Big vegetarian mammals can play a critical role in maintaining healthy ecosystems, study finds

January 17 2007

Removing large herbivorous mammals from the African savanna can cause a dramatic shift in the relative abundance of species throughout the food chain, according to scientists from Stanford University, Princeton University and the University of California-Davis. Their findings were published in the Jan. 2 edition of *Proceedings of the National Academy of Sciences* (PNAS).

In the study, the research team used large electric fences to exclude cattle, elephants, zebras and other herbivorous mammals from experimental plots on a ranch in central Kenya from May 2004 to December 2005. During that time, the scientists monitored changes in the populations of trees, beetles, lizards and other plant and animal species.

"All of the species studied increased in abundance in the absence of large plant-eating mammals," said lead author Robert Pringle, a graduate student in the Department of Biological Sciences at Stanford. These results are examples of what ecologists call cascading effects, he added.

Although elephants and zebras do not interact directly with insects, they share plants as a food source, Pringle noted. Previous studies have shown that when elephants and zebras are experimentally removed or hunted out, plant matter accumulates and insect populations increase.

"With an increase in insects comes an increase in the insects' predators, such as lizards," Pringle said. "Thus, the actions of a few dominant species ripple throughout the ecosystem."

The authors also found that the strength of the cascading effects varied considerably across the landscape, and that it was possible to predict where the effects would be weak or strong in terms of "primary productivity"—the transformation of solar energy into plant tissue during photosynthesis. Plants in areas of high primary productivity grow faster, making more energy available throughout the food chain. The study revealed that cascading effects are weaker in places where productivity is high, probably "because more productive plant communities absorb the impacts of herbivory and buffer the remainder of the community," the authors wrote.

"For years, ecologists debated whether cascading effects occurred in terrestrial environments, and even then, most studies centered around the activities of top carnivores, such as wolves," Pringle said. "While top predators are undeniably important to ecological function, this new study shows that large herbivores can also play critical roles."

Extinctions, past and present

The PNAS study is timely for several reasons, he added: "Large herbivorous mammals are declining throughout Africa and worldwide, and have already gone extinct in many places. Our results suggest that these declines are likely to have complicated, and often unanticipated, consequences for the entire ecosystem."

North America is one place where mammoths, giant sloths, camels and other large herbivores once were common. But most of these mega-fauna species were eliminated during the Pleistocene epoch that ended about 10,000 years ago, raising questions about how these extinctions

affected ecological processes. According to the authors, the cascading effects demonstrated in the experiment may have been important "in the history and evolution of ecosystems that today are bereft of large herbivores, and that although many of these cascades went extinct at the end of the Pleistocene along with the large herbivores that caused them, their legacies may well remain."

In 2005, another team of scientists made headlines by advocating a program of "Pleistocene re-wilding"—introducing large mammals from Africa and elsewhere into North America to simulate the lost Pleistocene fauna. Pringle made clear that his team's results do not speak to the wisdom of re-wilding. Nevertheless, he said, the new study should serve as a reminder that "the ecology we observe today is a product of history," and that humans have long played a leading role in that history.

"Humanity faces a lot of important decisions about how to manage Earth's ecosystems in the next few decades," he said. "By studying the ecology of places like Africa, where large mammals still exist, we can get glimpses of how life used to be organized in places like Europe and North America, and those inferences help explain phenomena that would otherwise seem strange. Snapshots of ecological history, even if from another continent, can help guide us to more robust conclusions about today's ecosystems and their conservation management."

Other co-authors of the PNAS paper are Truman P. Young of UC-Davis, Daniel I. Rubenstein of Princeton and Douglas J. McCauley, a Stanford graduate student. The study was conducted at the Mpala Research Centre in Nanyuki, Kenya. Support was provided by the Smithsonian Institution, National Geographic Society, National Science Foundation, U.S. Fish and Wildlife Service, William R. and Sara Hart Kimball Stanford Graduate Fellowship and Sherwood Family Foundation.

Source: Stanford University