MSC proposal 1
Supervised by Dr. Alice Dennis (UNamur) and Dr. Diaga Diouf (Université Cheikh Anta Diop)
2025-2026

Using long-read genomic sequencing to identify adaptive evolution and genomic rearrangements

Genomic changes are a key part of adaptive evolution. Identifying changes and how they allow species to persist in the face of adversity is an interesting way to observe historical and contemporary evolution. Domestication is an important process where human activity selects for specific mutations and accelerates the pace of evolutionary change. In a changing world, this can be fundamental to food security. With this in mind, we are working with lines of cowpeas (*Vigna unguiculata*) that have been **irradiated to induce mutations**. Several of these strains have increased drought tolerance and we are interested in the basis of this.

In this project, the student will sequence whole genomes from several different mutant strains, and compare them to their ancestral lineages. This will offer an opportunity to see evolution in action, and to help understand how different types of mutations have driven adaptation to extreme conditions.

This project will train the student in diverse, integrative methods including:
- DNA extraction
- Whole genome sequencing (Nanopore)
- Assembly and analysis of genome content
- Identification of genes evolving to cope with drought stressors

MSC proposal 2
Supervised by Dr. Alice Dennis (UNamur) 2025-2026

Do dispersal limitations allow for local adaptation in *Myosotella*

The intertidal snail *Myosotella* is found at high tidal elevations across Europe, and has invaded locations around the world (e.g. USA, Canada, South Africa, Iraq). This is perhaps surprising because *Myosotella* reproduces via larvae that can only crawl a very short distance. In this project, we will assess dispersal capabilities by comparing populations on both short and large geographic distances. Specifically, we will:

1. Sample marshes in BE, NL, and FR to collect *Myosotella* and estimate abundance and microhabitat conditions.

2. Use genetic sequencing (e.g. Sanger Sequencing or Illumina) to estimate gene flow among populations

4. (if time permits) construct models of microhabitat use.

This project will train the student in diverse, integrative methods including:
- DNA extraction, PCR
- DNA sequencing
- Field surveys
- Niche modelling

MSC proposal 3: Impact of sperm cryopreservation on offspring quality in Atlantic Salmon (*Salmo salar*)

In conservation programs, sperm cryopreservation is increasingly used, particularly for threatened species. It provides the possibility of preserving a genetic pool across generations without relying on the immediate availability of breeding males. This strategy helps reduce the risk of inbreeding and optimize the management of genetic diversity, a central issue for the success of reintroduction and long-term conservation projects (Almodóvar et al., 2020). However, cryopreservation can alter sperm quality due to various factors, including ice crystal formation, cryoprotectant toxicity, and oxidative stress (Ciereszko et al., 2014; Figueroa et al., 2016; Pérez-Cerezales et al., 2010; Xin et al., 2020). While the effects on gamete viability and motility have been extensively studied in Salmonids (e.g., Dziewulska et al., 2011; Figueroa et al., 2015; 2016; 2018), the potential impact of this technique on offspring remains poorly documented.

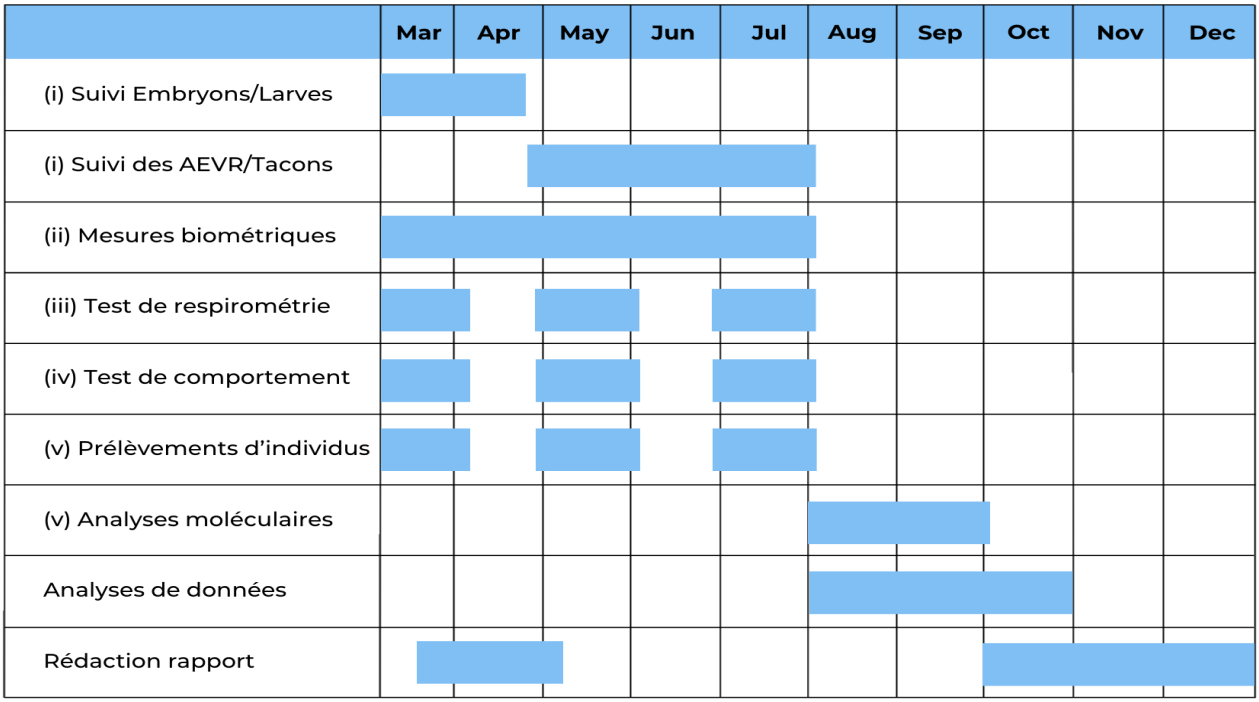
Within the framework of Atlantic salmon (*Salmo salar*) restoration efforts in the Meuse River basin, the limited availability of wild males (low return of spawners and a female-biased sex ratio) constitutes a major obstacle to the success of restocking programs (Benitez et al., 2020). In this context, sperm cryopreservation appears as a strategic option to safeguard and optimize reproductive efficiency. Numerous cryopreservation protocols have been developed for Atlantic salmon (Lahnsteiner, 2000; Horváth et al., 2012) and already allow fertilization rates comparable to those obtained with fresh sperm (Erraud et al., 2022). Nevertheless, the effects of this technique on offspring remain controversial. It has been suggested that cryopreservation could lead to artificial selection of sperm, alter certain average phenotypes of the progeny, or induce changes in genetic and/or epigenetic integrity transmitted to the zygote. These effects could influence development and only manifest at later stages, after the initial phase dominated by maternal effects, but they have not yet been evaluated.

Project Objective:

The objective of this project is to compare the effects of fresh and cryopreserved sperm on the development of Atlantic salmon, from the embryonic stage to the fry stage, including the emerging alevin with resorbed yolk sac stage (the release stage in natural environments for reintroduction). Embryonic and larval stages will be studied at the University, while monitoring at the resorbed yolk sac and fry stages will be conducted in river cages (Samson site) to reproduce conditions close to the natural environment. The parameters studied will include: (i) survival at critical stages such as eyed-egg, hatching, and emergence; (ii) biometric variables including individual size and weight; (iii) physiological measures, such as respirometry; (iv) behavioral observations, notably via the startle test; and (v) molecular analyses using qPCR targeting genes involved in development (brain) as well as immunity (liver and spleen). This project is expected to provide essential knowledge on the consequences of sperm cryopreservation in Atlantic salmon, with direct implications for salmonid conservation and population management programs.

Additionally, the student may participate in electrofishing campaigns (on foot or by boat) according to the team's needs.

Planning :


Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(i) Suivi Embryons/Larves
(i) Suivi des AEVR/Tacons
(ii) Mesures biométriques
(iii) Test de respirométrie
(iv) Test de comportement
(v) Prélèvements d'individus
(v) Analyses moléculaires
Analyses de données
Rédaction rapport

MSC proposal 4: The phenotypic plasticity of temperature tolerance in ants

To cope with thermal stress, insects can upregulate physiological mechanisms that buffer and repair heat-induced injuries, thereby enhancing their heat tolerance through thermal acclimation (phenotypic plasticity). However, how this acclimation capacity relates to local climatic gradients across space and time remains poorly understood in insects. In particular, do populations that naturally experience greater thermal variability, more extreme climates, or stronger seasonality possess a higher ability to mount acclimatory responses to thermal challenges? Addressing these questions is central to advancing our understanding of ecophysiology.

This project will use populations of European ant species already sampled across a latitudinal gradient (Finland, Belgium and France), with the aim of testing whether different acclimation regimes impact phenotypic cold and/or heat tolerance differentially across populations diverging in local climates. The student will (i) handle and care for live ant colonies, (ii) use different short acclimation regimes (e.g. a few days of exposure) to record (iii) heat and/or cold tolerance across populations using several metrics (CT_{max}, CT_{min}, survival curves, etc.). Finally, potential variations in acclimation potential across populations will be related to (iv) the climatic variability of sampling locations, using databases such as WorldClim and SoilTemp.

Figure 1. Two species of potential interest for this project: *Formica fusca*, the black European ant, and *Camponotus herculeanus*, the giant carpenter ant