A Spatial Dimension of Ecology: Ilkka Hanski Crafoord Laureate in 2011

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The Finnish ecologist Ilkka Hanski is awarded the Crafoord Prize in Biosciences for 2011 for his pioneering studies of how spatial variation affects the dynamics of animal and plant populations. Earlier Crafoord laureates in Biosciences include Robert L. Trivers (2007), Carl R. Woese (2003), John Maynard Smith, Ernst Mayr and George C. Williams (1999), Robert May (1996), Seymour Benzer and William T. Hamilton (1993), Paul R. Ehrlich and Edward O. Wilson (1990), Eugene P. Odum and Howard T. Odum (1987) and Daniel H. Janzen (1984).

A common textbook defines ecology as the study of the mechanisms behind species abundance and distribution where each species can be characterized by the size and location of its populations. Ecological populations are rarely constant over time and space but vary due to factors both intrinsic to the system and extrinsic environmental variation. Even in a spatially homogeneous environment, populations of predator and prey may show patchy distributions due to, for example, differences in movement rates. In most cases, variation in population sizes over space (and time) is, however, a result of spatial variation in the distribution of suitable habitats, and it is in this context that Ilkka Hanski has made his major contributions.

Inspired by a short paper by Richard Levins published in the late 1960s, Hanski initiated a development of both theory and empirical research that has now grown to become a major research area in ecology. Baptized as *Metapopulation Ecology* (Hanski 1999), this research now engages ecologists all over the world in studies in many different kinds of environments. Although animals and plants are most common, the metapopulation theories are used for all major groups of organisms. As in most scientific breakthroughs, the basic idea is quite simple. Each population is seen as an “individual”, which is born (the population is founded by colonization of a site) and ultimately dies (the population goes extinct). The likelihood of colonization is dependent on the presence of other populations in the surroundings (the isolation of the site) and the risk of extinction is dependent in the population size (the area of the site). From this simple basis of habitat area and isolation, Hanski has developed more complex theory to deal with the realism that makes

ecological studies such a challenge. These extensions consider aspects such as population dynamics in local populations and stochastic variation.

Along with the theoretical development, Hanski has also performed outstanding field studies, the most important being done on a butterfly (*Melitaea cinxia*) and its host plants in the Åland archipelago. For conservation biologists, Hanski’s studies have provided a tool box for analyzing how species are affected by habitat change and fragmentation. As habitat loss is considered as the major factor behind biodiversity decline and species extinction, the metapopulation theory has become a cornerstone of conservation biology. One major insight for conservation biology is the concept of “extinction debt” relating to the time delay between habitat loss and the extinction of a species which is particularly long when it is close to its extinction threshold.

Metapopulation theory has also led to further developments of ecological theory concerned with spatial aspects of whole communities and ecosystems—*metacommunity ecology* and *meta-ecosystem ecology*—no doubt providing us with important new insights on the spatial dimension of the dynamics of ecological systems. In particular, metacommunity theory has developed into a rich theory studying the effects of trade-offs related to colonization and competitive ability, species-specific responses to environmental heterogeneity, stochastic demographic processes and dispersal limitation on species diversity in heterogeneous landscapes.

REFERENCE

Hanski, I. 1999. *Metapopulation ecology*. Oxford: Oxford University Press.

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