Science and Technology Group

Annual Report FY2025

Matin Miryeganeh
Science and Technology Associate

1. Introduction

My research investigates how plants adapt to environmental change through genomic and epigenomic regulation, using mangrove trees as natural model systems. Mangroves thrive under extreme and fluctuating conditions such as high salinity, hypoxia, and tidal stress, making them ideal systems to study molecular mechanisms of climate resilience.

During FY2025, my research focused on completing a multi-year field-based epigenomic project examining how environmental stress history influences plant molecular responses. This work integrates whole-genome DNA methylation profiling and time-series transcriptomics to understand how plants retain and reset environmental information during changing conditions.

The project builds toward a mechanistic understanding of plant stress memory and plasticity in natural ecosystems, contributing to broader efforts to predict plant resilience under climate change.

2. Activities and Findings

2-1. Completion of Stress Memory Project

In FY2025, I completed analysis of a large reciprocal transplant experiment in the mangrove *Bruguiera gymnorhiza*, investigating how plants respond to changes in salinity environments.

Using time-resolved epigenomic and transcriptomic datasets collected over multiple weeks following environmental transfer, the study revealed that:

- DNA methylation acts as a **transient and reversible mediator of environmental memory**, rather than a permanent regulatory mark.
- Plants transferred from high-salinity to lower-salinity environments temporarily retain inherited epigenetic signatures that are progressively erased during acclimation.
- In contrast, exposure to increased salinity triggers gradual installation of new methylation patterns associated with stress responses.
- Epigenetic regulation primarily coordinates the **timing and stability of transcriptional responses**, rather than directly controlling nearby gene expression.

These findings provide field-based evidence that plant stress memory operates as a dynamic regulatory process shaping adaptation during environmental transitions.

A manuscript describing this work has been submitted and is currently under peer review.

2-2. Grant Milestone: JST FOREST Stage-Gate Review

FY2025 marked completion of Phase 1 of my JST FOREST (Fusion Oriented REsearch for disruptive Science and Technology) project.

The project successfully passed the program's Stage-Gate Review, which included submission of progress reports, evaluation documents, and an oral interview and presentation. Following this evaluation, the project was approved to proceed into Phase 2, enabling continuation of the research program for an additional four years (with potential future extension).

This milestone recognizes the project's progress toward establishing an integrative framework linking epigenomics, environmental adaptation, and climate resilience in long-lived plant systems.

3. Group Members (2025)

- Runrun Han (Research assistant)
- Lucas Yutaka Kimura (Research assistant)
- Yuko Abe (Research assistant)

4. Collaborators

- Dr. Wen-Hsin Lu (OIST)
- Prof. Yukiko Goda (OIST)
- Dr. Kaoru Tsuji (University of Tsukuba)
- Dr. Theofylaktos Apostolou (Chief Scientific Officer, EMBIO Diagnostics)
- Dr. James Kairo (Chief Scientist, Kenya Marine and Fisheries Research Institute, Kenya)
- Prof. Anusha Rajkaran (Department of Biodiversity and Conservation Biology, University of the Western Cape, South Africa)

5. Publications

Miryeganeh, M. (2025) Asymmetric salinity change reveals transient DNA methylation stress memory in a mangrove tree. Manuscript under review.

6. Conferences and Scientific Meetings

- JST Fusion Meeting. Kyoto, Japan. July 2025.
- JST Panel Meeting. Okayama, Japan. February 2026.

7. External Funding

1. **Japan Science and Technology Agency, FOREST (Fusion Oriented REsearch for disruptive Science and Technology) program**
   PI: Matin Miryeganeh, FY2023 ~ FY2030, Grant: 50,000,000 JPY (Phase 2 approved following Stage-Gate Review)
2. **Japan Society for the Promotion of Science (JSPS), KAKENHI**
   PI: Matin Miryeganeh, FY2023 ~ FY2025, Grant: 5,000,000 JPY

8. Grant Applications (Under Review)

1. JST–AJ-CORE Joint Call, 2026 — Under Review
Miryeganeh, M. (PI, Japan), Kairo, J. (PI, Kenya), Rajkaran, A. (PI, South Africa).
Mangrove Futures: Integrating Genomics, Ecology, and Restoration Science for Climate-Resilient Coastal Ecosystems.
International collaborative proposal integrating genomics, ecology, and restoration science for mangrove climate resilience. Status: Under review.

2. OIST Proof-of-Concept (POC) Program — Shortlisted (Interview Stage)
Miryeganeh, M. (PI).
Mangrove Monitoring Platform: Molecular Early-Warning System for Coastal Ecosystem Stress.
Proposal shortlisted and invited for pitch presentation. Final decision pending.