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Official publication of The Australian Rangeland Society

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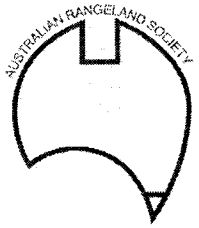

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EVIDENCE FOR A SUDDEN LOSS OF GRASSLANDS IN THE LAKE EYRE BASIN COINCIDENT WITH EUROPEAN SETTLEMENT

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The stable carbon isotopic composition ($\delta^{13}C$) of herbivore tissue (e.g., eggshell, bone, and teeth) reflects the $\delta^{13}C$ of the animal's diet offset by a biochemical fractionation. In Australia, most plants utilize either the C3 (Calvin) or C4 (Hatch-Slack) photosynthetic pathway and have characteristic $\delta^{13}C$ values. The average $\delta^{13}C$ value of C3 plants approximates –27‰ and the average $\delta^{13}C$ value of C4 plants approximates -13‰. C4 plants are predominantly grasses adapted to growth seasons with high temperatures and summer-dominated precipitation regimes, whereas C3 plants include most trees and shrubs and those grasses adapted to cool/temperate growth seasons. Thus, the $\delta^{13}C$ values of Australian generalist herbivore tissues, which reflects that of the ambient vegetation, should become increasingly positive in areas with increasing abundance of C4 grasses.

In the semi-arid zone of Australia the most abundant and best-preserved organic remains are eggshells of the large flightless birds, *Dromaius* (emu) and the extinct *Genyornis*. Because eggshells can be easily dated directly by AMS ^{14}C and their carbon is derived from the birds' food, these biominerals offer a unique opportunity to monitor vegetation change over the past 40 ka (ka = thousand years). We measured $\delta^{13}C$ in organic and inorganic fractions of eggshells laid by farm-raised emu fed a diet of known $\delta^{13}C$ to compute fractionation factors for organic and inorganic carbon. We use the $\delta^{13}C$ values of modern emu eggshell (n=100), collected from multiple sites across Australia, to test whether emu diets reflect the isotopic composition of ambient vegetation. Additionally, we use the $\delta^{13}C$ values of fossil emu eggshell collected from the Madigan Gulf (MG) region of Lake Eyre to monitor changes in regional vegetation patterns through the Holocene.

Modern emu eggshells from cool regions dominated by winter rainfall have the most negative $\delta^{13}C$ values, whereas those from the plains of northwestern Queensland have the most positive $\delta^{13}C$ values, consistent with C4 grass distributions. At MG, a large series of eggshells (n=20) laid over the past 25 years have $\delta^{13}C$ values indicating that emu diets in recent decades have been dominated by C3 plants ($\geq$ 80%), consistent with the current distribution of C3/C4 biomass at MG.

Between 10 and 5 ka, emu eggshell from MG indicate high isotopic variability and lack any consistent trend; the proportion of C4 grasses in the birds' diets ranged between 20 and 60%. Eggshell laid between 1 and 2 ka (n=7) and as recently as 150 years ago (n=2) are systematically more positive than the rest of the Holocene and reflect a diet comprised of 50% C4 grass. These results are in stark contrast to the 20 modern samples collected from the same region that strongly reflect a dominance of C3 plant uptake (all $\geq$80%). Not since the last glacial maximum has the proportion of grass in emu diets been consistently so small. The sample sizes are sufficiently large to conclude that the observed differences in eggshell $\delta^{13}C$ represent significant changes in the vegetation available to the egg-laying birds in the past 150 years. Changes in $\delta^{13}C$ between the early and late Holocene may be related to intensification of ENSO variability over these time frames.

We suggest that within the past 150 years there has been a major change in ecosystems in the vicinity of Lake Eyre, which has resulted in nearly complete loss of C4 grasses from the diet of *Dromaius*. This change may be due to the introduction of rabbits and pastoral stock into the region. Matching detailed historical records of rabbit arrival and stock introductions to a more complete time-series of eggshell isotopic analyses covering the same time period might resolve the relative importance of rabbits and pastoral animals in this process.