

【Grant-in-Aid for Scientific Research (S)】

Biological Sciences (Biology)



Title of Project : Sex differentiation in land plant: mechanism of genetic robustness and plasticity

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Research Area : Basic biology, Plant molecular and physiological science

Keyword : Land plant, Sexual determination, differentiation and reproduction, Environmental response

【Purpose and Background of the Research】

Establishment of germ cell line and regulation of gametogenesis are essential in sexual reproduction of multicellular organisms. Land plants are unique in their life cycle, in which the multicellular gametophyte (haploid, n) and sporophyte (diploid, $2n$) generations alternate. Bryophytes are basal land plants and have a gametophyte-dominant life cycle. Availability of genomic resources and molecular genetic tools has turned the liverwort *Marchantia polymorpha* into a model for investigating the evolution of land plants. In *M. polymorpha*, the sexual development is initiated in an environment-dependent manner. Its sex is determined by a gene on the female sex chromosome, *Feminizer*. We have identified the master regulator for sexual development, *BONOBO*, and its downstream transcription factor, *FGMYB*, which promotes female gametogenesis. We also identified a gene that encodes long non-coding RNA (lncRNA), *Suppressor of Feminization (SUF)*, which is expressed specifically in male and suppresses feminization. Focusing on this regulatory module, this study aims to elucidate the regulatory principles underlying the establishment of germ cell line and sexual differentiation in the gametophyte generation of plants.

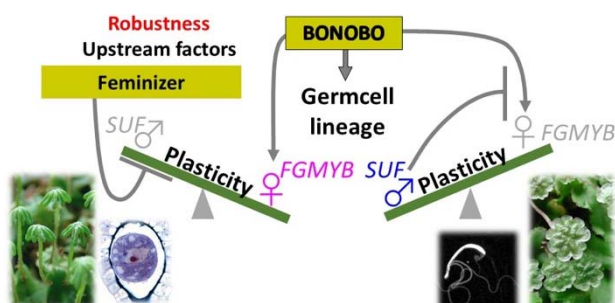


Figure 1 Regulation of sexual differentiation

【Research Methods】

We plan to (1) investigate the mechanism by which *BONOBO* induces *FGMYB* using promoter analysis and ChIP assay, (2) identify *Feminizer* on the female sex chromosome by examining sex-reversed mutants, (3) investigate the mechanism by which

SUF regulates the expression of *FGMYB* focusing on the structure and function of the lncRNA and the chromatin status at the locus, and (4) identify factors that play direct roles in *FGMYB*-driven feminization by examining phenotypes at a series of developmental stages and comparing different plant species.

【Expected Research Achievements and Scientific Significance】

Most studies on the mechanisms underlying sex determination and differentiation in plants focus primarily on organogenesis in the sporophyte generation. The novelty and significance of this study is to address the sexual development in the gametophyte generation. The regulatory framework of sex differentiation in the basal land plant should become a foundation for elucidating the robustness and plasticity of sex differentiation and the universal and diverse aspects of gametogenesis during the evolution of plants.

【Publications Relevant to the Project】

- Kubota, A. *et al.*, Co-option of a photoperiodic growth-phase transition system during land plant evolution, *Nature Comm.*, 5, 3668 (2014).
- Inoue, K. *et al.*, Phytochrome signaling is mediated by PHYTOCHROME INTERACTING FACTOR in the liverwort *Marchantia polymorpha*. *Plant Cell*, 28, 1406-1421 (2016).
- Bowman, J.L.* , Kohchi, T.* , Yamato, K.T.* , *et al.*, Insights into land plant evolution garnered from the *Marchantia polymorpha* genome. *Cell*, 171, 287-304 (2017).* Co-corresponding authors

【Term of Project】 FY2017-2021

【Budget Allocation】 141,500 Thousand Yen

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