

Funded PhD position

## Landscape Genomics of Adaptation to a Biocontrol Agent in an Agricultural Pest of Apple Orchards

**Application deadline:** May 15, 2026

### CONTEXT

Adaptation of pest species to control methods is a textbook example of evolution in action. While historically associated with synthetic pesticides, resistance also affects biocontrol agents, challenging their long-term sustainability. These adaptations cannot be understood as simple local responses to selection: their dynamics are fundamentally spatial. At the scale of agricultural landscapes, these spatio-temporal dynamics result from the interaction between selection pressures (driven by agricultural practices) and the dispersal of individuals, which continuously redistributes genetic variants among populations, and are strongly constrained by landscape structure, which determines connectivity.

In this context, understanding and predicting the spatio-temporal dynamics of resistance requires an integrative approach combining genomics, demo-genetics, spatial analyses, and remote sensing, in order to identify the relevant scales for monitoring and management—an essential condition for ensuring the long-term effectiveness of biocontrol strategies.

Within this framework, this project focuses on the adaptation of a major apple pest, the codling moth (*Cydia pomonella*), to a biocontrol agent, the codling moth granulovirus (CpGV). Widely used since the 1990s to reduce reliance on synthetic pesticides and provide an environmentally friendly alternative, CpGV is a cornerstone of orchard protection. However, since its first detection in 2005, resistance to CpGV-based products has increased, compromising the effectiveness of this widely used control method in both organic and conventional agriculture.

### OBJECTIVES AND SCIENTIFIC QUESTIONS

The main objective of this PhD project is to investigate how local and landscape-level selection pressures interact with dispersal and landscape structure to shape the spatio-temporal dynamics of resistance to CpGV in *C. pomonella* across multiple spatial scales. This will be addressed using landscape genomics and demogenetic approaches.

The main research questions include:

- What is the genetic structure of *C. pomonella* populations across spatial scales, and what does it reveal about gene flow and connectivity?
- Which landscape, environmental, and agronomic factors (orchard density and distribution, climate, treatment intensity) influence the frequency and spatial distribution of CpGV resistance?
- Does incorporating landscape connectivity improve the prediction of resistance patterns?
- To what extent can historical sampling series be used to reconstruct the spatio-temporal dynamics of resistance?



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- At which spatial and temporal scales should monitoring and collective management be implemented to optimize the durability of CpGV-based biocontrol strategies?

## WORKING ENVIRONNEMENT

This PhD builds on recent results that have identified the genetic bases and molecular markers associated with adaptation of *C. pomonella* to CpGV (e.g., Olivares et al., 2023). It also relies on the genotyping of more than 6,000 genetic markers (neutral and resistance-associated) from pooled samples collected in over 100 orchards within a production area in southeastern France (Basse Vallée de la Durance study site: <https://site-atelier-basse-vallee-durance.fr/>) and more than 300 orchards in France. These datasets will be further completed during the first year of the PhD. In addition, landscape-level data describing orchard distribution, land use, and agricultural practices are already available for the BVD study site. All these datasets will be used by the PhD candidate.

The PhD will be conducted at INRAE (Plantes et Systèmes de Culture Horticoles unit, Avignon: <https://psh.paca.hub.inrae.fr/>) within the CBC team (Conservation Biological Control). The project will be co-supervised by Bertrand Gauffre (landscape genetics) and Jérôme Olivares (resistance genomics) at PSH, and Anne-Lise Boixel (population dynamics, BIOGER unit, Paris-Saclay).

This PhD is part of interdisciplinary projects, offering a collaborative and stimulating research environment in close interaction with academic partners and stakeholders from the agricultural sector. It is embedded within the PARSADA ASAP project, dedicated to anticipating and managing resistance in agriculture, and the BIODICAPT project (PEPR Agroecology and Digital technology), which uses remote sensing approaches to characterize agricultural landscapes and practices.

## CANDIDATURE

Applicants must hold a Master's degree in biology or an equivalent qualification. A background in ecology and/or evolution, or an engineering degree in life sciences, is required. We are looking for candidates with strong skills in data analysis using R, including spatial analyses (GIS tools, remote sensing data), and a strong interest in landscape genomics and spatial ecology. Good scientific writing skills and strong English skills are expected.

**The application deadline is May 15, 2026 at 12:00 (noon).** The selection process will take place in two stages: a pre-selection by the supervisors, followed by interviews of shortlisted candidates on June 3rd by the doctoral school, which will select the successful candidate.

### Applications must include:

- A CV
- A cover letter (maximum 2 pages)
- Academic transcripts (Master 1 and Master 2 or equivalent)
- Contact details of two referees

To apply or for further information, please contact: [bertrand.gauffre@inrae.fr](mailto:bertrand.gauffre@inrae.fr), [jerome.olivares@inrae.fr](mailto:jerome.olivares@inrae.fr) et [anne-lise.boixel@inrae.fr](mailto:anne-lise.boixel@inrae.fr)

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