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Was it the CO_2 or the sulfur that did it? The mechanism of mass extinction of continental vertebrates at the end-Triassic extinction.

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Eruption of the giant Central Atlantic Magmatic Province (CAMP) is temporally linked to the end-Triassic extinction (ETE) event (1,2,3,4,5). Proposed killing mechanisms for plants and marine biota have included both CO_2 (4) and sulfur aerosols (3,6). Here we examine the kill mechanisms of the CAMP for land animals where we seek to explain the selectivity of the extinctions.

One striking aspect of Late Triassic continental communities is the prominent latitudinal provinciality with diverse crurotarsians (crocodile-relatives) and other non-dinosaurs in the tropics and much higher dinosaur diversity in the higher latitudes (7). Only a very few crurotarsian lineages survived the ETE, and a near-homogenization of continental vertebrate assemblages ensued.

Background high CO_2 concentration in the Late Triassic resulted in lack of polar ice and probably very high-temperature tropical continental interiors. While a doubling of CO_2 associated with CAMP eruptions produced a few degree increase in average temperatures (depending on the sensitivity), plausibly leading to some tropical lethality, how this produced a mass extinction in higher, cooler latitudes is harder to explain.

While successive CAMP eruptions contributed to CO_2 doublings over hundreds to thousands of years, taking two orders of magnitude longer to return to background, EACH major CAMP eruption produced an abrupt sulfur aerosol cooling lasting several years or decades, depending eruption duration. But there were many of these coolings as opposed to the few super-greenhouse warmings suggested by the CO_2 proxy data (4,5). The scale of these sulfur injections would have been orders of magnitude larger than anything seen historically (8) possibly leading to freezing tropical temperatures.

Both cruotarsians and dinosaurs as well as most other "reptiles", with their presumably uricotelic nitrogen waste systems (9) were been relatively resistant to heat induced water stress, but the former lack insolation, while the latter more likely had it (at least high latitudes forms), as did the closely related pterosaurs (also surviving the ETE). The long temporal wavelength of the super-greenhouse events should have allowed some crurotarsian migration, but there was nowhere to migrate to during the abrupt coolings. Thus, crurotarsian and other reptile extinctions of the ETE were a consequence of the extreme abrupt cold events, for which they had no adaptations, against background greenhouse and super-greenhouse conditions. In contrast, dinosaurs and their insulated relatives, as well as a few small crurotarsians and other non-dinosaurs, perhaps with burrowing habits, could better withstand the cold spells. This speculative scenario, in which both the CO_2 and sulfur contributed to the extinctions, is consistent with post-ETE global faunal homogenization, in which the higher latitude forms, especially dinosaurs, spread globally and took over the world.

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