Mysterious plants that do not travel but stay put A world's first! Supports Darwin's hypothetical theory published in *Nature*

Professor Masao Watanabe

Laboratory of Plant Reproductive Genetics, Division of Genetic Ecology, Department of Environmental Life Sciences, Graduate School of Life Sciences

Born in Ehime Prefecture in 1965. Graduated from the Department of Agronomy, Faculty of Agriculture, Tohoku University. Completed the first half of the doctoral course of the Division of Agricultural Sciences, Graduate School of Agricultural Science, Tohoku University. Acquired a Ph.D. in Agricultural Studies. Assumed positions of Assistant Professor at the Faculty of Agriculture, Tohoku University, then Associate Professor at the Faculty of Agriculture, Iwate University, then invited Professor for a 21st Century COE Program at Iwate University. Has been in current position since 2005.

http://www.ige.tohoku.ac.jp/prg/watanabe/

Brassica plants are used as research material. It is important for human beings to understand the fertilization of plants, because they eat their seeds/fruits. If climate change is drastic in the future, plants may evolve by changing their genes. The mystery posed by Darwin is still left unsolved.

Plants do not speak, nor can they travel freely. However, they have their own ways of taking in outside information. In 1876, Charles Darwin, who put forward the theory of evolution, proposed the hypothetical theory that self-fertilization, i.e. being pollinated with their own pollen, was advantageous for plants in an environment with few breeding partners. This spring, research results that support this hypothetical theory were published in *"Nature."*

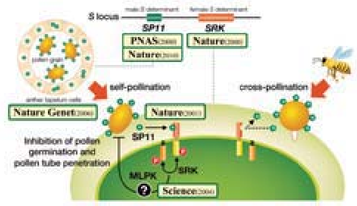
For many plants, if the stigma surface is pollinated with the plant's own pollen, this pollen is rejected, and as a result no seeds will be produced. This is because plants have the ability to distinguish their own pollen from other plants' pollen, i.e., self-incompatibility (SI). This trait is to prevent inbreeding depression, which is observed in most of animals and plants, including human being. On the other hand, there are self-compatible (self-fertilized) plants, like rice and *Brassica* plants. Why do these plants accept their own pollen? Professor Masao Watanabe and his collaborators elucidated the molecular mechanism of the evolution of SI.

Arabidopsis thaliana, known as a model plant, is self-compatible. Professor Watanabe, *et al.,* surveyed several ecotypes of *A. thaliana,* and found one ecotype (Wei-1) having functional *SRK* (female *S* determinant) and non-functional *SP11* (male *S* determinant). After modifying and repairing the non-functional *SP11*, the repaired (functional) *SP11* was introduced into Wei-1 ecotype. The transgenic *A. thaliana* showed the SI phenotype. This is the first case of success in artificial SI in *A. thaliana* using modified gene introduction in the world. Since Darwin, researchers have discovered how finely plants have adapted to various environments in wonderfully sophisticated ways. The data from Professor Watanabe's group is the first case of demonstration of the evolutionary process at the gene level.

Professor Watanabe has also done outreach activities at elementary and junior/senior high schools more than 100 times. In the future, he is looking forward to doing research with children. His ideas and ambition will be passed on to the next generation in this way. "A whole understanding of the molecular mechanism of plant activities should elucidate the problems of environments, food, and energy," says Professor Watanabe.

Members of Prof. Watanabe's laboratory. They do cross-breeding experiments of rapeseed plants at the green house. They cultivated several cruciferous plants, including cabbage, Chinese cabbage and radish (self-incompatible), and *Arabidopsis thaliana* and other wild relatives (self-compatible).

Spring is the important season for collecting the stigma (i.e., the top of the pistil) and anther (i.e., the top of the stamen) of Brassica flowers. This work requires picking up one stigma with a weight of 0.1 mg one at a time with tweezers. In one season, the members of laboratory will collect tens of thousands of stigma and/or anthers in total for several experiment.



A figure of a schematic model for the recognition mechanism of SI in cruciferous plants including turnips, cabbage, and Chinese radish. Self and non-self pollen are transferred to the stigma's surface by insects, like honey bees. If self pollen pollinates the stigma surface, SP11 (male *S* determinant) and SRK (female *S* determinant), bind, and SI reaction (rejection of self pollen) occurs. In contrast, when pollinated with non-self pollen, SP11 and SRK do not bind, and the pollen tube can penetrate into the papillar cells of the stigma surface. The scientific journals, in which our experimental results were published, are shown in the figure.

My favorite

"I still sharpen pencils by hand. So I need a knife. Tweezers are a very important tool for genetic experiments. I grind them by myself. And I always have candies for the throat, because I do a lot of lectures," says Professor Watanabe. Apart from them, on his desk there are shells of cicadas, models of a whale and seal, a miniature set of cabbages, Chinese radishes and Chinese cabbages, and so on. They are very important items to make his space comfortable and give him good ideas for experiments. There are three chestnuts in a pocket of his white coat—playing with them is helpful when he is thinking.