



THE NEW TOP DOG

Shape-shifting coyotes have evolved to take advantage of a landscape transformed by people. Scientists are now discovering just how wily the creatures are.

Near the dawn of time, the story goes, Coyote saved the creatures of Earth. According to the mythology of Idaho's Nez Perce people, the monster Kamiah had stalked into the region and was gobbling up the animals one by one. The crafty Coyote evaded Kamiah but didn't want to lose his friends, so he let himself be swallowed. From inside the beast, Coyote severed Kamiah's heart and freed his fellow animals. Then he chopped up Kamiah and threw the pieces to the winds, where they gave birth to the peoples of the planet.

European colonists took a very different view of the coyote (*Canis latrans*) and other predators native to North America. The settlers hunted wolves to extinction across most of the southerly 48 states. They devastated cougar and bobcat populations and attacked coyotes. But unlike the other predators, coyotes have thrived in the past 150 years. Once restricted to the western plains, they now occupy most of the continent and have invaded farms and cities, where they have expanded their diet to include squirrels, household pets and discarded fast food.

Researchers have long known the coyote as a master of adaptation, but studies over the past few years are now revealing how these unimposing relatives of wolves and dogs have managed to succeed where many other creatures have suffered. Coyotes have flourished in part by exploiting the changes that people have made to the environment, and their opportunism goes back thousands of years. In the past two centuries, coyotes have taken over part of the wolf's former ecological niche by preying on deer and even on an endangered group of caribou. Genetic studies reveal that the coyotes of northeastern America — which are bigger than their

BY SHARON LEVY

cousins elsewhere — carry wolf genes that their ancestors picked up through interbreeding. This lupine inheritance has given northeastern coyotes the ability to bring down adult deer — a feat seldom attempted by the smaller coyotes of the west.

The lessons learned from coyotes can help researchers to understand how other mid-sized predators respond when larger carnivores are wiped out. In sub-Saharan Africa, for example, intense hunting of lions and leopards has led to a population explosion of olive baboons, which are now preying on smaller primates and antelope, causing a steep decline in their numbers.

Yet even among such opportunists, coyotes stand out as the champions of change. "We need to stop looking at these animals as static entities," says mammalogist Roland Kays of the North Carolina Museum of Natural Sciences in Raleigh. "They're evolving."

At a fast rate, too. Two centuries ago, coyotes led a very different life, hunting rabbits, mice and insects in the grasslands of the Great Plains. Weighing only 10 to 12 kilograms on average, they could not compete in the forests with the much larger grey wolves (*Canis lupus*), which are quick to dispatch coyotes that try to scavenge their kills.

The big break for coyotes came when settlers pushed west, wiping out the resident wolves. Coyotes could thrive because they breed more quickly than wolves and have a more varied diet. Since then, their menu has grown and so has their range; they have invaded all the mainland United States (with the exception of northern Alaska) and Mexico, as

Wolf genes make the coyotes of northeastern North America bigger and stronger than those elsewhere.

KITCHIN AND HURST/ALL CANADA PHOTOS/CORBIS

well as large parts of southern Canada (see 'On the move').

The animals that arrived in the northeastern United States and Canada in the 1940s and 50s were significantly larger on average than those on the Great Plains, sometimes topping 16 kilograms. Kays and his colleagues studied the rapid changes in coyote physique by analysing mitochondrial DNA and skull measurements of more than 100 individuals collected in New York state and throughout New England. They found¹ that these northeastern coyotes carried genes from Great Lakes wolves, showing that the two species had interbred as the coyotes passed through that region. "Coyotes mated with wolves in the 1800s, when wolf populations were at low density because of human persecution," says Kays. In those circumstances, wolves had a hard time finding wolf mates, so they settled for coyotes.

Compared with the ancestral coyotes from the plains, the northeastern coyote-wolf hybrids have larger skulls, with more substantial anchoring points for their jaw muscles. Thanks in part to those changes, these beefy coyotes can take down larger prey; they even killed a 19-year-old female hiker in Nova Scotia in 2009. The northeastern coyotes have expanded their range five times faster than coyote populations in the southeastern United States, the members of which encountered no wolves as they journeyed east.

NEW TO THE CITY

Coyotes have even moved into Washington DC, appearing in Rock Creek Park in 2004, just a few miles from the White House. Christine Bozarth, a conservation geneticist at the Smithsonian Institution in Washington, has tracked their arrival and has shown that some of them are descended from the larger northeastern strain and carry wolf DNA². Bozarth says the coyotes are there to stay. "They can adapt to any urban landscape; they'll raise their pups in drainage ditches and old pipes," she says. She hopes that the coyotes will help to control the deer, whose numbers are booming. But Kays says that coyotes have not made a significant dent in the northeast's deer population. "Coyotes fill part of the empty niche, but they don't completely replace wolves," he says.

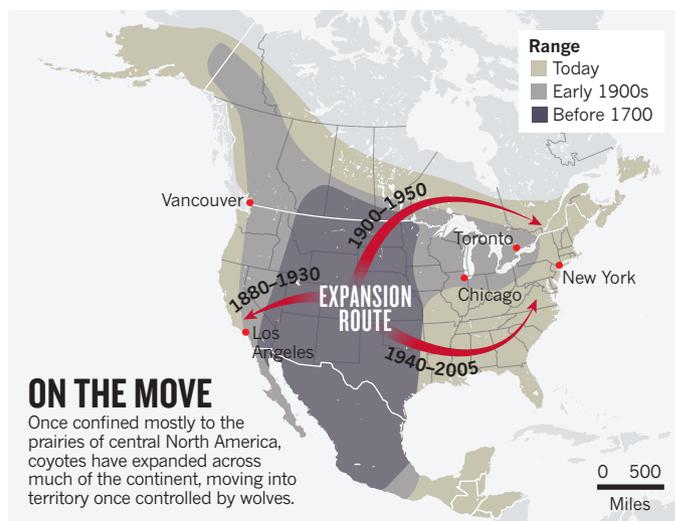
Oddly enough, it is the smaller coyotes in the southeastern United States that seem to be having a real impact on deer. About the same size as western coyotes, the southeastern ones have begun to exploit a niche left empty by the red wolves (*Canis lupus rufus*) that once roamed the southeast and specialized in hunting the region's deer, which are smaller than those in the northeast.

John Kilgo, a wildlife biologist with the US Forest Service in New Ellenton, South Carolina, and his colleagues found in a 2010 study³ that South Carolina's deer population started to decline when coyotes arrived in the late 1980s. More recently, he and his colleagues have studied deaths among fawns, using forensic techniques right out of a murder investigation⁴. They analysed bite wounds on the carcasses and sequenced DNA in saliva left on the wounds. They also searched for scat and tracks left by the killers and noted how they had stashed uneaten remains. More than one-third of the fawn deaths were clearly caused by coyotes, and circumstantial evidence suggests that the true number might be closer to 80%. "Coyotes are acting as top predators on deer, and controlling their numbers," says Kilgo.

At first, many researchers had a hard time accepting that conclusion because they thought that coyotes were too small to affect deer populations, Kilgo says. He hopes to study how the newly arrived coyotes will affect other members of the southeastern ecosystem, including wild turkeys and predators such as raccoons, foxes and opossums.

There is no danger that the southeastern coyotes will drive the abundant deer in that region to extinction. But at the northern extreme of their range, coyotes are threatening a highly endangered band of woodland caribou (*Rangifer tarandus caribou*) in the mature forests of Quebec's Gaspésie National Park. Logging and other changes there had taken a toll on the caribou even before coyotes arrived in the region in 1973 and settled into newly cleared parts of the forest. But then coyotes started hunting caribou calves and the population dropped even further.

A 2010 study⁵ found that coyotes accounted for 60% of the predation



SOURCE: COOK COUNTY, ILL., COYOTE PROJ. & S. GEHRT, OHIO STATE UNIV.

on these caribou, which now number only 140. Dominic Boisjoly, a wildlife biologist with Quebec's Ministry of Sustainable Development, Environment and Parks in Quebec City, says that the best way to protect the caribou would be to cease clear-cutting of the forest, thereby denying the predators a home.

Coyotes have been taking advantage of the changes wrought by humans for many thousands of years, according to a study of coyote fossils published this year⁶. Evolutionary biologist Julie Meachen at the National Evolutionary Synthesis Center in Durham, North Carolina, and Joshua Samuels at the John Day Fossil Beds National Monument in Kimberly, Oregon, made that discovery by measuring the size of coyote fossils dating back over the past 25,000 years. During the last ice age, coyotes were significantly larger than most of their modern counterparts and resembled the biggest of the present-day coyote-wolf hybrids in the northeast. They probably scavenged meat from kills made by dire wolves and sabre-toothed cats, and preyed on the young of the large herbivores, such as giant ground sloths, wild camels and horses, that thronged North America at that time.

But at the close of the ice age, about 13,000 years ago, most of the megafauna vanished — an extinction attributed to both climate change and the appearance of efficient Stone Age hunters. With them went the largest predators, allowing the smaller grey wolves to fill the vacant niche, which put them in competition with the largest coyotes. That conflict, as well as the loss of large herbivores, caused coyotes to shrink in stature. Within 1,000 years of the Pleistocene extinctions, coyotes had reached the same size as in most present-day populations.

Now, they're going through a whole new set of changes as they adapt to the modern landscape of North America. Genetic studies⁷ show that some coyotes are even interbreeding with dogs, which could lead to a different sort of hybrid animal. Researchers are struggling to keep up with the animals and their impacts as they lope into more new regions.

"Invading a landscape emptied of wolves may trigger a whole new pathway in terms of the coyote's evolution," says Bill Ripple, an ecologist at Oregon State University in Corvallis. "And the coyote's arrival will have unpredictable effects on other species in the ecosystem." ■

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1. Kays, R., Curtis, A. & Kirchman, J. J. *Biol. Lett.* **6**, 89–93 (2010).
2. Bozarth, C. A. et al. *J. Mammal.* **92**, 1070–1080 (2011).
3. Kilgo, J. C., Ray, H. C., Ruth, C. & Miller, K. V. *J. Wildlife Manage.* **74**, 929–933 (2010).
4. Kilgo, J. C. et al. *J. Wildlife Manage.* (in the press).
5. Boisjoly, D., Ouellet, J.-P. & Courtois, R. *J. Wildlife Manage.* **74**, 3–11 (2010).
6. Meachen, J. A. & Samuels, J. X. *Proc. Natl Acad. Sci. USA* **109**, 4191–4196 (2012).
7. vonHoldt, B. M. et al. *Genome Res.* **21**, 1294–1305 (2011).