

# Searching for population adaptation in the brown crab: can it be detected and used in management?

Marine Theme Objective: State of the Marine Environment

## What's the problem?

Many marine species have highly mobile adults and/or prolonged larval stages, features enabling dispersal over large distances. This has fostered assumptions that marine populations are essentially open over vast areas, such that declining numbers in one area will be replenished by individuals dispersing in from another area. However, recent studies employing genetic (DNA) markers have uncovered significant population subdivision of marine species, even at small geographical scales: such isolated populations are more vulnerable to demographic changes and require specific management. Natural selection also may have a greater influence on marine populations than previously thought, such that individuals may be locally adapted to a particular area. Characterisation of genetic structuring of populations of heavily exploited marine species such as the brown crab is needed in order to decide whether fished stocks should be managed on a local, regional or national basis. Identification of local genetic adaptation of populations is necessary also for management of genetic biodiversity.

## What were the aims of the project?

The fundamental objective of this project was to develop genetic markers to allow a test for signals of local adaptation in the brown (edible) crab, *Cancer pagurus*. The brown crab was chosen as the test species for two key reasons:

1. First, it is commercially exploited throughout its distribution and is an important socioeconomic resource, and so information on local adaptation is valuable for management efforts aimed at resource sustainability.
2. Second, the brown crab is an abundant and widespread shelf species and so can act as a model to indicate the role of natural selection in population diversity of other marine species.

Genetic theory predicts that individual genetic markers that are not subject to natural selection should all reveal similar patterns of variation among populations. The aim was to screen variation in a range of crab populations at a large number of independent markers, including ones developed from gene regions potentially subject to natural selection. Identification of aberrant (outlier) patterns at particular markers may indicate natural selection, and so permit inferences as to the geographical pattern of adaptation.

The project was completed on 30th September 2009.

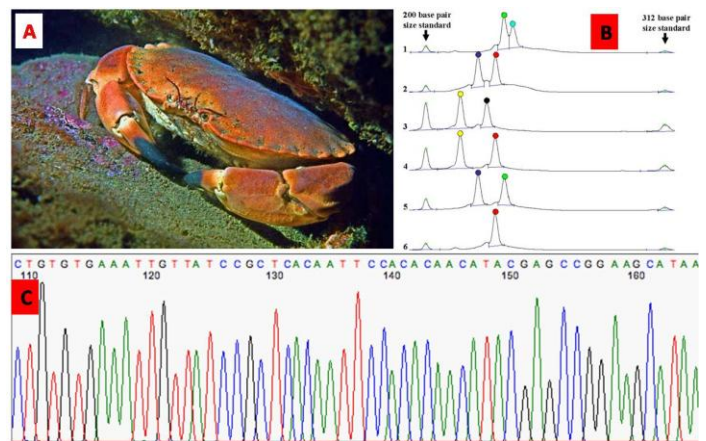


Figure 1: The brown crab (A) and genetic methods used to search for signatures of adaptation (B – DNA size markers; C – DNA sequencing). (Source: Royal Holloway University of London).

## Which policy areas will the research inform?

The project was conducted to improve stock assessments of edible crabs, and to determine the most appropriate spatial scale for the management of crab fisheries. The results will help to achieve Good Environmental Status (GES) for the Marine Strategy Framework Directive; to develop appropriate fisheries enforcement tools (MMO/IFCA); and for a general understanding of the distribution of genetic biodiversity in natural (marine) populations.

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### What are the results from the project and how will they be used?

Genetic information was collected on the stock structures of edible crabs (*Cancer pagurus*) in the English Channel and North Sea. The population of origin of each crab was determined by genotyping (determining the genes from DNA) individual larvae. The most striking geographical pattern observed was a genetic break occurring between samples from Orkney and Shetland, indicating that populations to the north/east and south/west of this area may be differentially adapted.

Another distinct result was the detection of a strong adaptive signal for a sample collected from within a Swedish fjord. Although this is a preliminary study there is compelling evidence that local adaptation is present, and can be detected with molecular markers, in the brown crab. Our data indicate that different adaptations may be occurring on both macro- and micro-geographical scales. By extension local adaptation may be present in many more widespread marine species in UK waters.

The project also highlighted the key role of female crabs and hydrodynamics (water movements) in determining population stability and fragmentation.

These data are being incorporated into ongoing crab management. The crab fishery is presently managed on a regional basis, with the Shetland Islands fishery recognised as independent from Scandinavian and North Sea fisheries. The identification of a genetic break between Orkney and Shetland supports this regional configuration. The data will be presented at the forthcoming ICES WGCRAAB workshop to discuss how future management strategies can incorporate additional findings of the research.

#### Future work

Understanding local adaptation of exploited populations is essential to accurately define management units and identify conservation priorities, as well as in monitoring the effects of exploitation on sustainability and evolution of marine populations. In light of on-going climate change a focus on local adaptation is essential as this will aid prediction of species responses.

The recent trend in fisheries genetics has been to employ “neutral” DNA markers, which have proven efficient at describing movements of individuals. However, it is recommended that future genetic studies of marine species should preferentially include functional (protein producing) DNA markers: this should enhance resolution of genetic diversity and stock structuring within exploited species, but more importantly permit identification of locally adapted population units.

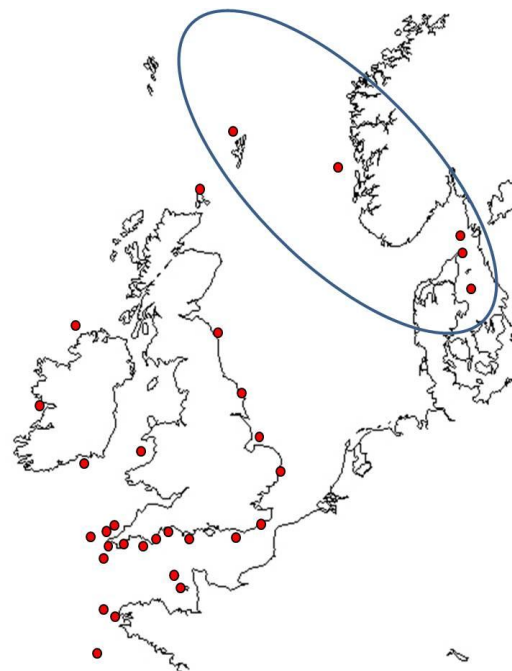


Figure 2: Geographical pattern of putative regional adaptation in brown crab. (Source: Royal Holloway University of London).

#### Where can I find further information about this and related research?

This project was part of work into evolution of marine populations in the research group of Dr Paul Shaw (email: [p.shaw@rhul.ac.uk](mailto:p.shaw@rhul.ac.uk)). Further information can be obtained at <http://www.rhul.ac.uk/Biological-Sciences/AcademicStaff/Shaw/>.

Alternatively, please contact Defra's Marine and Fisheries Science Unit: [marinescience@defra.gsi.gov.uk](mailto:marinescience@defra.gsi.gov.uk).

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