Journal of Ecology

Journal of Ecology 2008, **96**, 567–568 doi: 10.1111/j.1365-2745.2008.01382.x

DISPERSAL SPECIAL FEATURE – EDITORIAL

Plant dispersal across multiple scales: linking models and reality

The study of dispersal has undergone a revival over the last decade. This increase in research activity has been marked by edited books (e.g. Bullock *et al*. 2002; Levey *et al*. 2002) and collections of papers devoted to the subject in ecological journals (e.g. Cain *et al*. 2003; Nathan 2005). This Journal of Ecology Special Feature, consisting of 12 papers, aims to examine the current state of knowledge about plant dispersal and to illustrate the major advances that have been made in this rapidly growing field over the last few years.

The key features of dispersal we asked authors to address in writing for this Special Feature are summarized in its title. Plants are generally sessile, and dispersal of seeds or other diaspores links the life cycle of an immobile individual to processes at local, landscape and biogeographic scales. One of the key themes driving the renaissance in plant dispersal research is the growing recognition that easily-observed dispersal at local scales (typically a few tens of metres) cannot be simply extrapolated to yield understanding and prediction of processes at larger scales. Studying plant dispersal across multiple scales requires the development of new statistical, simulation and mathematical models to predict dispersal more precisely and to use the better data to understand ecological processes at these scales. Authors of the papers in this Special Feature were encouraged to present their own interpretation of this general premise. Thus, the papers address a wide range of questions about dispersal across multiple scales. Despite this range, three common issues can be identified.

(1) MECHANISTIC MODELS OR INVERSE MODELLING?

Models of various types have contributed to progress in dispersal research. The Special Feature reports on ways in which mechanistic wind dispersal models have been extended to include more realistic representation of processes such as seed abscission and turbulence (Bohrer *et al*. 2008; Soons & Bullock 2008). Mechanistic modelling of dispersal by other vectors is now waking from a period of stasis, and papers in the Special Feature report new approaches to data gathering and modelling for seed dispersal by animals (Carlos & Morales 2008; Levey *et al*. 2008; Soons *et al*. 2008). While mechanistic models have became a holy grail for many dispersal researchers, inverse modelling is of more immediate use in generating dispersal kernels from seed trap (Muller-Landau *et al*. 2008) and genetic (Jones & Muller-Landau 2008) data. However, as these papers show, there are statistical problems with this approach. A potential bridge between the two methods is provided by an inverse modelling technique that incorporates spatial heterogeneity explicitly (Schurr *et al*. 2008).

*Correspondence author. Centre for Ecology and Hydrology, Benson Lane, Crowmarsh Gifford, Wallingford, OX10 8BB, UK. E-mail: jmbul@ceh.ac.uk

(2) SIMPLICITY OR COMPLEXITY?

Papers in this Special Feature conclusively demonstrate that studying plant dispersal across multiple scales requires the examination of complexities beyond the traditional simplifications. We ask, for example, whether small-scale processes affect long-distance dispersal, and conversely, do large-scale processes affect short-distance dispersal? Several papers show that conditions at the seed source, such as wind speed and plant density, affect the initiation of dispersal and so the probability of long-distance dispersal (Bohrer *et al*. 2008; Carlos & Morales 2008; Soons & Bullock 2008). The crucial role of environmental heterogeneity in affecting dispersal at all scales is demonstrated, both for species dispersed by animals (Levey *et al*. 2008) and by wind (Bohrer *et al*. 2008; Pounden *et al*. 2008; Schurr *et al*. 2008). The finding that simple life-history attributes cannot explain variation in key features of dispersal (Muller-Landau *et al*. 2008) also shows the need to add complexity in dispersal studies. Only a few simplifications examined are still supported, such as the assumptions of no inertia (Bohrer *et al*. 2008) and no collisions for some types of wind-dispersed seeds (Pounden *et al*. 2008).

(3) DISPERSAL OR DEMOGRAPHY?

Dispersal, however important, is just one part of the life cycle. Although demography is at the core of plant population ecology, dispersal has generally been poorly integrated into this research field. The Special Feature shows how models can be used to integrate dispersal with demography to gain a better understanding of spatial population dynamics. This allows analysis of the factors governing both local persistence and regional spread, and the papers show that each is affected by demographic and dispersal processes (Hampe *et al*. 2008; Higgins *et al*. 2008; Jongejans *et al*. 2008; Soons & Bullock 2008; Schurr *et al*. 2008). At larger scales, these models demonstrate the critical importance of long-distance dispersal; even if only a tiny proportion of seeds travel long-distances, these have a disproportionate effect on large-scale processes (Jongejans *et al*. 2008; Soons & Bullock 2008). Equally, local dynamics are strongly affected by dispersal at smaller scales, which determines the pattern and magnitude of plant establishment (Hampe *et al*. 2008; Higgins *et al*. 2008).

These themes show that the keys to understanding, modelling and predicting plant dynamics at any scale are to check our simplifications and address the challenge of adding complexity, to use a variety of modelling methods to simulate the focal process of dispersal and the resulting patterns, and to combine these tools and insights to examine dispersal consequences more rigorously. This is an area of research of relevance to the interests of many plant ecologists and this Special Feature provides an essential overview of recent progress and current understanding.

James M. Bullock*
Ran Nathan
Guest Editors

References

Bohrer, G., Katul, G.G., Nathan, R., Walko, R.L. & Avissar, R. (2008) Effects of canopy heterogeneity, seed abscission and inertia on wind-driven dispersal kernels of tree seeds. *Journal of Ecology*, **96**, 569–580.

Bullock, J.M., Kenward, R.E. & Hails, R. (2002) *Dispersal Ecology*. Blackwell Science, Oxford.

Cain, M.L., Nathan, R. & Levin, S.A. (2003) Long-distance dispersal. *Ecology*, **84**, 1943–1944.

Carlo, T.A. & Morales, J.M. (2008) Inequalities in fruit-removal and seed dispersal: consequences of bird behaviour, neighbourhood density and landscape aggregation. *Journal of Ecology*, **96**, 609–618.

Hampe, A., García-Castaño, J.L., Schupp, E.W. & Jordano, P. (2008) Spatio-temporal dynamics and local hotspots of initial recruitment in vertebrate dispersed trees. *Journal of Ecology*, **96**, 668–678.

Higgins, S.I., Flores, O. & Schurr, F.M. (2008) Costs of persistence and the spread of competing seeders and sprouters. *Journal of Ecology*, **96**, 679–686.

Jones, F.A. & Muller-Landau, H.C. (2008) Measuring long-distance seed dispersal in complex natural environments: an evaluation and integration of classical and genetic methods. *Journal of Ecology*, **96**, 642–652.

Jongejans, E., Shea, K., Skarpaas, O., Kelly, D., Sheppard, A.W. & Woodburn, T.L. (2008) Dispersal and demography contributions to population spread of *Carduus nutans* in its native and invaded ranges. *Journal of Ecology*, **96**, 687–697.

Levey, D.J., Silva, W.R. & Galetti, M. (2002) *Seed Dispersal and Frugivory*. CABI, Wallingford.

Levey, D.J., Tewksbury, J.J. & Bolker, B.M. (2008) Modelling long-distance seed dispersal in heterogeneous landscapes. *Journal of Ecology*, **96**, 599–608.

Muller-Landau, H.C., Wright, S.J., Calderón, O., Condit, R. & Hubbell, S.P. (2008) Interspecific variation in primary seed dispersal in a tropical forest. *Journal of Ecology*, **96**, 653–667.

Nathan, R. (2005) Long-distance dispersal research: building a network of yellow brick roads. *Diversity and Distributions*, **11**, 125–130.

Pounden, E., Greene, D.F., Quesada, M. & Contreras Sánchez, J.M. (2008) The effect of collisions with vegetation elements on the dispersal of winged and plumed seeds. *Journal of Ecology*, **96**, 591–598.

Schurr, F.M., Steinitz, O. & Nathan, R. (2008) Plant fecundity and seed dispersal in spatially heterogeneous environments: models, mechanisms and estimation. *Journal of Ecology*, **96**, 628–641.

Soons, M.B. & Bullock, J.M. (2008) Non-random seed abscission, long-distance wind dispersal and plant migration rates. *Journal of Ecology*, **96**, 581–590.

Soons, M.B., van der Vlugt, C., van Lith, B., Heil, G.W. & Klaassen, M. (2008) Small seed size increases the potential for dispersal of wetland plants by ducks. *Journal of Ecology*, **96**, 619–627.

