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EDITORIAL

Introduction to the special virtual issue on climate change

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This special virtual issue of *Plant Ecology* draws together 14 papers on climate change published in the journal over the past 5 years. It encompasses a range of ecosystems and species, and issues relating to potential climate change effects on plants and plant communities. The potential impacts of global climate change on the distribution of species, and the distribution, structure and function of communities in the 21st century have been the subject of an ever-increasing scientific literature over the past two decades (Parry 2007). Recent global analyses show that anthropogenic climate change is already affecting species and ecosystems and will continue to do so, with changes in the phenology, distribution and abundance of plants and animals reported for marine, freshwater and terrestrial plants and animals. Measured changes are heavily biased in the directions predicted under global warming scenarios and include earlier timing of spring events such as flowering, bud burst and egg laying, and latitudinal and altitudinal shifts in species ranges (Parmesan 2006). The magnitude and rate of on-going climate change, combined with other stressors, may exceed the adaptive capacity of species and resilience of ecosystems. In addition, changing climate combined with current, and future altered, disturbance regimes may lead to exacerbated rates of range contraction and extinction in plant species unable to maintain contact with suitable habitat through dispersal (Westerling et al. 2011; Moritz et al. 2012). Changes to ecosystems may include impoverished species mixes, simplified ecosystem structure and function, and greater vulnerability to invasive species (Malcolm et al. 2006; Midgley and Thuiller 2007; Keeley and Brennan 2012).

Three key conclusions from the 2007 International Panel on Climate Change (Parry 2007) highlight the threat that anthropogenic climate change poses for global plant biodiversity: (1) Resilience of many ecosystems is likely to be exceeded by the combination of climate change, associated disturbances (e.g. wildfire) and other global change drivers. (2) Increases in global temperature of more than 1.5–2.5 °C and rising atmospheric CO_2 concentrations are projected to cause major changes in ecosystem structure, function and species interactions. (3) 2–30 % of plant species globally are at increased risk of extinction.

Many studies on the potential impacts of climate change on plant and animal species have used bioclimatic envelope models which predict the future distribution of species using the correlation of their present range to present-day climate parameters, and the future geographic distribution of these climates based on a range of possible climate futures as described in various GCMs (e.g. Thuiller et al. 2005). Pearson and Dawson (2003) have highlighted the shortcomings of this approach as it ignores factors

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such as biotic interactions, habitat fragmentation, evolutionary change and dispersal ability—and the predictions of such models are difficult to validate (Araújo et al. 2005). Most importantly, it provides no mechanistic understanding of the environmental, ecophysiological and demographic factors that drive species responses. The papers collected in this virtual issue address climate change based on empirical and experimental evidence. They include studies on the plant ecological effects of changes in temperature and rainfall (especially drought), on latitudinal and altitudinal ranges (including effects on snowbeds and treelines), on refugia, seedling establishment, phenology, competition and alien species, and on both individual species and community level responses.

Plant species will respond to climate change in one of three possible ways; migrate to keep pace with climate change (but limited by habitat fragmentation, dispersal ability and substrate requirements), adapt in situ through selection of tolerance traits, or go extinct (Aitken et al. 2008). It is imperative that research continues to explore the potential impacts on plant species and communities of global warming, including interactions with other global change drivers such as shifting disturbance regimes. Such research also needs to address the potential effects of altered frequency and intensity of climate driven events in addition to changing mean conditions and this will be the subject of a forthcoming special thematic issue of Plant Ecology.

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