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A high CO_2 -driven decrease in plant transpiration leads to perturbations in the hydrological cycle and may link terrestrial and marine loss of biodiversity: deep-time evidence.

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CO_2 is obtained and water vapor simultaneously transpired through plant stomata, driving the water uptake of roots. Stomata are key elements of the Earth's hydrological cycle, since a large part of the evapotranspiration from the surface to the atmosphere takes place via stomatal pores. Plants exercise stomatal control, by adjusting stomatal size and/or density in order to preserve water while maintaining carbon uptake for photosynthesis. A global decrease in stomatal density and/or size causes a decrease in transpiration and has the potential to increase global runoff.

Here we show, from 91 fossil leaf cuticle specimens from the Triassic/Jurassic boundary transition (Tr-J) of East Greenland, that both stomatal size and density decreased dramatically during the Tr-J, coinciding with mass extinctions, major environmental upheaval and a negative C-isotope excursion. We estimate that these developmental and structural changes in stomata resulted in a 50-60% drop in stomatal and canopy transpiration as calibrated using a stomatal model, based on empirical measurements and adjusted for fossil plants. We additionally present new field evidence indicating a change to increased erosion and bad-land formation at the Tr-J. We hypothesize that plant physiological responses to high carbon dioxide concentrations at the Tr-J may have increased runoff at the local and perhaps even regional scale. Increased runoff may result in increased flux of nutrients from land to oceans, leading to eutrophication, anoxia and ultimately loss of marine biodiversity. High-CO_2 driven changes in stomatal and canopy transpiration therefore provide a possible mechanistic link between terrestrial ecological crisis and marine mass extinction at the Tr-J.