Biodiversity in heterogeneous environments

PhD project with B. J. Graae (Ecology), I. I. Ratikainen (Behaviour and Evolution) and Jonathan Lenoir (Macro-ecology, Jules Verne University of Picardie, France)

With changing climate, populations have two survival options – they can remain in the area and tolerate the new climatic conditions ('stay'), or they can migrate to track their climatic niches elsewhere in the landscape ('go'). Staying requires broad climatic tolerance, niche shifts, acclimation through plasticity or genetic adaptations. Going, in contrast, requires good dispersal and colonization capacity. Species lacking the capacities required to either stay or go under climate change are predicted to go extinct. However, both the extent of climate change experienced locally, and the capacities required for staying or going in response to climate change are strongly affected by the temporal and spatial variation in (micro)-climate associated with topography within the landscape.

The aim of this Ph.D. project is to test theories about how landscape topography with all its corresponding microclimatic variance will affect species capacity to adapt or disperse in response to climate change. We do so by investigating phenotypic variation of species occurring in landscapes with varying levels of topographical complexity: from flat to very rough and complex terrains. We will compare the phenotypic mean and variation between generalist species with wide climatic niches and specialist species with narrower climatic niches. We will further compare the species life history traits. The studies will also benefit from the use of two large European databases for selection of species. One of these is the EVA[1], in which Lenoir is part of the council. The second is the Nordic Vegetation Database compiled partly for the Stay or Go network in which the ideas of this project has been developed. This network was funded by Nordforsk to take place from 2010-2013 and has so far generated several papers, whereof one is highly cited (Lenoir *et al.* 2013)[2] and another is soon to be submitted presenting the main ideas (Graae et al. in prep). These databases are large and macro-ecological patterns can be compared with those observed at smaller scale from field studies. Additionally, it can be expected that different combinations of climatic heterogeneity in time and space will give different predictions for capacities to stay or go, and these can be explored by creating suitable individual based simulation models based on the selected species and their life-histories.

The project will entail conceptual developments, theoretical modelling (individual based simulation models) and analysis of empirical data. The weight of each of these parts is flexible and open to modification according to the qualifications and interest of the candidate. As a point of start we though suggest four WPs in the project:

WP1: Field studies testing hypotheses about behaviour of the species in the field, in response to the variation in landscape topography.

WP2: Greenhouse studies testing hypotheses on evolutionary processes related to landscape heterogeneity, e.g. the local adaptation and plasticity of the selected species.

WP3: Simulation model of adaptation to landscapes that vary both in time and space.

WP4: Comparisons of macro-ecological patterns to patterns found in the first three WPs.

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[1] http://euroveg.org/eva-database-who-we-are

[2] Lenoir J., Graae B.J., et.al. (2013). Local temperatures inferred from plant communities suggest strong spatial buffering of climate warming across Northern Europe. Global Change Biology, 19, 1470-1481.