【Grant-in-Aid for Transformative Research Areas（A）】

Genomic dynamics underlying the plastic hermaphroditism in plants : the basis of exploratory reproductive adaptations.（Innovative Plant Reproductive Systems）

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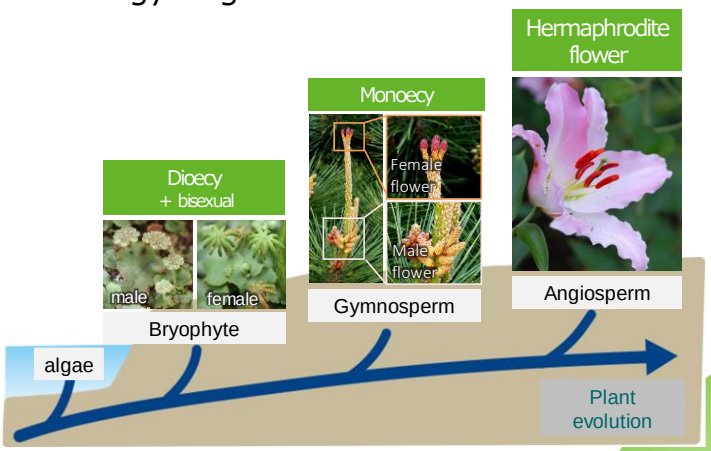
Research Area Information	Number of Research Area : 22A303　Project Period (FY) : 2022-2026 Keywords : Reproduction, Genome evolution, Interdisciplinary fusion

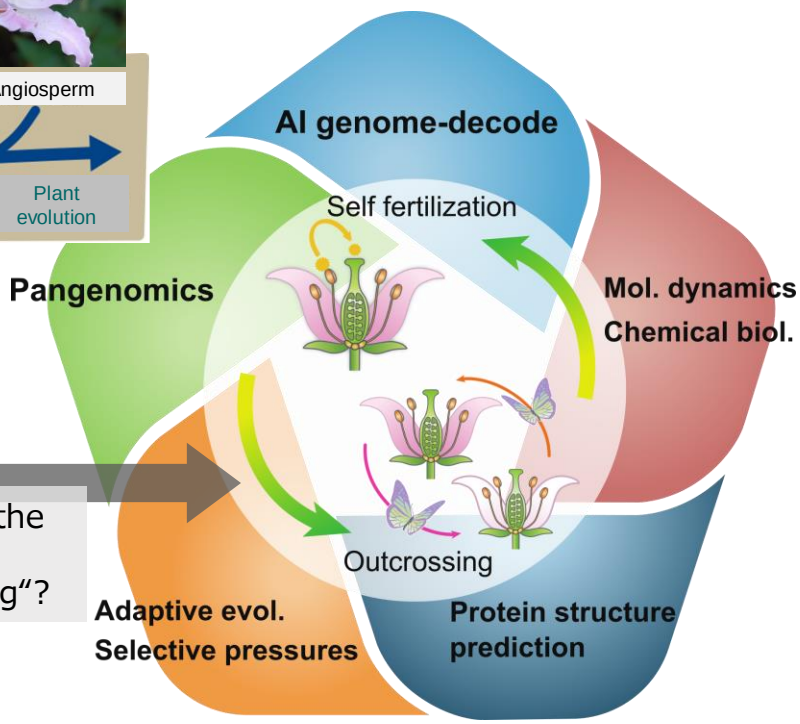
Purpose and Background of the Research

●Outline of the Research

What triggers the plastic transitions between "self fertilization" and “outcrossing“?
Plants have evolved “flower”, which is the reproductive organ to make next generations. Most of the flowers are hermaphrodites, sharing male and female functions. At glance, this bisexuality may be thought to promote only self-fertilization, but not to maintain genetic diversity. Thus, plants have established various outcrossing systems on hermaphrodite flowers, including self-incompatibility, which distinguishes between self- and non-self-pollen, or separated sexuality.
Plants, unlike animals, are unable to move, so they have to genetically switch their reproductive system between "self fertilization" and “outcrossing“ to adapt to the environment. This genetic switching exhibit “very fast evolution", which have been historically recorded in the plant genomes. In this research area, we are trying to elucidate the genome dynamics that drives the "fast reproductive evolution“, from a new interdisciplinary viewpoints, including the application of advanced information technology to genome data.



Evolution of hermaphrodite flower



What genome dynamics trigger the plastic transitions between "self fertilization" and “outcrossing“?

Figure 1. Concept of our research area: Transitions of reproductive systems in plants, unveiled via interdisciplinary approaches.

● **Hermaphrodite flower, a versatile reproductive system promoting hybridization with others**

The hermaphroditic flower would be an "elegant system" that enables not only self-fertilization but also outcrossing. There, various outcrossing systems, including sexuality, self-incompatibility, and attraction of pollen-carrying insects, have been established. We would like to clarify the mechanisms triggering these reproductive systems, to finally gain insights into their commonality along the process of plant evolution. Through comparisons of genetic changes and genome evolution, we aim to uncover key dynamics for the “versatile reproductive system" that is unique to plants.

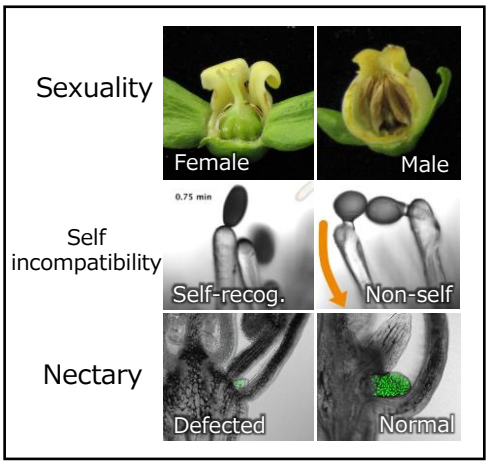


Figure 2. Various outcrossing systems in plant

Expected Research Achievements

● **Elucidating the factors behind the ‘Innovative' plant reproductive systems**

A number of studies, so far, have unveiled various reproductive systems specific to each plant species. These studies have revealed that plant reproductive systems have rapidly and constantly changed. Here, we will bundle these individual findings to integrate the diverse reproductive mechanisms across the plant evolution. This would shed light on the potential factors common to transitions of various reproductive mechanisms and reveal the key to driving their ‘innovation'.

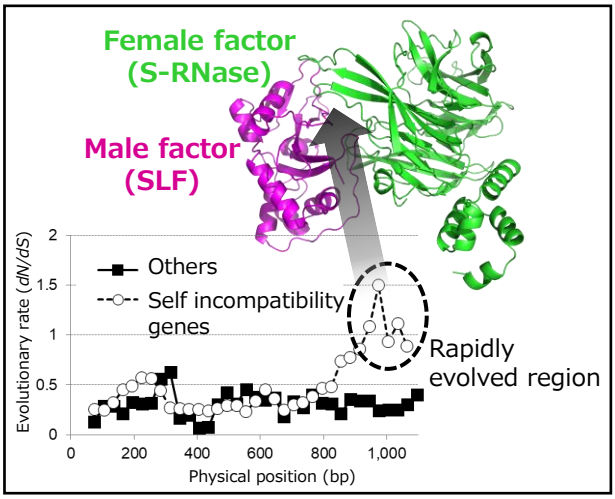


Figure 3. The rapid evolution of the male-female interactive domain in self-incompatibility genes.

● **Designing novel cultivation/breeding systems based on the plant reproductive diversity**

The knowledge of various mechanisms for switching self-fertilization and outcrossing, can be actively utilized with the aim of agricultural implementation. Application of recent genomic technologies, such as gene-editing, on the found genomic/genetic factors, would enable ‘the design of a novel reproductive system that has not existed in the current crops’, to construct a new model for crop production and breeding.

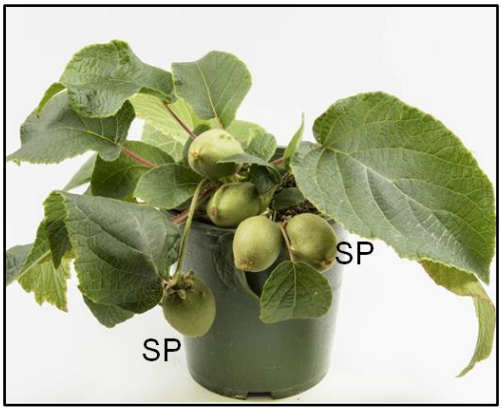


Figure 4. Design of “rapid flowering & hermaphrodite” kiwifruit, based on our results.

● **Creation of 'new academic perspectives' through interdisciplinary fusion**

We aim to create a 'fusion of different disciplines' in plant science, with advanced informatics, including AI technology, as the core of the network, to interconnect chemical technology, structural biology, evolutionary and genome science.

Homepage Address, etc.	https://www.ige.tohoku.ac.jp/prg/flower/