Theories of Quantitative Character Evolution and Stochastic Population Dynamics

Russell Scott Lande

2011 Balzan Prize for Theoretical Biology or Bioinformatics

Balzan GPC Adviser: Charles Godfray
Researchers: Emmanuelle Porcher, Céline Devaux
Affiliated Institution: Imperial College London
Period: 2012-2015

Russell Scott Lande is Royal Society Research Professor at Imperial College London. With the second part of his Balzan Prize, Lande supported young researchers at the postdoctoral and graduate student levels. Two experienced postdoctoral researchers were employed through Imperial College London, Silwood Park Campus, modeling the joint evolution of mating systems, flowering phenology and inbreeding depression in plants. Both were based at their home institutions in France: Emmanuelle Porcher at the Musée national d'Histoire naturelle and Céline Devaux at Université Montpellier 2, doing collaborative research supervised by Professor Lande, with frequent visits to Silwood Park by them and to their home institutions by Professor Lande.

The Centre for Conservation Biology (CCB) organized a workshop entitled *Stochastic demography in fluctuating environments: theory and empirical patterns* from 23 to 27 April 2012. The workshop was aimed at young scientists in the initial stages of their scientific career and focused on models for describing the demography of populations in fluctuating environments, methods for estimation of parameters from data and presentations of empirical examples that illustrate the practical application of this quantitative approach for understanding dynamics of populations. Central topics covered were the concepts of demographic and environmental stochasticity, density-dependence in age-structured populations, techniques for estimating key parameters in age-structured models, spatial synchrony in population fluctuations, population viability analyses and community dynamics.

A major part of the workshop was comprised of introductory lectures by Professors Steinar Engen, Russell Lande and Bernt-Erik Sæther. The aim of these lectures was to give an overview of the theories in stochastic population dynamics and demography, to show their significance for general understanding of principles explaining patterns in fluctuations of natural populations and to demonstrate how these models could be parameterized using data from different model systems. The second part of the course consisted of exercises in practical applications of the models in analyses of data using a multitude of computer programmes mainly developed by researchers at CCB. These practicals were supervised by Professor Jarle Tufto and Researcher Vidar Grøtan. The final part of the course consisted of short presentations in which the participants presented their own research.

Research was conducted with Dr. Céline Devaux, who was hired as a consultant for three summers, and with Dr. Emmanuelle Porcher who was hired as an employee of Imperial College London for two years beginning September 2012. Results to date include five published papers and one submitted, and two manuscripts in preparation. The research focuses on developing quantitative theories of the evolution of plant mating systems, particularly mixed self-fertilization and outcrossing, as influenced by pollination ecology and the evolution of inbreeding depression.

Publications

Porcher, E. and R. Lande. 2013. Evaluating a simple approximation to modeling the joint evolution of self-fertilization and inbreeding depression. *Evolution* 67: 3628-3635.

Devaux, C., R. Lande and E. Porcher. 2014. Pollination ecology and inbreeding depression control individual flowering phenologies and mixed mating. *Evolution* 68: 3051-3065.

Devaux, C., C. Lepers and E. Porcher. 2014. Pollinator constraints on the ecology and evolution of plant mating systems. *Journal of Evolutionary Biology* 27: 1413-1430. Connor, J. and R. Lande. 2014. Raissa L. Berg's contributions to the study of phenotypic integration, with a professional biographical sketch. *Philosophical Transactions of the Royal Society B* 369: 20130250.

Lande, R. and E. Porcher. 2015. Maintenance of quantitative genetic variance under partial self-fertilization, with implications for evolution of selfing. *Genetics* 200: 891-906. Porcher, E. and R. Lande. 2016. Inbreeding depression under mixed outcrossing, self-fertilization and sib-mating (submitted).

Devaux, C., E. Porcher and R. Lande. 2016. The evolution of pollen limitation in self-compatible animal-pollinated plants (manuscript).

Lande, R. and E. Porcher. 2016. Interaction of stabilizing selection on quantitative traits with purging of recessive lethal mutations in partially selfing populations (manuscript).