

## PhD PROPOSAL FOR THE DOCTORAL SCHOOL « Végétal, Animal, Aliment, Mer, Environnement »

### GENERAL INFORMATION

<b>Thesis title:</b> Divergences and hybridizations into the <i>Venturia inaequalis</i> population complex
<b>Acronym of the project:</b> DivHyb
<b>Disciplinary field 1:</b> Evolutionary Biology <b>Disciplinary field 2:</b> Population genomics
<b>Three keywords:</b> Populations genomics – Hybridization – Life history traits
<b>Registration establishment:</b> Université d'Angers
<b>Research unit:</b> IRHS UMR 1345 UA, INRAE, IA RA
<b>Name of the thesis director HDR (Accreditation to supervise research) required:</b> LEMAIRE Christophe MCU,HDR <b>Email address of the thesis director:</b> Christophe.lemaire@univ-angers.fr <b>Name of the thesis co-director (if applicable):</b> HDR (Accreditation to supervise research) required: <b>Email address of the thesis co-director (if applicable):</b> <b>Name of the thesis co-supervisor 1 (if applicable):</b> <b>Email address of the thesis co-supervisor 1 (if applicable):</b> <b>Name of the thesis co-supervisor 2 (if applicable):</b> <b>Email address of the thesis co-supervisor 2 (if applicable):</b>
<b>Contact(s) (mailing address and E-mail):</b> IRHS Equipe Ecofun, 42 rue G. Morel 49075 beaucouzé
<input checked="" type="checkbox"/> <b>Doctoral school contest</b> <input type="checkbox"/> <b>Interview</b> <input type="checkbox"/> <b>Other (specify):</b>

## SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

### Socio-economic and scientific context: (10 lines)

Apples are the most heavily treated crop in France because of the ascomycete *Venturia inaequalis*, responsible for scab, the symptoms of which are brown spots on the fruit. As the presence of spots on fruit is forbidden in distribution circuits, apple growers have to spray their orchards an average of 25 times a year. Genetics is the most promising lever for combating this disease, but it is necessary to characterise the pathogenic populations of *V. inaequalis*, which are known to be highly adaptable. Six more or less divergent populations have been identified within this species. They are characterised by their origin (wild or cultivated habitat), their host specificity (apple or *pyracantha*) and their virulence. It has recently been shown that the uncultivated habitat can serve as a reservoir of virulence for resistant apple varieties recently launched on the market. It is therefore essential to be able to assess gene flows between the different populations hosted by these different hosts as part of the development of sustainable agriculture that uses fewer pesticides.

### Assumptions and questions (8 lines)

The ability of two divergent populations to hybridise is inversely proportional to their divergence time. In this thesis we propose to evaluate this hypothesis. We will estimate the divergence time and gene flow between 3 pairs of populations of the ascomycete fungus *Venturia inaequalis*, the agent responsible for scab on the Rosaceae family. It is important to know whether and how hybrids are affected in their fitness. Are particular genomic zones responsible for hybrid depression?

### The main steps of the thesis and scientific procedure (10-12 lines)

- 1- Estimation of demographic scenarios (divergence times, population sizes, migrant rates, etc.) between the 6 populations of the fungus *V. inaequalis*
- 2- Assessment of levels of divergence between populations, hybridisation potential and consequences for hybrid fitness
- 3- Identification of genomic areas affected by natural selection (host adaptation)
- 4- Hybridisation and consequences, segregation bias, search for QTLs, search for incompatibility

### Methodological and technical approaches considered (4-6 lines)

**Divergence** The PhD student will have access to 100 genomes to study divergence times between the 6 populations and data from 60 individuals genotyped using SNP 70K chips. Use of demographic inference methods (ABC, dadi, MMC, etc.).

**Hybridisation** The PhD student will have 79 genomes of natural hybrids and 120 genomes of hybrids obtained in vitro. GWAS techniques, local ancestry method, analysis of genomic clines (Bgc), comparison of characteristics, etc.

### Scientific and technical skills required by the candidate

Biologist/bioinformatic profile, capable of processing large amounts of genomic data. Good command of statistics. Knowledge of population genetics desirable.

## THESIS SUPERVISION

<b>Unit name:</b> IRHS	<b>Team name:</b> ECOFUN
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<b>Unit director name:</b> Marie Agnès Jacques	<b>Team director name:</b> Bruno Le Cam
<b>Mailing address of the unit director:</b> IRHS 42 rue Geoges Morel 49071 Beaucouze	<b>Mailing address of the team director:</b> IRHS ECOFUN 42, rue Geoges Morel, 49071 Beaucouze
<p><b>Thesis director</b></p> <p>Surname, first name: Lemaire Christophe</p> <p>Position: MCU HDR</p> <p>Obtained date of the HDR (Accreditation to supervise research): November 2014</p> <p>Employer: Université d'Angers</p> <p>Doctoral school affiliation:</p> <p>Rate of thesis supervision in the present project (%): 100%</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 0%</p> <p>Number of current thesis supervisions/co-supervisions: 0%</p>	
<p><b>Thesis co-director</b></p> <p>Surname, first name:</p> <p>Position:</p> <p>Obtained date of the HDR (Accreditation to supervise research):</p> <p>Employer:</p> <p>Doctoral school affiliation:</p> <p>Rate of thesis supervision in the present project (%):</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):</p> <p>Number of current thesis supervisions/co-supervisions:</p>	
<p><b>Thesis co-supervisor 1 (if applicable)</b></p> <p>Surname, first name:</p> <p>Position:</p> <p>Accreditation to supervise research <input type="checkbox"/> yes <input type="checkbox"/> no If yes, date diploma received:</p> <p>Employer:</p> <p>Doctoral school affiliation:</p> <p>Rate of thesis supervision in the present project (%):</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):</p>	

Number of current thesis supervisions/co-supervisions:
<p><b>Thesis co-supervisor 2 (if applicable)</b></p> <p>Surname, first name:</p> <p>Position:</p> <p>Accreditation to supervise research <input type="checkbox"/> yes <input type="checkbox"/> no If yes, date diploma received:</p> <p>Employer:</p> <p>Doctoral school affiliation:</p> <p>Rate of thesis supervision in the present project (%):</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):</p> <p>Number of current thesis supervisions/co-supervisions:</p>
<p><b>Private partner (if CIFRE funding, private funding...)</b></p> <p>Surname, first name:</p> <p>Position:</p> <p>Employer:</p> <p>Rate of thesis supervision in the present project (%):</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):</p> <p>Number of current thesis supervisions/co-supervisions:</p>
<p><b>International partner (if Cotutelle thesis)</b></p> <p>Surname, first name:</p> <p>Position:</p> <p>Employer:</p> <p>Rate of thesis supervision in the present project (%):</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):</p> <p>Number of current thesis supervisions/co-supervisions:</p>
<p><b>Professional status of previous PhD students supervised by both director and co-supervisors (from 5 years)</b></p> <p><i>Please provide the following information for <u>each</u> PhD students supervised</i></p> <p>Surname, first name: Guitton Ellen</p> <p>Date of PhD beginning and PhD defence: October 2016/May 2020</p> <p>Thesis supervision: C. Lemaire</p> <p>Professional status and location:</p>

in training

Contract profile (post-doc, fixed-term, permanent):

List of publications from the thesis work:

Feurtey, A.\*, Guitton, E.\*, de Gracia Coquerel, M., Duvaux, L., Shiller, J., Bellanger, M. N., ... & **Lemaire, C.** (2020). Threat to Asian wild apple trees posed by gene flow from domesticated apple trees and their “pestified” pathogens. *Molecular Ecology*, 29(24), 4925-4941

**Five main recent publications of the supervisors on thesis subject:**

1- Feurtey, A., Guitton, E., de Gracia Coquerel, M., Duvaux, L., Shiller, J., Bellanger, M. N., ... & **Lemaire, C.** (2020). Threat to Asian wild apple trees posed by gene flow from domesticated apple trees and their “pestified” pathogens. *Molecular Ecology*, 29(24), 4925-4941.

2- Le Cam, B., Sargent, D., Gouzy, J., Amselem, J., Bellanger, M. N., Bouchez, O., ... & **Lemaire, C.** (2019). Population genome sequencing of the scab fungal species *Venturia inaequalis*, *Venturia pirina*, *Venturia aucupariae* and *Venturia asperata*. *G3: Genes, Genomes, Genetics*, 9(8), 2405-2414.

## THESIS FUNDING

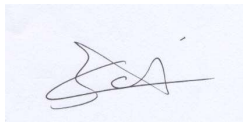
Origin(s) of the thesis funding: ED VAAME
Gross monthly salary: 2 100.00 € (2024) ; 2 200.00 € (2025) ; 2 300.00 € (2026 )
Thesis funding state: Non acquired
Funding beginning date/duration of the thesis funding: 01 11 2024 3 years

Date: 21 03 2024


Name, signature of unit director: Marie Agnès Jacques



Name, signature of team director: Bruno Le Cam



Name, signature of thesis project director: Christophe Lemaire



**All sections must be filled in. Once completed, please save the proposal form in PDF format using the following naming: Supervisor Name\_Unit\_Subject Acronym\_EN.pdf**  
**Please also send a Word version to make it easier to change the layout if necessary.**

**Documents to be send to: [ed-vaame@doctorat-paysdelaloire.fr](mailto:ed-vaame@doctorat-paysdelaloire.fr)**