Ancient bones point to shifting grassland species as climate changes

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CORVALLIS, Ore. - More rainfall during the growing season may have led to one of the most significant changes in the Earth's vegetation in the distant past, and similar climate changes could affect the distribution of plants in the future as well, a new study suggests.

In a report in Science Advances, an analysis was done of mammoth and bison hair, teeth and bones, along with other data. It concludes that a changing climate -- particularly increasing rainfall and not just atmospheric carbon dioxide -- explains the expansion of grassland plants during the latter part of the Neogene, a geologic era that includes the present.

The research was led by Jennifer Cotton as a post-doctoral researcher at the University of Utah and in the College of Forestry at Oregon State University. She is now an assistant professor at the California State University, Northridge.

Scientists have long known that some grassland species became more abundant during this period, including the ancestors of corn, sugar cane and sorghum. Known as C_4 grasses, they use a different method of metabolism via photosynthesis from most other types of vegetation, called C_3 grasses. They tend to thrive under warm, moist conditions, in addition to low levels of carbon dioxide in the atmosphere.

"The point of the work was to understand what drove one of the most dramatic biological transitions in the past 65 million years, and also to better understand the past so that we can make predictions about the future," said Cotton. "We know that the balance between C_3 and C_4 grasses is controlled by both atmospheric CO_2 and climate, but the relative influence of each of these factors has not been clear.

To understand what drove that transition, the researchers analyzed carbon isotopes in 632 samples of bison and mammoth tissues from across North America over the past 18,000 years, corresponding to the time between the peak of the last ice age to

the present. The researchers were able to show that, over time, the animals' diets shifted toward more C_4 plants and those plants gradually spread north.

By combining their findings with data on climate, temperature and changing carbon dioxide concentrations, the researchers showed that increasing precipitation during the growing season was the single most important factor in the spread of C_4 grasses. In recent years, increases in rainfall and temperature have enabled farmers to grow corn in the upper Midwest in areas dominated by wheat.

"Both atmospheric CO_2 and climate have been changing and will continue to change in the future," said Cotton, "and many have suggested that additional CO_2 in the atmosphere will benefit C_3 grasses, causing them to outcompete C_4 grasses. Our results suggest that climate, rather than CO_2 fertilization, will drive future changes to C_3 and C_4 grass distributions, which will likely benefit C_4 grasses in much of the Great Plains."

The National Science Foundation provided funding for the research. Cotton's co-authors included Christopher J. Still and Thomas M. Mosier at Oregon State, Thure E. Cerling at the University of Utah and Kathryn A. Hoppe at the University of Washington.

The paper is online at http://advances.sciencemag.org/content/2/3/e1501346.

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