Annex 16 – Marine phylogeographic structuring during climate change: the signature of leading and rear edge of range shifting populations (by Vitor Almada, ISPA)

Principal Investigator: Vitor Almada, Instituto Superior de Psicologia Aplicada (ISPA)
UIEE - Unidade de Investigação em Eco-Etologia, Portugal

Other partners:

- Center for Marine Sciences, University of Algarve, Portugal
- IMEDEA - Mediterranean Institute for Advanced Studies, Spain
- Biologische Anstalt Helgoland, Alfred-Wegener Institute for Polar and Marine Research, Germany
- Institute of Marine Research, Flødevigen., Norway
- Universidad de Cadiz, Spain

The patterns of marine animal and plant geographical distribution along the shores of Western Europe and the Mediterranean are fairly recent. During glacial phases, the sea surface temperatures along West Europe dropped markedly and the warm temperate organisms must have survived either in the Mediterranean or in areas more to the South, like the West African shore. With the reestablishment of interglacial conditions, the biogeography of West Europe became one where a succession of ranges begin or end along the stretch of coast comprised between the Mediterranean and the Baltic. Depending on their thermal tolerances, the warm water species have their northern limits along this latitudinal gradient, while the cold temperate species have their southern limits along that same gradient. If a warming process of the North Atlantic and the Mediterranean occurs on a scale that follows that predicted for the global warming, we are to expect local extinctions of the less warm adapted European species in the Mediterranean and in South West Europe, as well as northward shifts.

In the last decades, both types of shifts have been documented with warm water organisms being increasingly recorded in areas to the north of their usual range and local extinction or decreases in abundance in cold temperate species in the south. In addition, a rise in sea surface temperature will not only affect the occurrence of particular species but also the ecosystem as a whole as the complex nature of trophodynamic interactions and diversity patterns might change dramatically. The geographical range of many temperate marine species is therefore constrained by climate, but the effects of climate on population performance at the limits of their range, both at their low and high latitude boundaries remain poorly known. The extreme richness of the Atlanto-Mediterranean area makes it a natural laboratory in which to study the processes involved in the marine faunal and floral change. In phylogeographic terms, the present situation of decadal-scale climate regime changes provides a unique opportunity to study the differences in intra-specific genetic structure between the leading edge of advancing populations and the rear edge near the extinction zone. Indeed, although much insight has been gained on the processes of range

shift and range expansion with studies on terrestrial organisms, specially based on reconstruction of Pleistocene scenarios, we know much less about the corresponding processes in marine organisms. If we are able to capture this signature, it will be in all probabilities, a highly valuable tool to detect at an early stage, the signs of a population that is beginning to be unable to maintain its presence at a given latitude, while at the same time getting a better understanding of the characteristics of the genetic traits that mark expanding marine populations. Many studies have demonstrated decreases of genetic diversity in the extreme north of the range of several species, a process which has been interpreted as a likely indication that the postglacial recolonization did not yet led to equilibrium. However, many processes common in terrestrial organisms such as lineage sorting during the expansion and the formation of stable hybrid zones, are still being questioned when marine organisms are concerned. The large population sizes of many marine organisms, the presence of highly dispersive life stages and the presence of quick transport mechanisms capable of carrying large masses of eggs larvae or even mobile adults, are among the factors that raise concerns about the general applicability of terrestrial models to marine animals and plants.

The present project, aims to monitor, sample and genotype a number of target species, in predetermined rocky-shore stations in the Mediterranean and along West Europe, with special attention to species having distributional limits within this area. The project will use both mitochondrial and nuclear markers as well as standard phylogeographic, historical demographic and food web related tools to compare the patterns detected in retreating edges and leading edges of cold temperate and warm water organisms respectively. The genetic study will be replicated for a subset of species in two different years in order to assess the reproducibility (i.e. temporal stability) of the results. At the same time the project will search for changes in distributional records that might, specially at the range limits of the target species which may suggest changes in abundance during the study period. In addition, the trophic ecology of each target species will be investigated in order to detect trophodynamic changes and adaptations along the latitudinal gradient. Apart from the main objectives this study will help to define the geographical limits of populations that are distinct, thus helping policy makers to develop conservation schemes and marine protected areas.