Research direction

Arbuscular mycorrhizal symbiosis

Personal Profile

Education:

Mar 2010: B.S. in Agriculture, The University of Tokyo

Mar 2012: M.S. in Agriculture, The University of Tokyo

Mar 2015: Ph.D. in Agriculture, The University of Tokyo

Working experience:

Apr 2015–Mar 2018: Postdoctoral Fellow, National Institute for Basic Biology

April 2018–May 2020: Japan Society for the Promotion of Science Research (JSPS) Fellow

June 2020–Aug 2022: Assistant Professor, Tohoku University

Research work

Our group studies arbuscular mycorrhizal (AM) symbiosis. AM symbiosis started shortly after plant terrestrialization and is currently conserved in more than 70% of land plants. The elucidation of AM symbiosis is important for understanding plant physiology, ecology, and evolution. We aim to understand how plants and AM fungi find and recognize each other and focus on the signaling molecules. We are also trying to establish new fundamental experimental systems for AM symbiosis research, including axenic culture and transfection.

Main Achievements

1. Axenic culture of AM fungi

AM fungi supply inorganic nutrients to plants in exchange for carbon sources from plants. They play important roles in terrestrial ecosystems and are used in agriculture as biofertilizers. However, AM fungi cannot proliferate alone because they do not produce spores without host plants, which disturbs both basic research and agricultural applications of AM fungi. We focused on the finding that cocultivation of AM fungi with some bacteria induces the spore formation in AM fungi and isolated branched-chain fatty acids from the bacteria as the compounds inducing spore formation. We also found that palmitoleic acid induces more spores and that palmitoleic acid-induced spores can colonize host plants and form the next generation of spores (Kameoka *et al.*, 2019. *Nat. Microbiol*). Based on these results and our following studies (Sugiura *et al.*, 2020. *PNAS*; Tanaka *et al.*, 2022. *Commun. Biol.*), we established the first AM fungus axenic culture system, which will be a breakthrough for the production of AM fungus inoculums.

2. Transcriptomic atlas of AM fungi

AM fungi differentiate a variety of hyphal structures and spores; however, the differences in their physiological functions are largely unknown. We revealed the structure-specific transcriptome of AM fungi using the SMART-seq2 method, which enables analysis of the transcriptome from trace samples. In particular, we focused on the exchange of nutrients, the main function of AM symbiosis, and showed the roles of each structure in the transport and metabolism of nutrients (Kameoka *et al.*, 2019. *Plant Cell Physiol.*). These findings provide a comprehensive dataset to advance our understanding of the transcriptional dynamics of fungal nutrition in this symbiotic system.

Publications

1. **Kameoka H***, Gutjahr C* (2022) Functions of Lipids in Development and Reproduction of Arbuscular Mycorrhizal Fungi. Plant Cell Physiol 63: 1356–1365 ***co-corresponding authors**
2. **Kameoka H[1]**, Tsutsui I[1], Saito K, Kikuchi Y, Handa Y, Ezawa T, Hayashi H, Kawaguchi M, Akiyama K (2019) Stimulation of asymbiotic sporulation in arbuscular mycorrhizal fungi by fatty acids. Nat Microbiol 4: 1654–1660 **[1]co-first authors**
3. **Kameoka H***, Maeda T, Okuma N, Kawaguchi M* (2019) Structure-specific regulation of nutrient transport and metabolism in arbuscular mycorrhizal fungi. Plant Cell Physiol 60: 2272–2281 ***co-corresponding authors**
4. **Kameoka H**, Kyozuka J (2018) Spatial regulation of strigolactone function. J Exp Bot 69: 2255–2264
5. **Kameoka H**, Dun EA, Lopez-Obando M, Brewer PB, de Saint Germain A, Rameau C, Beveridge CA, Kyozuka J (2016) Phloem transport of the receptor DWARF14 protein is

required for full function of strigolactones. Plant Physiol 172: 1844–1852

6. **Kameoka H**, Kyozuka J (2015) Downregulation of rice *DWARF 14 LIKE* suppress mesocotyl elongation *via* a strigolactone independent pathway in the dark. J Genet Genomics 42: 119–124
7. Seto Y[1], **Kameoka H**[1], Yamaguchi S, Kyozuka J (2012) Recent advances in strigolactone research: chemical and biological aspects. Plant Cell Physiol 53: 1843–1853 **[1]co-first authors**
8. Kodama K, Rich MK, Yoda A, Shimazaki S, Xie X, Akiyama K, Mizuno Y, Komatsu A, Luo Y, Suzuki H, **Kameoka H**, Libourel C, Keller J, Sakakibara K, Nishiyama T, Nakagawa T, Mashiguchi K, Uchida K, Yoneyama K, Tanaka Y, Yamaguchi S, Shimamura M, Delaux PM, Nomura T, Kyozuka J (2022) An ancestral function of strigolactones as symbiotic rhizosphere signals. Nat Commun 13: 3974
9. Tanaka S, Hashimoto K, Kobayashi Y, Maeda T, **Kameoka H**, Ezawa T, Saito K, Akiyama K, Kawaguchi M (2022) Asymbiotic mass production of the arbuscular mycorrhizal fungus *Rhizophagus clarus*. Commun Biol 5: 43
10. Sugiura Y, Akiyama R, Tanaka S, Yano K, **Kameoka H**, Kawaguchi M, Akiyama K, Saito K (2020) Myristate as a carbon and energy source for the asymbiotic growth of the arbuscular mycorrhizal fungus Rhizophagus irregularis. PNAS 117: 25779-25788
11. Seto Y, Yasui R, **Kameoka H**, Tamiru M, Cao M, Terauchi R, Sakurada A, Hirano R, Kisugi T, Hanada A, Umehara M, Seo E, Akiyama K, Burke J, Takeda-Kamiya N, Li W, Hirano Y, Hakoshima T, Mashiguchi K, Noel JP, Kyozuka J, Yamaguchi S (2019) Strigolactone perception and deactivation by a hydrolase receptor DWARF14. Nat Commun 10: 191
12. Luo L, Takahashi M, **Kameoka H**, Qin R, Shiga T, Kanno Y, Seo M, Itoh M, Xu G, Kyozuka J (2019) Developmental analysis of the early steps in strigolactone-mediated axillary bud dormancy in rice. Plant J 97: 1006–1021
13. Maeda T, Kobayashi Y, **Kameoka H**, Okuma N, Takeda N, Yamaguchi K, Bino T, Shigenobu S, Kawaguchi M (2018) Evidence of non-tandemly repeated rDNAs and their intragenomic heterogeneity in *Rhizophagus irregularis*. Commun Biol 1: 87
14. Kobayashi Y, Maeda T, Yamaguchi K, **Kameoka H**, Tanaka S, Ezawa T, Shigenobu S, Kawaguchi M (2018) The genome of *Rhizophagus clarus* HR1 reveals a common genetic basis for auxotrophy among arbuscular mycorrhizal fungi. BMC Genomics 19: 465
15. Kobae Y, **Kameoka H**, Sugimura Y, Saito K, Ohtomo R, Fujiwara T, Kyozuka J (2018) Strigolactone biosynthesis genes of rice are required for the punctual entry of arbuscular mycorrhizal fungi into the roots. Plant Cell Physiol 59: 544–553
16. Arite T, **Kameoka H**, Kyozuka J (2013) Strigolactone positively controls crown root elongation in rice. J Plant Growth Regul 31: 165–172

17. Yoshida S, **Kameoka H**, Tempo M, Akiyama K, Umehara M, Yamaguchi S, Hayashi H, Kyozuka J, Shirasu K (2012) The D3 F-box protein is a key component in host strigolactone responses essential for arbuscular mycorrhizal symbiosis. New Phytol 196: 1208–1216

18. Minakuchi K, **Kameoka H**, Yasuno N, Umehara M, Luo L, Kobayashi K, Hanada A, Ueno K, Asami T, Yamaguchi S, Kyozuka J (2010) *FINE CULM1* (*FC1*) works downstream of strigolactones to inhibit the outgrowth of axillary buds in rice. Plant Cell Physiol 51: 1127–1135