PhD student (M/F):

Theoretical and statistical modeling of eco-evolutionary feedback loops from abundance-phenotype time series

See the offer on the CNRS website

Job description

Scientific Context

Eco-evolutionary feedback loops describe the reciprocal interactions between the genetic adaptation of organisms and their biotic or abiotic environment. While environmental components such as competition impose natural selection on morphology, physiology, and behavior, organisms in turn modify their environment through their abundance and traits, thereby influencing the competition acting on phenotypes.

Despite their theoretical and applied relevance, these feedback loops remain poorly understood empirically. Few theoretical or statistical tools currently exist to detect them from observational data in natural settings or to predict their consequences for population dynamics and trait evolution.

Project Presentation

This project focuses on a potentially major feedback loop between body size and population density. Body size is a key ecological trait likely to influence individual reproduction. In return, population density also affects body size, either through plastic responses or by altering the evolutionary optimum via competition intensity.

The project has a dual purpose, both fundamental and methodological:

1. From a fundamental perspective, determine the conditions under which eco-evolutionary feedback loops emerge in natural environments, as well as their eco-evolutionary consequences.
2. From a methodological perspective, assess sampling strategies and modeling tools to detect these loops.

The PhD candidate will develop empirically usable theoretical models, conduct mathematical and numerical analyses to explore model behavior, and use advanced statistical tools to fit models to body size-abundance time series observed in natural conditions. Specifically, they will extend a basic eco-evolutionary model recently developed by our consortium to account for increasing biological complexity (e.g., populations open to dispersal, overlapping generations, population structure) or for specific sampling effects, such as limited capture rates. The

performances of mechanistic eco-evoltionary models built from *a priori* assumptions will be compared with the performances of alternative machine learning-based approaches that will put less emphasis on *a priori* assumptions.

Required Skills

We are seeking a candidate with a master's degree in applied mathematics, theoretical biology, or ecology, who is attracted to fundamental questions in ecology and evolution. Strong training in programming (R, BUGS/JAGS, Python, etc.) and statistics is required (Bayesian and frequentist approaches; knowledge of machine learning would be an asset).

Work environment

This PhD is already funded as part of the collaborative ANR BackOut project (Eco-Evolutionary Feedback Loops out from the Laboratory), which runs from 2025 to 2029 and involves 6 national and international partners. The PhD candidate will be co-supervised by Arnaud Le Rouzic (CNRS Researcher, EGCE, IDEEV, Université Paris-Saclay) and Eric Edeline (INRAE Research Director, DECOD, Rennes) and will benefit from interactions with other project partners , including Julien Papaïx (INRAE BioSP) and Willem Bonnafé (University of Oxford).

The PhD candidate will be based at the EGCE research unit in Gif-sur-Yvette, approximately 35 km south of Paris, on the new Paris-Saclay campus. EGCE is part of the Institute of Diversity, Ecology, and Evolution. Arnaud Le Rouzic's "Genomes and Evolution" group includes 8 researchers and approximately 15 international students and postdoctoral fellows. Regular in-person meetings with the co-supervisor will be organized.

Compensation and benefits

Compensation: 2300 € gross monthly.

Annual leave and RTT: 44 days.

Remote work: possible and financially compensated.

Transport: covered by 75%, or sustainable mobility allowance of up to € 300.

Applications

A CV and a cover letter (mentioning two references) must be submitted through the CNRS application web site, before November 5th 2026 23:59. Preliminary inquiries can be e-mailed to Arnaud Le Rouzic (arnaud.le-rouzic@universite-paris-saclay.fr) and Eric Edeline (eric.edeline@inrae.fr).