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update

Feces, fungus, and the fall of megafauna

We live in strange times. For millions of years, continents and islands hosted many very large animals (e.g., mammoths, giant sloths, gorilla-sized lemurs, rhino-sized wombats), but beginning 50,000 years ago, extinctions swept away this diversity everywhere except Africa. Relative to earlier extinctions, this event was unprecedented in its selectivity against large animals. In most affected areas, the extinction postdated the arrival of modern *Homo sapiens*. This pattern and chronology implicate humans as drivers of the extinction, but the nature of their impacts (hunting, habitat alteration, introduced species, etc.) is unclear. In the Americas and Eurasia, the extinction coincided with climate and ecosystem changes that may have exacerbated human impacts. The close temporal coincidence of anthropogenic, biotic, and climatic events at the end of the Pleistocene has made it hard to test specific extinction hypotheses and has obscured the ecological repercussions of losing so many large animals.

A recent paper by Gill et al. (2009) tackles these issues with a new proxy for large animal abundance that is microscopic. Large herbivore dung is infested by a fungus, *Sporormiella*, that sheds spores that are found in sedimentary records along with the pollen and charcoal that are used to reconstruct vegetation and fire history. *Sporormiella* (and presumably large herbivore) abundance began to decline in the northeastern U.S. at the first appearance of humans (~14.8 ka), reaching trace levels by 13.7 ka. This crash in abundance precedes 1) the appearance of "non-analog" floras at 13.7 ka, 2) increased fire at 13.7 and 10.5 ka, 3) the appearance of the sophisticated Clovis tools at 13.1 ka, 4) the onset of Younger Dryas cooling and 5) the final extinction of the large mammals, both ~12.9 ka.

This chronology falsifies hypotheses that link population declines to the Younger Dryas event or dietary problems associated with non-analog floras. Instead, it raises the possibility that a human-induced large herbivore crash contributed to the unusual non-analog floras and to increased fuel loads that spurred fires. The study has some minor weak spots: the ^{14}C chronology is messy (though the relative timing of events is unlikely to change), the quantitative relationship between animal and spore abundance is complicated, and the big change in fire regime is at 10.5 ka, long after large mammals have vanished. Still, this promising approach may illuminate how our strange, large–animal depauperate ecosystems came to be, as well as the consequences of losing so many co-evolutionary partners and potential ecosystem engineers.

Gill J.L., Williams J.W., Jackson S.T., Lininger K.B., & Robinson G.S. (2009) Pleistocene Megafaunal Collapse, Novel Plant Communities, and Enhanced Fire Regimes in North America. Science, 326, 1100 – 1103.

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