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Abstract: The desperate plight of the cheetah has highlighted a fundamental rift between ecologists and geneticists on how to help save endangered species. Since the early 1980s, O'Brien and many others have published a stream of scientific papers reporting the alarming fact that cheetahs are about as genetically similar as inbred laboratory mice, and that this hampers their ability to reproduce and survive both in captivity and in the wild. However, independent researchers found that the cheetah is not especially impoverished and there is no evidence that genetic deficiencies contributed to poor reproduction or high infant mortality. According to their opinion, "the preoccupation with genetics diverts attention from the real threat to the cheetah's future, which is loss of its habitat".

A strategy for survival?

The desperate plight of the cheetah has highlighted a fundamental rift between ecologists and geneticists on how to help save endangered species

Roger Lewin

THE cheetah, the world's swiftest sprinter, is a symbol of superior biological design. This lean cat reaches its top speed of 112 kilometres an hour within seconds from a standing start, propelled by powerful legs and fuelled by enlarged lungs, heart and adrenals. An image of a cheetah, sitting alert atop a knoll, surveying the savanna for prey, captures what it means to be wild and free.

Yet the cheetah's future survival is precarious at best, and at worst, a lost cause. Its natural habitat is rapidly vanishing in the wake of the human appetite for agricultural land. And the cheetah's predicament has stripped its genetic heritage to a minimum, leaving it susceptible to disease, incapable of reproducing successfully either in the wild or in captivity, and lacking the evolutionary potential to adapt to different environments.

"It's true, the cheetah's plight, particularly its genetic impoverishment, came to symbolise our perception of endangered species, and where our concern about them should lie," says Stephen O'Brien, a geneticist at the US National Cancer Institute, Maryland. Since the early 1980s, O'Brien and many others have published a stream of scientific papers reporting the alarming fact that cheetahs living thousands of kilometres apart—in southern and East Africa—are about as genetically similar as inbred laboratory mice.

Top priority

Biologists have long believed that genetic diversity is fundamental to a species' biological fitness and healthy survival. The absence of diversity was assumed to spell disaster for the health of an impoverished population. As a result, genetic diversity has come to be a top priority in conservation biology.

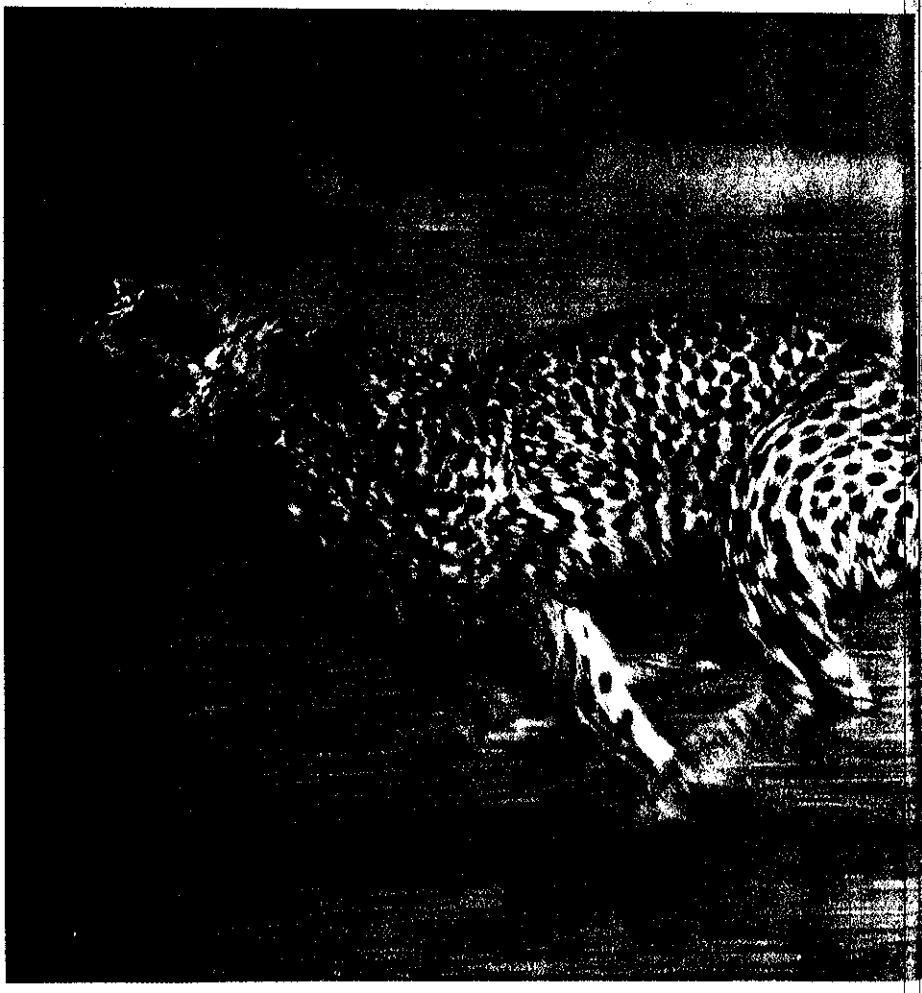
Recently, however, the intellectual foundation of O'Brien's theories have come under attack. What was once accepted as gospel has been described in separate critiques as "a loosely strung chain of poorly established findings" and as "not meeting the minimum standards of evidence".

Even O'Brien's former collaborators and coauthors have joined the fray. Tim Caro, an ecologist at the University of California at Davis, described some of O'Brien's analyses as "severely flawed".

O'Brien portrays the criticisms as "spurious and fallacious arguments". He wrote of a prominent paper in the journal *Conservation Biology* (vol 8, p 961) that it was "a rambling, self-contradictory polemic that has so many misstatements, misinterpretations, disciplinary prejudices, and errors of omission as to be misleading (at best) and a disservice to the readers". The paper, by Michelle Merola, an ecologist at the University of New Mexico, is "an embarrassment" and "should never have been published", fumes O'Brien.

When researchers set about each other in this way, there is more at stake than the objective assessment of data and technical standards. In this case, there is a turf war going on, with geneticists pitted against ecologists over the priorities in conservation. In the bad old days, the ecologists' story goes, if you were interested in saving endangered species you had to focus exclusively on their genetic health. Now, they urge, you should forget genetics and simply concentrate on the real ecological problems—that is, preserving habitat.

Beyond the rhetoric, there are some real issues. First, cheetahs are facing the prospect of extinction in the wild, so



conservationists need to know the cause of their decline if they are to stop it. Secondly, the captive breeding of cheetahs has been a miserable failure: the zoo population is unable to sustain itself. What is the cause of this failure? How can it be reversed?

O'Brien first became involved with cheetahs in the early 1980s, when the De Wildt Cheetah Breeding and Research Centre in South Africa, invited him and several colleagues to try to find out why only one in ten cheetahs that had been caught in the wild would bred in captivity, and why more than a third of the offspring never reached maturity. They quickly found that the cheetahs' sperm count was just a tenth of that in domestic cats and of the viable sperm, almost 80 per cent were abnormal, compared with the usual 29 per cent in domestic cats. These facts alone seemed to explain the cheetah's poor reproduction. They also pointed to an underlying cause. Sperm abnormalities like these are often seen in highly inbred animals.

So O'Brien and his colleagues ran tests to find out whether cheetahs are inbred, with very low genetic variation. In one test, they examined the structure of more than 200 different proteins from cheetahs in zoos in South Africa, Europe and the US. In typical mammals, as many as a third of the proteins would be expected to show some variety in structure within the population. In the cheetahs, there was virtually no variation. Inbreeding also often causes asymmetry in structures such as the head, with, say, the right eye socket being different from the left. Robert Wayne, one of O'Brien's colleagues, found just such unevenness in a large sample of cheetah skulls in museum collections.

The most startling discovery, however, was the fact that cheetahs accepted skin grafts from unrelated individuals. In animals in which the immune defences are genetically diverse, such grafts are usually rejected within 10 to 12 days. The grafts survived at least 20 days in cheetahs, some much longer.

'The preoccupation with genetics diverts attention from the real threat to the cheetah's future, which is loss of its habitat'

Within a few years of embarking on the project, O'Brien and his colleagues seemed to have the answers: cheetahs are genetically impoverished, and this hampers their ability to reproduce and survive both in captivity and in the wild.

Population bottleneck

The cause of the cheetah's current plight, O'Brien and his colleagues speculated, was probably a series of recent population crashes. During these crashes, which are also called population bottlenecks, a large proportion of the population dies off. Although the numbers may recover, the passage through the bottleneck robs the population of some of its genetic variability. "It's like a poker game," says O'Brien. "With just a few cards in your hand, there's a lot less variability than in the whole pack. You may be lucky and be dealt a good hand, but usually you're not."

Ten thousand years ago, cheetahs roamed across large parts of the world, but most of them perished after the end of the Ice Age. More recently, the species has suffered from hunting and loss of its habitat. So O'Brien's hypothesis of a series of crippling bottlenecks looked extremely plausible. The geneticist's version of the cheetah's story entered conservation lore and biology textbooks.

There matters remained until a couple of years ago, when independent researchers tore into O'Brien. Merola and Australian ecologist Graeme Caughley both surveyed the bulk of the genetic work and said the cheetah is not especially impoverished—adding "even if it is, it doesn't imperil the species, either in the wild or in captivity". There was no evidence that genetic deficiencies contributed to poor reproduction or high infant mortality, they concluded. Neither author had carried out any direct research, but they had examined O'Brien's reports and found them wanting. "My main concern," says Merola, "is that the preoccupation with genetics diverts attention from the real threat to the cheetah's future, which is loss of its habitat."

Meanwhile, in October last year Caro, and his colleague Karen Laurensen from the University of Stirling, who have spent years studying cheetah behaviour in the Tanzanian Serengeti, also concluded that O'Brien has got it wrong (*Conservation Biology*, vol 9, p 1329). Instead, they say, "predation is the key source of mortality". Only about 5 per cent of cheetah cubs live a year, say Caro and Laurensen. The great majority of them die in the jaws of lions and hyenas—deaths which cannot be attributed to defective genes.

O'Brien says that when the researchers first reported their data, half the deaths could not be definitively accounted for. He also suggested that the ecologists' presence at cheetahs' lairs probably alerted lions to the location of a potential meal, thus artificially increasing the level of predation. Caro and Laurensen vigorously deny this.

In zoos, the spotlight has also shifted away from genetic factors as the cause of the cheetah's problems. Efforts to make the breeding situation more natural have begun to boost success rates, sometimes dramatically. For instance, in December last year, Donald Lindburg of the San Diego Zoo, said that "there is nothing inherently wrong with them, only with the way they are handled". The remark was based on the demonstration at the zoo that even with low sperm counts and high rates of sperm abnormality, males can sire offspring easily. O'Brien is sceptical, and says that it would be a miracle if the low sperm counts and high levels of abnormality did not affect reproduction.

In March last year, the eminent Oxford ecologist Robert May—now the government's chief scientific adviser—said "O'Brien's case is persuasive". Nevertheless, he said, its impact on captive breeding is probably less important than better management. The bottom line, in May's opinion, is that low genetic diversity does compromise the future of the species, especially since it leaves them very susceptible to disease. Noting that the maintenance of habitat is the prime concern of conservationists, he concluded that genetic diversity "remains an important consideration for many conservation programmes, and particularly for cheetahs".

An important shift in priorities is taking place. Genetic factors are giving way to ecology and management practices in conservation. O'Brien says that he never claimed that genetics held the entire answer, and agrees that habitat loss "is the primary concern for the species' future". □

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