they need to conserve. Cheetahs have seemed particularly vulnerable to extinction for reasons of specialization and genetics (amazing uniformity of genes among individuals). It is necessary to get involved in reintroduction programs or ecological monitoring or enter the world of conservation politics, especially at a local level.

# CHEETAHS ON THE SPOT

BY CAROL CRUZAN MORTON

**T**IM CARO CANNOT TELL a cheetah by its spots. The realization dawned on him in his first year in the Serengeti National Park, Tanzania. Caro, now a member of the UC Davis Center for Population Biology, was beginning a 10-year study of the park's cheetahs that culminated this year with a new book, called *Cheetahs of the Serengeti Plains*.

When he began the project in 1980, Caro snapped photos of each animal for an index to help identify individual animals in the field. But after the film was processed, Caro would find himself with a picture in hand trying to match characteristic spot patterns on that cheetah's face, chest and tail to the animal outside the window of his Land Rover.

"Matching the animals proved to be unbelievably difficult," he says. "I would see cheetahs as a bunch of spots. So I would just take another picture of the animal out there instead of trying to match it up."

Eventually, Caro found he could identify many individuals by odd features, such as scars or broken tails, by matching some photos after he left the Serengeti, and by limited radio tracking. These individuals provided Caro with the data to debunk some old ideas about carnivores in general and cheetahs in particular.

Caro's book describing his field work has been lauded for its carefully collected data

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about the biology of cheetahs in the wild, for its expert analysis of the evolutionary causes of social behavior and for its clear presentation of the functions of cheetah behavior. The book's findings may provide new insights into better management strategies. Caro's results may put a spotlight on the animals, perhaps enhancing their chances of survival through increased public awareness.

During his decade studying cheetahs, Caro became increasingly alarmed over the vulnerability of this endangered species. He became convinced that biologists need to turn their attention to the most immediate need of their subjects—survival.

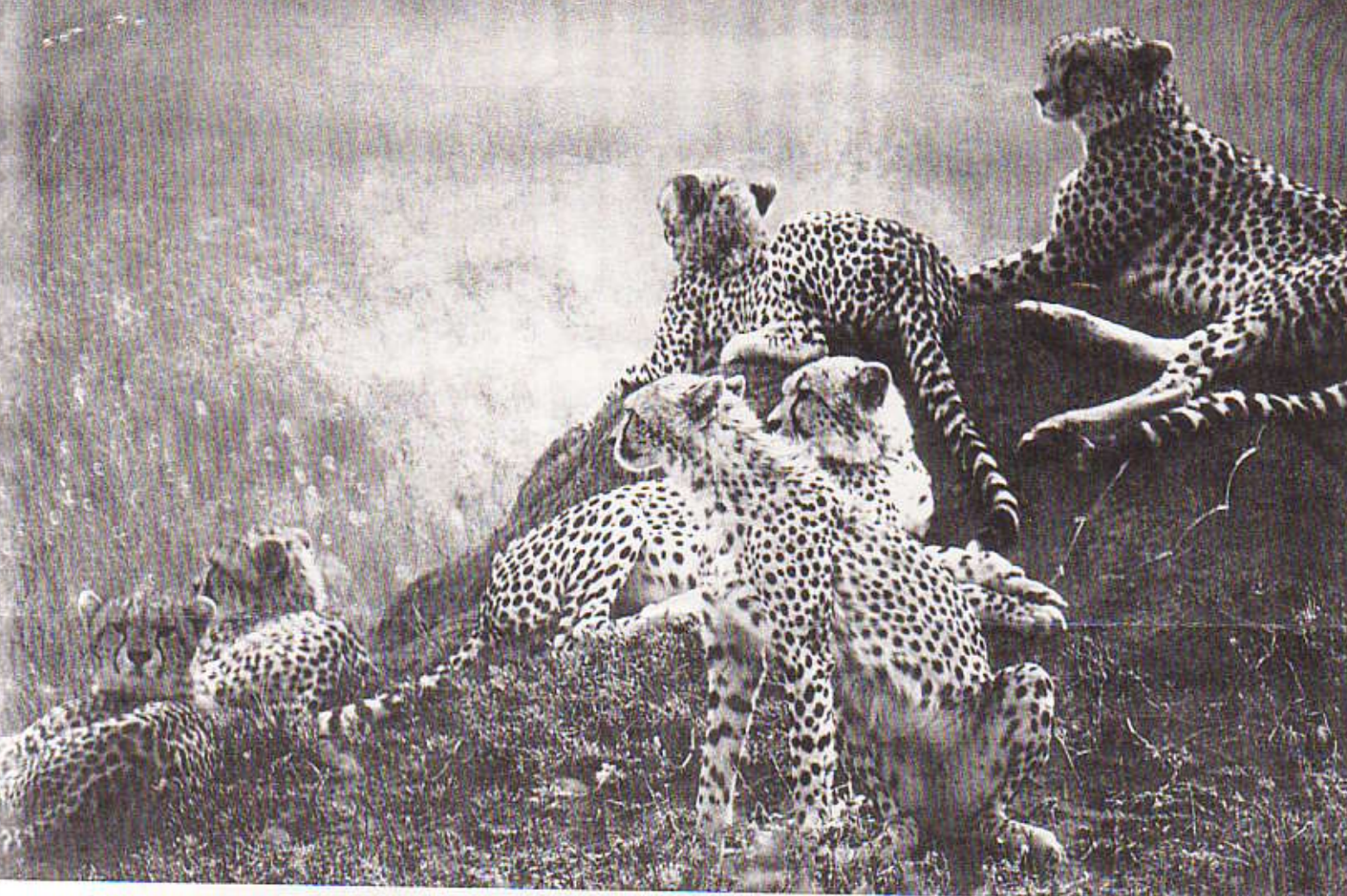
"As biologists born in this century, at this exciting and terrible time, we have the obligation to do something about stopping the mass extinctions happening in our lifetime," he says. "It is the most important thing going on in the natural world. If those of us who are particularly interested do nothing but study the animals while they're disappearing, people will look back and hold us responsible. At the moment, we have to take up the challenge of trying to save the species."



Illustrations by Dafila Scott, from *Cheetahs of the Serengeti Plains* by T.M. Caro, © 1994 by The University of Chicago.

**S**aving the species wasn't foremost on Caro's mind when he first went to Africa. Caro had taken on the Serengeti cheetah project as a postdoctoral study to continue his investigations into feline play. He was interested in academic questions about the evolution and development of behavior.

Caro's journey began soon after he bought



In a family group evolved to protect the cubs against predators, a mother and six 8-month-old cheetah cubs rest on a termite mound in the early morning. (Photo by Tim Caro)

a surplus Land Rover with 145 miles on it from the British Army and talked his girlfriend (now wife), Monique Bergerhoff Mulder, an associate professor of anthropology at UC Davis, into driving from London to the Serengeti. Driving across southern Sudan, Caro remembers seeing a cheetah cross the road in front of the Land Rover. A few minutes later a Murle warrior with spear appeared, tracking it.

In the Serengeti, Caro observed and recorded the demography and behaviors so critical to studying long-lived animals like cheetahs.

For his play studies, Caro had intended to follow six litters from birth until the cubs became independent, or about 18 months old. He found a mother and her three young cubs and watched them for a week. He planned to come back the next month for another week of observation.

After returning and spending a fruitless week searching for the family, it became clear that what he had set out to do was impossible.

"That brush with reality suddenly opened my mind to other possibilities," says Caro, who was drawn to the curious-

ly flexible social structure of the cheetah community.

Cheetahs are unique among wild cats, teetering on the edge of sociality between the uniquely clubby lions, who live in social groups called prides, and the 35 other wild cat species, who prefer solitary living. Female cheetahs live alone, like other cats, except when they have cubs. Young litter mates continue living together for up to six months after leaving their mother. Male cheetahs, on the other hand, tend to live in small permanent fraternal coalitions.

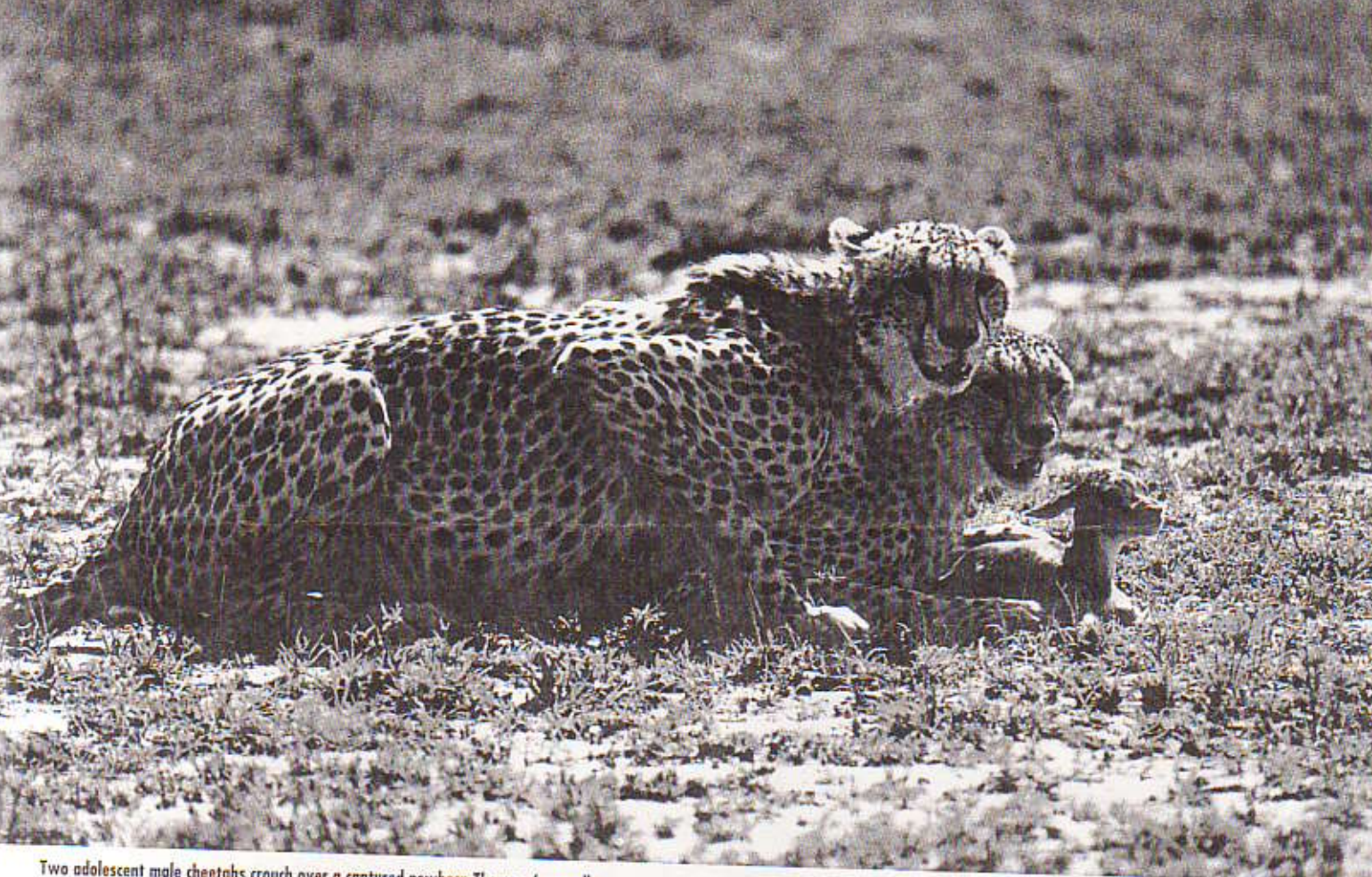
In particular, Caro was interested in the causes and repercussions of group living for adult males. Previously, scientists assumed carnivores lived in groups for purposes of cooperative hunting. Yet evolutionary theory assumes the most powerful force is the drive to pass along one's genes to the next generation. If a male cheetah lived with another male, then there was a 50 percent probability that he would share the matings with willing females that wandered through their territory and thus would contribute only half as many offspring to the next generation as would a solitary male, Caro reasoned. He wondered

what benefit was worth such an evolutionary risk.

In search of answers about cheetah social living, Caro traveled into the field for weeks at a stretch, rising with the cheetahs at dawn and observing them till dusk, when they would all go to sleep. Eventually, he was able to gather data on about 50 litters with mothers, 33 groups of males and 20 groups of adolescents.

Detailed in his book, the findings of his cost-benefit analysis of group living in cheetahs challenges the long-held belief that cooperative hunting motivates group living in cheetahs and other carnivores. In explaining the social behavior of male cheetahs, Caro found that mating is more important than eating, and so are defending territories and fending off predators.

"There are multiple reasons for group living in this asocial species," Caro concludes in his book. By living in groups, males can gain and hold territories favored by females, adolescents can reduce harassment from predators, and mothers can further their reproductive success by protecting cubs from predators and providing them with food. "Large predators are subject to



Two adolescent male cheetahs crouch over a captured newborn Thomson's gazelle.

the same selection pressures that affect other mammals and birds: the need to maintain a territory, escape predation, and obtain access to mating partners," Caro writes.



Cheetahs have seemed particularly vulnerable to extinction for reasons of specialization and genetics. Cheetahs are uniquely adapted for high-speed chases required to catch fleet prey. The fastest land mammal over short distances, cheetahs seem to resemble greyhounds more than they do other cats. They have a slight build, long, thin legs, a deep narrow chest and a small, delicate domed skull. Unretractable claws offer traction for running. Enlarged nasal passages have evolved to facilitate quick oxygen exchange. Cheetahs hunt by day, kill most of their prey by strangling, and lose about one in 10 kills to spotted hyenas or lions. Some biologists believe that such specialized traits ill dispose the species to adapt fast enough to en-

vironmental changes over evolutionary time and the more rapid changes currently induced by humans.

Second, cheetahs have an amazing uniformity of genes among individuals, even those from different subspecies. Their impoverished genetic diversity has been blamed as the cause of their dwindling populations. Not so, argued Caro and former student Karen Laurenson, now at the Upland Research Group in Scotland, in a paper last year in the weekly journal *Science*. The more imminent threats to cheetahs and other small wild populations are posed by humans. Humans are responsible for poaching, habitat fragmentation, decimation by exotic species and pollution. Even the apparently helpful act of setting up protected areas like the Serengeti National Park changes the relationship among the animals.

For example, citing mortality data from the Serengeti cheetah project, the researchers revealed that the biggest threat to cheetahs in the wild was the high popula-

tion of lions, also protected in the Serengeti National Park. They found that 95 percent of cheetah cubs born in the Serengeti die before adulthood, most of them while still helpless in their dens. Seventy-five percent of these cubs were killed by marauding lions.

Indeed, this finding solves the riddle of why cheetahs live at lower numbers than lions and hyenas in the Serengeti, as well as in other protected areas in Africa. Presently, conservation biologists are arguing over the relative importance of genetic or environmental problems affecting small populations of endangered species.

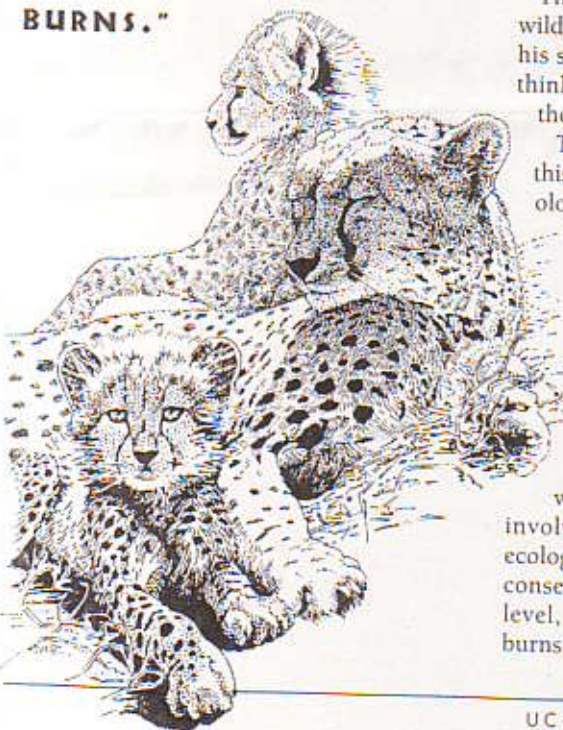
"The *Science* piece was important," says Marc Mangel, a colleague of Caro's in the UC Davis Center for Population Biology. "It challenged, with evidence, a common paradigm that populations are declining because of genetic factors. It showed pretty clearly that it's more likely to be ecological factors, not genetic factors."



Caro left the Serengeti in 1984 and returned to his native England as a postdoctoral research scientist at University of Cambridge, analyzing the cheetah data. He moved to this country in 1987, where he spent two years as a visiting research scientist at the University of Michigan, carrying out analysis for his book and often returning to the Serengeti. He joined the UC Davis faculty in 1990 and is now an associate professor of wildlife, fish and conservation biology.

The year he came to UC Davis, Caro formally passed the cheetah project along to a London-based scientist. But he is not forgetting Africa. With two graduate students, he and his wife and son, now 4, will be leaving this summer to spend one year in Katavi National Park, in western Tanzania, four days drive from the nearest international airport. There, Caro will work on animal behavior and conservation biology

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and Borgerhoff Mulder can apply her work in evolutionary anthropology to conservation issues.

To structure his transition from behavioral ecology to conservation, Caro has begun a book project addressing the relationship between the two disciplines. He has invited 25 behavioral ecologists, including four from UC Davis, to contribute chapters that discuss how their work might apply to conservation and population management, weaving together for the first time in print two traditionally separate fields. He already teaches an upper-division undergraduate course on conservation biology.



During his cheetah studies, Caro grew deeply attached to the land and its residents. "Going to sleep in the back of the vehicle surrounded by thousands of wildebeests stretching as far as the eye can see, hearing them gallop off en masse in the night as the whoops of spotted hyenas get louder, or waking up to the vibrations of a cheetah cub chewing on my tire meant that I gained a close appreciation of the lives of some of these species, perhaps all the more so because I was on my own with them," Caro writes.

In the small Serengeti research community, most conversations those days led to talk about the biology and politics of conservation. Caro arrived in Africa interested in pure biology, but he quickly became impressed by the power of individual people to take small steps toward perpetuating wild places like the Serengeti.

The fate of cheetahs and other threatened wildlife became more urgent to Caro when his son, Barnabas, was born. "I started to think seriously about what will be here in a thousand years' time," Caro says.

The last chapter in his book reflects this new sense of mission in applying biological techniques to conservation. "We already know a great deal about the ecology and behavior of free-living cheetahs, much more than about most endangered species, and while detailed studies of individuals in their natural habitat raise new questions about evolution and ecology, they fail to address the conservation of the species head on," writes Caro. "My advice is to get involved in reintroduction programs or ecological monitoring or enter the world of conservation politics, especially at a local level, rather than fiddling while Rome burns."



Caro fits a radio collar to a cheetah for more detailed study.



Two male cheetahs groom each other before setting off for a hunt.



Caro and his son explore the next research site in Katavi.



Caro left the Serengeti with nearly 10,000 photographs, mostly unsorted and unidentified. He found an answer to sorting those 10,000 cheetah photos in England, where he enlisted the aid of a couple of computer programmers to adapt a system they had developed for identifying whales and seals.

Each photo was videotaped, and the digitized images were stored on a computer. With a custom program for cheetahs, the computer then literally identified the cheetahs by their spots.

