

Laboratory Research Project Proposal

Adaptation of poplar rust to the poplar varietal landscape INRA – IAM

| Hosting organization | |
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| Organization | INRA (Institut National de la Recherche Agronomique) |
| Research Unit | UMR1136 IAM Interactions Arbres-Microorganismes |
| | INRA / Université de Lorraine |
| Full Address | Centre INRA de Nancy |
| | Route de l'Arboretum |
| | 54280 Champenoux |

| Contact person | |
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| The research proposal | |
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| Short title of the proposal | Adaptation of poplar rust to the poplar varietal landscape. |
| Long title of the proposal | Adaptation of poplar rust to the poplar varietal landscape: an integrated approach of population genomics, landscape epidemiology and evolution of life history traits. |
| Location | UMR1136 Interactions Arbres-Microorganismes Centre INRA de Nancy 54280 Champenoux |
| Expected starting date | March 2013 |
| Duration | 24 months |
| Research proposal description | Poplar rust, caused by the fungus <i>Melampsora larici-populina</i> , is a major phytosanitary constraint of commercial poplar cultivation in Europe. In the last 50 years many rust-resistant cultivars were bred and released, but since they all relied on qualitative resistance (i.e. major resistance genes), they became all overcome by the pathogen within a short period. We have shown that the breakdown of rust resistance R7 has left deep footprints in the population genetic structure of the pathogen (Xhaard <i>et al.</i> 2011 Mol. Ecol.). The originality of the poplar rust pathosystem for this type of study is the perennial character of the host plant, and thus the stability of the poplar varietal landscape, which provides a constant selection pressure over time. Our goal is to integrate approaches of population genomics, landscape epidemiology and evolution of life history traits of the fungus in order to: <i>(i) Identify genetic signatures of adaptation of the pathogen's populations to the poplar varietal landscape.</i> The poplar varietal landscape will be described at the scale of France, with an estimated frequency of poplar cultivars carrying different qualitative resistance genes on a regional basis. This poplar varietal landscape will be compared to the phenotypic (virulence pattern) and genetic variation at peutral loci and loci involved in |



| | virulence of <i>M. larici-populina</i> populations collected throughout France, in order to test the hypothesis of a structuration of the pathogen's populations by the host and an adaptation to the major resistance genes released. (<i>ii</i>) Assess the ability of the pathogen to adapt to quantitative resistances. In the last decade, breeders have devoted many efforts to develop new poplar cultivars with quantitative resistance to rust, since it is believed to be more durable than qualitative resistance. But quantitative resistance is also challenged by the ability of the pathogen's populations to evolve. The evolvability of <i>M. larici-populina</i> populations will be assessed through the study of variation in life history traits related to aggressiveness level (latency, lesion size, spore production) and dispersal capacities (spore size and shape) of the pathogen, and the study of trade- offs between these traits, assessed through G -matrix comparisons (Nespolo <i>et al.</i> 2009 Evolution). |
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| Keywords | Fungal plant pathogen, host adaptation, landscape, signature of selection, life history traits, evolutionary trade-offs, virulence, aggressiveness, gene-for-gene model |
| Subjects of the research | Landscape epidemiology, population genomics, evolutionary |
| proposal | quantitative genetics, plant pathology |
| Deadline for application | 15 November 2012 |

Required experience and skills of the hosted fellow

Disciplines

LS8_1 Ecology (theoretical, community, population, microbial, evolutionary ecology)

LS8_2 Population biology, population dynamics, population genetics, plant-animal interactions

LS9_5 Agriculture related to crop production, soil biology and cultivation, applied plant biology

LS9_7 Forestry, biomass production (e.g. for biofuels)

Expertise and competences

Candidates should have a good background in ecology, evolutionary biology, and population genetics. Knowledge of host – parasite interactions, especially plant pathology, is not mandatory but would be appreciated. Skills in statistical genetics would also be appreciated.

Hosting conditions and research facilities

The postdoctoral fellow will be hosted by the UMR Interactions Arbres-Microorganismes (ca. 90 persons), within a research theme called "Mechanisms and evolution of the poplar-poplar rust interaction". This new transversal theme (starting in 2013) covers a wide range of disciplines (protein biochemistry, structural molecular biology, genomics and transcriptomics, population genomics and genetics, epidemiology, evolutionary biology, modeling) and gathers expertise and knowledge from 6 researchers with complementary scientific backgrounds. These researchers have a long-standing experience with the poplar-poplar rust pathosystem, and increasing expertise on population genetics and population genomics of the pathogen.

Members of this theme have strong scientific interactions with tree geneticists at INRA Orléans and Evry on durability of resistance genes in poplar. The postdoctoral fellowship will take part in an ANR-funded project (GANDALF, "Genomic and adaptation of fungal life history traits involved in host-pathogen interactions", BioAdapt call, 2013-2016) involving 9 research teams and studying 9 fungal pathogens.

One strength of the poplar-poplar rust pathosystem is the availability of complete genome sequences of both the host (Tuskan *et al.* 2006 Science) and the pathogen (Duplessis *et al.* 2011 PNAS). Another strength is the availability of massive biological resources since we have a unique collection of living isolates of *M. larici-populina* collected worldwide since 1989. The Research Unit houses several well-equipped laboratories dedicated to pathogen culture, phenotyping, genotyping and other molecular biology techniques.



| Financial | resources |
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Estimated gross salary of the hosted fellow

Basic gross salary: 2300 €/month Mobility allowance: 1360 €/month Total = gross salary 3660 €/month:

Ethical issues and limitations

None

Announcement on the AgreenSkills website (protected area)

Investigation of the adaptation of the poplar rust fungus (*Melampsora larici-populina*) to the poplar cultivation through an integrated approach of population genomics, landscape epidemiology and evolution of life history traits. Skills required: ecology, evolutionary biology, population genetics.