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symposium summary

Recent views from the macroscope

Inaugural meeting of the British Ecological Society Macroecology Special Interest Group – London, UK, 20th June 2012

In the decade since the British Ecological Society (BES) Symposium *Macroecology: Concepts and Consequences* (Blackburn & Gaston 2003), the field has continued to expand and develop. Macroecological literature is burgeoning and the field has steadily moved to a central position of influence within ecology (Beck et al. 2012). Continuing this momentum, a new BES Special interest group (SIG) has been established, and the inaugural meeting, *What is Macroecology?* was held on June 20th in London (Keith et al. 2012). Attended by around 100 researchers from 11 countries, the meeting was a great opportunity to review progress in the field, identify new opportunities and outline a focus for future efforts.

The SIG chair Nick Isaac (Centre for Ecology and Hydrology, Wallingford) opened by introducing the aims of the SIG, which included the promotion of data access and standards, the showcasing of methodological advances and the facilitation of interdisciplinary collaboration. Ian Owens (Natural History Museum, London) followed with a personal account of progress made in the field over the past decade, highlighting a number of hot topics which dominate present macroecological efforts. These themes permeated proceedings throughout the day, not only through the seven invited presentations summarised below, but also through the 16 or so poster presentations. These posters provided an innovative opportunity for researchers at various career stages to present their take on the meeting's primary questions—via 60-second presentations first, followed by the 'typical' poster session. The presentations emphasised the breadth of macroecology: from palaeoecology to predicting future responses to climate change.

Growing opportunities

In his keynote address, Owens discussed how macroecology has been evolving, and its scope expanding, as a result of the compilation of molecular phylogenies, high-resolution records of spatial distribution, increased computing power and new analytical techniques. In particular, he highlighted important initiatives undertaken to collate and make data available such as the National Biodiversity Network[1], the Global Biodiversity Information Facility[2] and the Map of Life[3].

The opportunities emanating from the accumulation of diverse biological datasets were echoed by a number of other speakers. Nick Dulvy (Simon Fraser University, Vancouver) described his group's work which makes use of compilations of experimentally derived thermal tolerance data, records of latitudinal distribution and evidence of recent biogeographical shifts, emphasising the advantages of adding temporal dynamics to macroecological analysis (Sunday et al. 2012). Likewise, Katrin Böhning-Gaese (Biodiversity and Climate Research Centre, Frankfurt) showed how large data sets generated by recent studies of biotic interactions have facilitated the comparative analysis of local feeding networks across latitudinal gradients. These analyses led to the interesting and counterintuitive finding that tropical plant–frugivore networks were significantly less specialised than temperate networks and composed of fewer modules.

Owens, however, cautioned that there is still much work required to increase data access and complementarity. Additionally, macroecological studies continue to be seriously biased taxonomically, particularly towards birds, mammals and plants while invertebrates (particularly insects) and marine systems (Raffaelli et al. 2005)

1. http://www.nbn.org.uk, last accessed 19/09/2012
2. http://www.gbif.org, last accessed 19/09/2012
3. http://www.mappinglife.org, last accessed 19/09/2012

remain highly under-represented relative to their taxonomic diversity. A holistic macroecological understanding will require that such biases are addressed.

Bridging Gaps

Another recurrent theme of proceedings was the importance of breaking down current theoretical and methodological barriers and integrating knowledge across often unnecessarily divergent ecological fields. Owens stressed the magnitude of opportunities afforded to macroecology by linking genotypes, individuals, species and habitats. Böhning-Gaese spoke more specifically about integration across ecological scales, arguing that incorporating information on community-level processes can provide illuminating missing detail to macroecological investigations. She showed how combining habitat preference with traditional climatic macroecological predictor variables, in models of bird species distribution, produced a much better fit to empirical data and also delivered profoundly different projections of the impact of climate and land-use change.

Dulvy showed how cross-biome analyses can lead to revealing insights. Differences exposed by contrasting the extent to which marine and terrestrial species fill their thermal ranges directly informed predictions regarding expected responses to climate change of species across the two biomes (Sunday et al. 2012). This agrees with recent studies of the potential for testing macroecological hypotheses in marine systems (Webb 2012).

The continuing search for process

The call to move from pattern to process has been a fixture of macroecological literature for some time now (Blackburn and Gaston 2003). But in a field where experimental manipulation is usually impractical, unethical or impossible, and in which researchers approach macroecological questions from diverse theoretical frameworks, this journey has not been straightforward. While progress toward unifying the numerous theories of macroecology has been made, Owens had to concede that mechanistic explanations for many macroecological patterns continue to evade us. However, he argued that whilst questions still remain, the field is becoming more adept at refining and reframing them, allowing evidence of mechanisms to accumulate, a point amply demonstrated by a number of talks that followed.

Dulvy argued that rapid, large-scale anthropogenic environmental changes could be viewed as 'natural experiments' in macroecology. Specifically, he showed how the impacts of climate change could be used to determine processes driving distributional extents, while Felix Eigenbrod (University of Southampton) referred to using species introductions as natural experiments.

Trevor Price (University of Chicago) demonstrated how careful selection of the study system can allow the relative contribution of diverse drivers of macroecological patterns to be assessed. His work on gradients in the diversity of Himalayan birds makes use of dual altitudinal and latitudinal gradients, combined with phylogenetic data to tease apart the contribution of historical and ecological factors in determining range limits (Price et al. 2011).

Another important development in macroecology has been the adoption of null models to account for the contribution of neutral processes to macroecological patterns. However, Sean Connolly (James Cook University, Queensland) argued that caution was required when using null models with no biological basis. By contrasting with a process-based framework, he argued that randomisation models probably overestimate the contribution of mid-domain effects to empirical patterns of species richness (Connolly 2005). Connolly's framework also allowed incorporation of environmental gradients, producing illuminating differences from corresponding null models and interesting consistency with empirical data. Connolly made the important overarching point that moving from pattern to process will require increased integration of theoretical and conceptual approaches with classical empirical macroecology.

New Applications

Owens emphasised the increasing opportunities for applied macroecology to emerge as an important player at the science–policy interface, making significant contributions in tackling current threats (e.g. biodiversity loss, climate change, emerging diseases) – many of which operate on macroecological scales, necessitating equivalently scaled solutions. A notable example of 'applied macroecology' was Eigenbrod's discussion of the potential for macroecological methods to aid in mapping ecosystem services. This field shares many similarities with macroecological research, but has emerged in response to the environmental crisis, and so policy is currently ahead of science. The need to inform policy decisions as quickly as possible has led to issues of data quality. This aside, Eigenbrod made a case for how macroecological hypothesis-driven thinking and sophisticated statistical methods could be employed to increase robustness of management efforts, by increasing understanding of causal drivers underpinning ecosystem services. This work has obvious parallels with research into the macroecology of functional groups.

Kate Jones and David Redding (University College London) also presented a novel infiltration of macroecological thinking into the field of epidemiology, an approach they have termed 'disease macroecology'. They showed how considering infectious diseases as ecological entities, coupled with an investigation of the broader mechanisms behind observed global patterns can provide large-scale context to mechanistic epidemiological models (Jones et al. 2008). They argued that considering disease dynamics in the context of a wider ecological system could additionally reveal any moderating effects of biodiversity on the spread of infectious disease.

Conclusions

It is clear that macroecology will continue to make important contributions not only to ecology, but increasingly also in wider social and economic spheres (e.g. Burger et al. 2012). Ascribing process to macroecological pattern remains key, and although evidence of progress was amply demonstrated at the meeting, the journey is certainly not complete. Important objectives include the bridging of gaps between data and theory and the integration of research efforts across spatial and taxonomic scales, but collaborative interdisciplinary action may yet provide the greatest challenge. Institutional barriers have already been cited as potentially constraining progress in the field (Raffaelli et al. 2005). Perhaps, therefore, the most important outcome of a BES macroecological SIG is to facilitate coordination of innovative action and foster interdisciplinary cooperation. We hope that the BES's example, together with that of the pioneering Macroecology Specialist Group of the Ecological Society of Germany, Austria and Switzerland (Graham & Winter 2012) – and, of course, the IBS – will stimulate exciting new macroecological activities elsewhere in the world's ecological community.

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