Scientists use fossilized feces to reconstruct moa diet

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Giant Haast's eagle attacking New Zealand moa. Artwork: John Megahan. Copyright: PLoS Biology. Via Wikipedia.

(Phys.org) —Until it became extinct in the 15th century, the moa, a flightless bird, played a significant role in New Zealand's ecology. In a study published in the *Proceedings of the National Academy of Sciences*, Alan Cooper of the University of New South Wales in Sydney and his colleagues reveal they have used coprolites to reconstruct the dietary habits of four moa species. They determined how the moa's extinction has affected New Zealand's ecosystems and considered whether any existing species can take its place.

In the past 50,000 years, many large herbivores, which play an integral part in shaping vegetation communities, have become extinct. By

analyzing fossilized feces, or coprolites, scientists can determine what these animals ate and gain a better understanding of the ecological impact of their extinctions. Cooper and his team chose to study the moa because it was the largest herbivore in New Zealand before humans arrived in the 13th century, and moa coprolites are relatively easy to find.

The team examined 51 coprolites found at Daley's Flat in the Dart River Valley in South Island. Radiocarbon dating and analysis of ancient DNA (aDNA) revealed that the coprolites belonged to at least 22 individuals of 4 different species: the South Island giant moa (*Dinornis robustus*), the upland moa (*Megalapteryx didinus*), the heavy-footed moa (*Pachyornis elephantopus*) and the little bush moa (*Anomalopteryx didiformis*). Before the moa became extinct, nine species lived on New Zealand. This is the first time scientists have been able to study more than one species at a single site.

When the researchers examined fossilized plant materials, pollen and plant aDNA found in the coprolites, they found significant differences in the diets of the four species. They were able to create ecological models explaining how all four could coexist near Daley's flat. While the bush moa found its food in the forests, the heavy-footed moa restricted itself to plants in open herb fields. The South Island giant moa and the upland Moa ate plants from both forests and fields. The South Island giant moa may have eaten low-quality fibrous plant matter that the other, smaller moas would not have been able to digest. The upland moa's diet may have varied seasonally.

The team believe the extinction of the South Island giant moa would have changed the forest canopy and understory, while the extinction of the shorter upland and bush moas would have affected the understory. The extinction of the heavy-footed moa would have caused the loss of herbs that depend on animals for seed dispersal. The researchers found

that no living herbivore can fulfill all of these species' ecological roles. The ecological changes stemming from their extinctions are irreversible.

More information: Resolving lost herbivore community structure using coprolites of four sympatric moa species (Aves: Dinornithiformes), *PNAS*, Published online before print September 30, 2013, DOI: 10.1073/pnas.1307700110

Abstract

Knowledge of extinct herbivore community structuring is essential for assessing the wider ecological impacts of Quaternary extinctions and determining appropriate taxon substitutes for rewilding. Here, we demonstrate the potential for coprolite studies to progress beyond single-species diet reconstructions to resolving community-level detail. The moa (Aves: Dinornithiformes) of New Zealand are an intensively studied group of nine extinct herbivore species, yet many details of their diets and community structuring remain unresolved. We provide unique insights into these aspects of moa biology through analyses of a multispecies coprolite assemblage from a rock overhang in a montane river valley in southern New Zealand. Using ancient DNA (aDNA), we identified 51 coprolites, which included specimens from four sympatric moa species. Pollen, plant macrofossils, and plant aDNA from the coprolites chronicle the diets and habitat preferences of these large avian herbivores during the 400 y before their extinction (?1450 AD). We use the coprolite data to develop a paleoecological niche model in which moa species were partitioned based on both habitat (forest and valley-floor herbfield) and dietary preferences, the latter reflecting allometric relationships between body size, digestive efficiency, and nutritional requirements. Broad ecological niches occupied by South Island giant moa (Dinornis robustus) and upland moa (Megalapteryx didinus) may reflect sexual segregation and seasonal variation in habitat use, respectively. Our results show that moa lack extant ecological analogs, and their extinction represents an irreplaceable loss of function from

New Zealand's terrestrial ecosystems.