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COMBINER L'ÉCOLOGIE, L'ÉVOLUTION ET LES CHANGEMENTS CLIMATIQUES

COMBINING ECOLOGY, EVOLUTION AND CLIMATE VARIATION AND CHANGE

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I have over the years worked on a variety of evolutionary and ecological problems. Over the last decade of so, much of my work has focused upon the population dynamics effects of climate variation where climate has been measured by "climate packages" such as the North Atlantic Oscillation (NAO); see Stenseth et al. (2003).

We know that climate influences a variety of ecological processes. These effects operate through local weather parameters such as temperature, wind, rain, snow, and ocean currents, as well as interactions among these. In the temperate zone, local variations in weather are often coupled over large geographic areas through the transient behavior of atmospheric planetary-scale waves. These variations drive temporally and spatially averaged exchanges of heat, momentum, and water vapor that ultimately determine growth, recruitment, and migration patterns. Recently, there have been several studies of the impact of large-scale climatic forcing on ecological systems. In Stenseth et al. (2002) we reviewed how two of the best-known climate phenomena—the North Atlantic Oscillation and the El Niño–Southern Oscillation—affect ecological patterns and processes in both marine and terrestrial systems.

During my work I have highlighted that climate indexes such as the North Atlantic Oscillation (NAO) is properly seen as a package of weather (Stenseth and Mysterud 2005). As an example I will mention my work on the Canadian hare-lynx population cycle, which I have studied rather extensively (Stenseth et al. 1999).

Across the boreal forest of Canada, lynx populations undergo regular density cycles. Analysis of 21 time series from 1821 onward demonstrated structural similarity in these cycles within large regions of Canada. The observed population dynamics are consistent with a regional structure caused by climatic features, resulting in a grouping of lynx population dynamics into three types (corresponding to three climatic-based geographic regions): Pacific-maritime, Continental, and Atlantic-maritime. A possible link with the North Atlantic Oscillation is suggested.

This ecological work of ours has been followed up by population genetic work (Rueness et al. 2003).

Using both nuclear and mitochondrial DNA markers, we report here a close resemblance between the earlier observed spatial ecological structuring of the Canadian lynx and its spatial genetic structuring. Specifically, we demonstrate that the Rocky Mountains represent a barrier to gene flow in western Canada, and, somewhat surprisingly, we detect the presence of a geographically invisible barrier south of Hudson Bay (coinciding with the separation between the ecological Continental and Atlantic regions). No evidence for isolation in different glacial refugia within North America was found. We suggest that ecological factors underlying the spatial dynamic structuring also strongly influence the genetic structuring of the Canadian lynx.

This work was subsequently followed up by a synthesis demonstrating that the genetic structuring could be explained by the ecological processes, processes which themselves to a large extent were driven by climate factors (Stenseth et al. 2004a).

Introducing a new population model, the "climate forcing of ecological and evolutionary patterns" model, we linked the observed ecological and evolutionary patterns. Specifically, we demonstrate that there is greater phase synchrony within climatic zones than between them and show that external climatic forcing may act as a synchronizer. We simulated genetic drift by using data on population dynamics generated by the climate forcing of ecological and evolutionary patterns model, and we demonstrate that the observed genetic structuring can be seen as an emerging property of the spatiotemporal ecological dynamics.

In a subsequent follow-up paper we pointed out that a key factor is the snow conditions (Stenseth et al. 2004b). We demonstrated that the observed geographic structuring matches zones of differential snow conditions, in particular surface hardness, as determined by the frequency of winter warm spells. Through a modified functional response curve, we show that various features of the snow may influence lynx interaction with its main prey species, the snowshoe hare (Lepus americanus). This study highlights the importance of snow, and exemplifies how large-scale climatic fluctuations can mechanistically influence population biological patterns.

Currently I am the chair of CEES, a multidisciplinary unit focusing on the dynamics in time and space: Our focus is that ecological and evolutionary processes are inescapably intertwined. Environmental changes affect the ecology of species causing novel selection pressures to which the species respond evolutionarily. Ever since the industrial revolution the influence of human activity on earth has accelerated, and today anthropogenic impacts on the biota are of great concern to politicians, academics, and laypeople. In order to comprehend how such distortion of the environment may affect tomorrow's nature, we need more and better knowledge of how ecology determines the course of evolution, which again determines future ecological dynamics. ***Understanding how living organisms respond and adapt to environmental changes remains a major and most urgent scientific challenge.***

I feel very honored to have been elected foreign member of the French Academy of Science. This is to me a great honor in itself. I am also very pleased with this membership since I have had very good links with French ecologists, and am today working on developing a formalized French-Norwegian network of ecologists – greatly supported by the Embassies of the two countries.

A main mission of this European Research Group is to establish a French-Norwegian Observatory – a data bank – for long-term ecological data to serve scientific projects/studies *on the ecological effects of environmental (e.g., climate) changes: understanding what has happened in the past regarding ecological effects of climate variability will help us be prepared for what might happen should climate change. External funding is, however, needed for the French-Norwegian Observatory to materialize. Currently we are working on obtaining such funding.*

Me being elected member of the French Academy of Science will certainly help in this effort.

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