Biological Sciences

Title of Project：Intrinsic periodicity of cellular systems and its modulation as the driving force behind plant development

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【Purpose of the Research Project】

Plants continue to produce new tissues and organs throughout their life. Owing to these growth characteristics, periodically repeated structures appear in many scales in plant bodies (Fig.1). An important point to note for plant periodic structures is that the periodicity can readily change in response to both internal and external cues. This "modulation of periodicity" appears to be the basis for developmental plasticity in plants.

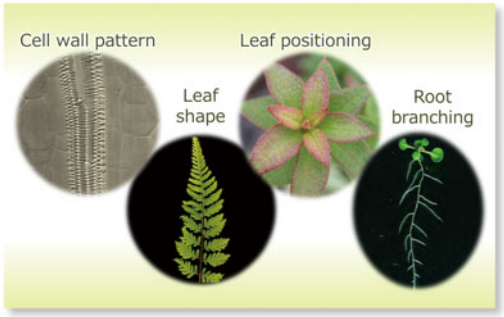

Fig.1 Plants produce periodic structures in many scales

Mechanisms producing periodic structures in organisms are best studied for somitogenesis and epidermal patterning in animals. In the case of plants, root branching and phyllotactic leaf patterning are known to be correlated with periodic hormonal responses in time and space. However, molecular determinants of their periodicity and upstream modulators are so far unknown.

【Content of the Research Project】

In this project, we work to elucidate the mechanisms of periodic structure development in plants and their role in establishing species-specific morphologies and growth plasticity. Special interests are directed to generators of oscillations and mechanisms modulating the periodicity. Close collaboration between plant biologists, information scientists, and mathematical biologists is one way to accelerate the project. Here, plant biologists analyze growth and developmental dynamics on many scales by live imaging analysis and searching for regulatory factors. Mathematical biologists take the approach of modelling oscillations and morphogenesis. Information scientists develop novel tools to help with the biologists' discoveries and data interpretations. Notably, organized collaboration between information scientists and plant developmental biologists is unprecedented, and one of the challenges of research which we are seeking to address in this project.

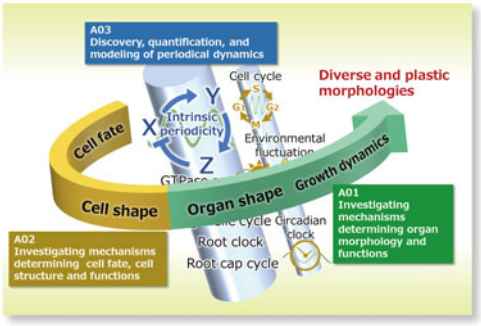

Fig.2 Reconstructing the principles of plant development based on periodicity and its modulation

Interdisciplinary collaboration in this project is meant to be not just a form of technical complementation, but also an ideology of working synergistically to develop new tools and technologies. Once established, such tools and technologies will be shared by the project members. Fostering young researchers with interdisciplinary mindsets is another important goal of this project.

【Expected Research Achievements and Scientific Significance】

Elucidation of mechanisms which generate periodic structures and their modulation will provide answers to fundamental questions in plant developmental biology. Additionally, identification of genes associated with plant periodic structures is important for crop breeding, as plant productivity can be dramatically improved through mutations affecting the number of repetitive units.

【Key Words】

Oscillation in biology: In many biological systems, mechanisms exist to produce periodic behaviors autonomously. Periodic structures in plants are thought to derive from some sort of autonomous oscillation, though their molecular identities are so far unknown.

【Term of Project】 FY2019-2023

【Budget Allocation】 1,159,900 Thousand Yen

【Homepage Address and Other Contact Information】

http://plant-periodicity.org