



Predicting future shifts in species diversity

Jens-Christian Svenning, Jeremy Kerr and Carsten Rahbek

It is both an exciting and challenging time to be an ecologist. It is reasonable to say that our science has never before been confronted by such threats to biological diversity caused by global changes in land use and climate, nor advanced so fast to meet them. The pace of discovery has accelerated incredibly, and the recent “Danish Biodiversity Information Facility (DanBIF) International Conference on Biodiversity Informatics and Climate Change” was a remarkable landmark on the journey. The conference was jointly organized by DanBIF <www.danbif.dk>, the Dept of Biological Sciences, Aarhus Univ., and the Dept of Biology, Copenhagen Univ., and held at Aarhus Univ. in Denmark 5–6 April, 2008.

The aim of the conference was to bring world-leading scientists in the biodiversity informatics field together to provide a state-of-the-art overview of current and potential future climate change impacts on biodiversity. Biodiversity and ecosystems are already changing at unprecedented rates, and that pace could accelerate further in the 21st century due to global warming and other anthropogenic changes in the global environment (Sala et al. 2000, Fischlin et al. 2007). Thematically the conference focused hard on the roles of past and present climate as determinants of biodiversity as well as the potential biodiversity impacts of the anticipated climates of the near future, while acknowledging their possible lack of past analogs (Williams et al. 2007). These issues are the kind of complex broad-scale problems that are difficult to study by the traditional experimental approaches, motivating the macroecological research theme in common to all papers included here. We are pleased to present six papers from the DanBIF International Conference on Biodiversity Informatics and Climate Change in this issue of *Ecography*.

Predicting how species diversity will respond to climate change is critical for conservation planning in the 21st century. Success in this area hinges on both conceptual and methodological advances in how we approach these problems. But success will not come easily and ignoring the past will not help predict the future: several papers provide evidence that past climate changes have left long-lasting legacies in the geographic diversity patterns. Stropp et al. (2009) use an extensive data set of tree inventory plots spread across the Amazon Basin and Guiana Shield to elucidate the drivers of tropical tree diversity and find evidence that paleoclimatic stability is a key control of

regional-scale diversity. Svenning et al. (2009) provide evidence for strong geographic heterogeneity in the species richness–environment relationships in the European flora and discuss their linkage to Plio-Pleistocene climate change. Confidence in projections of the future distributions of species requires demonstration that recently-observed changes can be predicted adequately. Willis et al. (2009) use a dynamic spatially-explicit population modelling framework to demonstrate that recent changes at the expanding northern boundaries of three butterfly species can be predicted with good accuracy. In the line with the two previously mentioned studies, but at a smaller spatiotemporal scale Willis et al. (2009) find that each species’ distribution prior to expansion was critical in determining the exact spatial pattern of the current distribution. Willis et al. (2009) also show that realistic representation of dispersal is of key importance for modelling future range shifts. This issue is also a focus of the study by Engler et al. (2009): here, the authors carried out projections of future distribution over the 21st century for 287 mountain plant species in a study area of the western Swiss Alps using the often used unlimited and no dispersal scenarios and two more realistic scenarios, and conclude that the more realistic dispersal simulations produced results that were significantly closer to unlimited dispersal than to no dispersal. Baselga and Araújo (2009) investigate approaches to predicting biotic responses to changing environmental conditions, distinguishing between community response models and species-based models. Algar et al. (2009) use global change as a pseudo-experiment, testing whether spatial relationships linking climate to butterfly species richness are able to predict how richness changed during the climate changes observed in the 20th century. Surprisingly, this approach proves at least as effective as species distribution models, suggesting both a new way to predict biodiversity responses to global change and that spatial macroecological relationships can truly be causative.

These studies produce a strong consensus that accurate predictions of future shifts in species diversity will demand more sophistication than simple projections of species’ climatic niche space. Fortunately, these papers also advance the theoretical framework necessary to move the field beyond its correlative first principles and into a realm where both theory and empirical discovery can inform

policy more effectively. That is both the challenge confronting this science and its best opportunity to contribute indelibly to improving the outlook for biological diversity and perhaps also ourselves.

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