Master internship
2024-2025
Team Delattre

ENS DE LYON

Exploring the emergence of a new sex chromosomes in species with vanishing males

Ecole Normale Supérieure de Lyon
Laboratoire de Biologie et Modélisation de la Cellule
https://www.ens-lyon.fr/LBMC/equipes/NematodeCell

Scientific background

We work on a group of nematode species featuring a progressive loss of males and sexuality, whereby sperm cells are essential for activating the development of eggs but do not contribute any gene to their female progeny. By contrast sperm DNA is transmitted in only 10% of fertilisation events, and when it is, it always gives males. Males are thus rare, making up ~10% of the population (*1*, *2*). Surprisingly, we recently uncovered that this 'pseudosexual' reproductive system is linked to the emergence of a neo-Y chromosome: while closely-related sexual species have a XX/XO sex chromosome system, the pseudosexuals are XX/XY (Figure 1). We also showed that while males produce both X- and Y-bearing sperm, the Y-bearing sperm are much more successful at fertilising oocytes (*1*). Based on this, we hypothesise that the Y chromosome allows the males to "fight back" under a scenario of sexual conflict.

Project description

Th goal of the project is to i) reconstruct the evolutionary origin of the neo-Y chromosome (did it emerge after fusion of the ancestral X with an autosome, or is it derived from a new pair of autosomes), ii) uncover the function the Y-linked genes, their origin and their rate of evolution, iii) analyze the role of the Y-linked genes. In particular, we will search for genes that favors the Y-bearing sperm at fertilisation. To this end, you will compare the genomes of sexual and pseudosexual species for which we have already assembled the genomes and predicted the sex chromosomes. Thanks to a strong

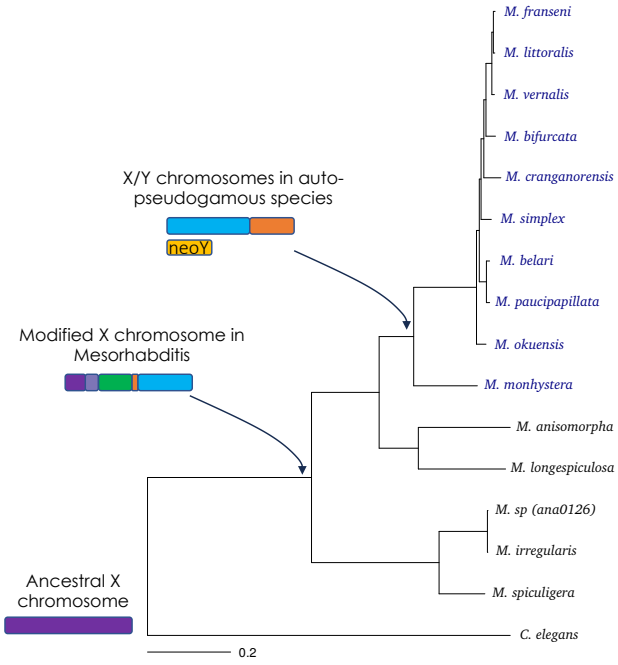

Figure 1: Phylogeny of the genus *Mesorhabditis*, with colored rectangles showing the X and Y chromosomes. Chromosomes are coloured according to ancestral origin: while the X chromosomes of C. elegans is fully purple, the X of Mesorhabditis has diverged at the base of the genus, and the 'rare-male' species (in blue) have further evolved a Y chromosome. **You will reconstruct the events that have led to these transitions.**

synteny in genes in nematodes, it is possible to reconstruct the history of karyotype changes (*3*).

What you will learn

The project can be oriented towards bioinformatics, bench work (to test Y-linked gene function) or a combination of the two, depending on the profile and interest of the applicant. You will learn how to independently develop ideas, pursue a research project and communicate your results in oral and written form

Wet lab: you will learn nematode rearing, genome engineering (CRISPR/Cas), molecular biology and microscopy.

Dry lab: you will handle 3rd generation (PacBio, Nanopore) and Hi-C sequencing data. You will work on 'chromosome painting" with BUSCO, develop scripts in Python and bioinformatic pipelines in Nextflow.

Your qualification

We are seeking a student with strong interest in genomics and evolutionary biology.

Host environment and contact: you will work in a team that mixes computational and wet-lab approaches to understand the evolution of reproductive systems (https://www.ens-lyon.fr/LBMC/equipes/NematodeCell). Send a CV and a cover letter to Marie Delattre marie.delattre@ens-lyon.fr and to Brice Letcher brice.letcher@ens-lyon.fr

References (*from the lab)

1. *M. Grosmaire, C. Launay, M. Siegwald, T. Brugière, L. Estrada-Virrueta, D. Berger, C. Burny, L. Modolo, M. Blaxter, P. Meister, M.-A. Félix, P.-H. Gouyon, M. Delattre, Males as somatic investment in a parthenogenetic nematode. *Science* **363**, 1210–1213 (2019).
2. *C. Launay, M.-A. Félix, J. Dieng, M. Delattre, Diversification and hybrid incompatibility in auto-pseudogamous species of Mesorhabditis nematodes. *BMC Evol. Biol.* **20**, 105 (2020).
3. S. Tandonnet, G. D. Koutsovoulos, S. Adams, D. Cloarec, M. Parihar, M. L. Blaxter, A. Pires-daSilva, Chromosome-Wide Evolution and Sex Determination in the Three-Sexed Nematode Auanema rhodensis. *G3 Bethesda Md* **9**, 1211–1230 (2019).