A Combination of Plant Interactions and Climate Determines Plants.

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Introduction

We are interested in how plant traits are linked to ecological strategies and evolution of different species. Our research also explores the effect of environmental gradients on plant biodiversity and community composition, across a wide variety of ecosystems including floodplain meadows, Cape flora and agroforestry systems.

Climate extremes will elicit responses from the individual to the ecosystem level. However, only recently have ecologists begun to synthetically assess responses to climate extremes across multiple levels of ecological organization. We review the literature to examine how plant responses vary and interact across levels of organization, focusing on how individual, population and community responses may inform ecosystem-level responses in herbaceous and forest plant communities. We report a high degree of variability at the individual level, and a consequential inconsistency in the translation of individual or population responses to directional changes in community- or ecosystem-level processes. The scaling of individual or population responses to community or ecosystem responses is often predicated upon the functional identity of the species in the community, in particular, the dominant species. Furthermore, the reported stability in plant community composition and functioning with respect to extremes is often driven by processes that operate at the community level, such as species niche partitioning and compensatory responses during or after the event. Future research efforts would benefit from assessing ecological responses across multiple levels of organization, as this will provide both a holistic and mechanistic understanding of ecosystem responses to increasing climatic variability.

An emergent consequence of global climate change has been the increase in the frequency and severity of climate extremes. Climate extremes, such as drought, heavy precipitation, heat waves and cold snaps, have the potential to produce large impacts to ecosystem dynamics. However, the type and magnitude of ecological impacts resulting from climate extremes, both within and among ecosystems are highly variable. With regard to plant responses, the variation can range from changes to species population genetics. altered local species richness rapid shifts in Eco tone boundaries to continental-scale reductions in gross primary production. Implicit in these examples is the necessary consideration of the scale of the measurement. Ecologists have long recognized that the scale of an observation can significantly influence conclusions about the underlying processes determining a pattern.

It is also often the case that certain processes determine patterns observed at different scales, as 'fast' processes at fine scales and 'slow' processes operating at broader scales can affect and feedback to each other. These notions apply equally to ecosystem responses to climate extremes. For example, high sensitivity or alterations at fine scales, such as in plant physiology, can underlie and buffer impacts to broad scale processes, such as in net primary production .Therefore, an understanding of the cross-scale interactions between different levels of ecological organization within an ecosystem may inform variability in ecosystem-level responses to climate extremes.

It is important to consider that the timescales of recovery of forest ecosystems from these mortality events may exceed the shorter timescales of many ecological studies, resulting in the perception of permanent change. This highlights the need to understand the timescales of extreme event impacts versus the longer timescales of recovery dynamics in ecosystems with long-lived species. In other words, with short-term extreme events, such as drought, there is likely to be a mismatch in the timescale of dynamics driven by physiological (short-term growth) versus demographic responses (short to long-term re-growth and recruitment dynamics) and alterations in physical processes that may modify these responses over time. Indeed, there is extensive knowledge of shorter term responses of ecosystems to disturbances and climate extremes, as well as understanding of century-scale dynamics as observed from pollen records during glaciation cycles, but our understanding of dynamics at medium timescales and the mechanisms determining these dynamics remains limited.

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