

EXOTIC: EXperimentally Orientated genomics Tackling Insects adaptive Challenges during bioinvasions

Summary of the project

Invasive species raise evolutionary questions as well as ecological and economical problems, but few research programs have considered the specific genetic mechanisms underlying the evolutionary forces that lead aliens species to a better adaptation in the introduced environment.

The Asiatic ladybird *Harmonia axyridis* (HA) originates from Southeast Asia and has been used as a biological control agent in North America and Europe. Yet, it is now considered as an invasive species in these areas. HA has indeed been introduced into new areas since 1916 but established populations were not observed before 1988 in the USA and 2001 in Europe. The main negative impacts include the loss of biodiversity through intraguild predation, pullulation in homes resulting in allergies, and deterioration of fruit and wine quality.

EXOTIC aims at understanding the adaptive changes that have taken place during HA invasion through genome-wide comparison of native, biocontrol and invasive populations. This will be done through an interdisciplinary approach integrating ecology, evolution, analytical chemistry and genomics at several biological levels (genes, phenotypes, individuals and populations) Both experimental studies and population genomics will be conducted to investigate the contemporary evolutionary shifts of several life-history traits that could affect the invasive success of the Asiatic ladybird *Harmonia axyridis* (HA). This will allow deciphering the adaptive pathways underlying the global invasive success of *H. axyridis* and assessing the negative impacts on native ladybird species.

EXOTIC aims at achieving the following outcomes: 1. Developing a single genomic resource for scientists interested in *H. axyridis* genomics 2. Improving methods to identify genomic regions under selection using population Next Generation Sequencing (NGS) data 3. Better understanding the adaptive potential of invasive species populations using key life-history traits 4. Conducting the first comparison between experimental evolution studies and more direct approaches focusing on samples of wild populations 5. Implementing the first well-documented study of the evolutionary shifts and genetic basis of life-history, behavioral and immunity traits during an invasive process.

EXOTIC may be considered as a pilot project using the model species HA. The proposed lines of research are expected to be extended to other species of agro-economic interest.

On a policy and socioeconomic perspective, EXOTIC could have several impacts. For example, information concerning evolutionary shifts and the genetic basis of traits linked to invasiveness could help to identify biocontrol agents that are not destined to become invaders. The project is also expected to help address the numerous negative impacts of HA invasion, by promoting the development of effective management strategies. For example, much of the damage caused by HA originates from its aggregation behavior. Understanding the genetic link between aggregation and invasion could provide strategies for the control of HA using specific attractants and traps. Besides, it

has recently been showed that HA hemolymph (i.e. the circulatory fluid of various invertebrate animals that is functionally comparable to the blood and lymph of vertebrates) contains strong and constitutive antibacterial activity that is not present in native ladybirds. In addition, the analysis of the immunity-related transcriptome led to the identification of 50 antimicrobial peptides, which represents the highest diversity of these defense molecules reported in insects. EXOTIC could therefore have some consequences concerning the development of new anti-infective drugs or pathogen-resistant plants.

To optimize the use of the projects outputs by policymakers and relevant stakeholders, EXOTIC will benefit from the participation of the French applicants in the Grand Federative project BIOFIS (Bioagressors and invasive species: from individual to population to species) of Montpellier Agropolis Foundation (2010-2014). One objective of BIOFIS is to formalize recommendations in management practices against bioagressors and invasive species. We will thus capitalize on this growing network (mainly national services such as ANSES, technical institutes, producers) to boost the dissemination of the EXOTIC research results to other scientists (such as European projects FP7 "PURE" and "IPRABIO") and to non-scientific stakeholders and the general public.

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