Project title: Sensing and transmission of environmental signals across generations

Host institution: University of Warwick

Theme: Evolution

Key words: Cross-generational inheritance; stress; sex determination; germline; evolution; nematode

Supervisory team (including institution & email address):

Andre Pires da Silva (andre.pires@warwick.ac.uk) and Robin Allaby (R.G.Allaby@warwick.ac.uk)

School of Life Sciences, Gibbet Hill, CV4 7AL, Coventry

Project Highlights:

- This project will focus on mechanisms by which organisms rapidly respond to sudden environmental changes.

- We will use an animal model in which the mother senses environmental stress signals to produce stress-resistant progeny.

- The project will include the use of the most recent genome-editing tools, as well as biochemistry, and next-gen sequencing.

Overview

Sudden environmental changes are challenging for the survival of many organisms. Some of these organisms evolved mechanisms to cope with uncertainty, by sensing the environment and transmitting selected adaptive traits to the next generation.

We use the nematode *Auanema freiburgensis* as model to study the mechanisms by which environmental signals sensed by the mother results in the modification of the germline to produce stress-resistant progeny. In this nematode, chemicals produced by nematodes of the same species are used as signals for overcrowding. Thus, by sensing these chemicals, the mother ‘prepares’ the progeny to withstand the lack of food that occurs in overcrowded conditions. The progeny arrests development in the form of larvae, and can survive in the absence of food for several months. Once in a benign environment, the larvae resume development to become self-fertilizing adults. The main objectives of the project are to identify the chemical nature sensed by the mothers, how the sensory neurons convey the information to the gonad, and how the germline changes result in different kinds of progeny.

![Conceptual framework](image)

**Figure 1:** Conceptual framework. An environmental trigger changes the state of the soma, which sends a signal to modify the germline.

Methodology:

Chemicals will be isolated from nematode cultures and tested for their influence on the sex determination and stress-resistance in the F1 generation. To identify the neuron sensing the chemicals, single cells will be tested by killing them with the use of a laser microbeam. The nature of the communication signal between the neuron and the germline will be tested by doing gene knockouts using the genome editing technology. Changes in the germline upon neuronal signal will be tested using immunoprecipitation with antibodies recognizing histone modification markers.

Training and skills: Maximum 100 words – excluding CENTA training information

Students will learn to use the latest genome editing technologies (CRISPR/Cas9) to inactivate gene function and to tag genes to visualize their time and site of expression. Furthermore, students will acquire skills in bioinformatics (learn how to code in Unix and R), how to ablate single cells and immunocytochemistry. In addition, students will learn how to organize and execute their experiments in a timely fashion, how to
document experiments, prepare presentations, write professional articles and work in a team. Many of those skills are transferable to other disciplines and professions.

CENTA students are required to complete 45 days training throughout their PhD including a 10-day placement. In the first year, students will be trained as a single cohort on environmental science, research methods and core skills. Throughout the PhD, training will progress from core skills sets to master classes specific to CENTA research themes.

Partners and collaboration (including CASE):
The chemical characterization of the signals produced by nematodes will be in collaboration with the chemist Frank C. Schroeder at Cornell University (USA). The characterization of gene expression changes will be performed with the collaboration with the laboratory of Oded Rechavi at Tel-Aviv University (Israel).

Possible timeline:
**Year 1:** Fraction and test chemicals produced by the nematode. Make laser ablations of single neurons.
**Year 2:** Generate mutants for neuroamines and neuropeptides using CRISPR/Cas9. Characterize mutants. Start immunocoprecipitation experiments.
**Year 3:** Transcriptome analysis of animals exposed to defined chemicals. Characterize candidate genes involved in cross-generational inheritance using genome editing technologies.

Further reading:

Further details:
Andre Pires da Silva
University of Warwick
Email: andre.pires@warwick.ac.uk