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Plant-insect & plant-fungi symbiosis and coevolution

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Research impact at a glance

Because of their sessile life-forms, plants need various partners for their reproductions. Although plants are autotroph, their collection of inorganic nutrients needs supports by fungi. Our researches focus on the interaction of plants and other organisms especially insects and fungi and their consequences on plant evolution or coevolution of both organisms.

Detailed description of the research

Background:

Land plants hold a vast variety of species in terrestrial ecosystems. Although the diversity of land plants is the result of adaptation of various environments, interactions of other organisms also act as important drivers for evolution of land plants. Land plants have sessile life-forms and need mobile partners (e.g. pollinators and seed dispersers) to reproduce. Microbial (fungi and bacteria) communities are also quite important for nutritional supply and healthy growth of plants. We are investigating those interactions between plants and other organisms and their effects o plant evolution.

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On-going research:

1. Plant-insect symbiosis and coevolution

Flowering plants rely on pollinators (mainly insects) for their sexual reproduction. Flowers are composite organs with highly organized arrangements of sepals, petals, stamens, and stigmas. Natural selections by insect pollinators affect various aspects of floral characteristics such as size, coloration, or array in inflorescence. We mainly investigate plant-pollinator interactions and their effects on floral characteristics. We also study special case of plant-insect coevolution such as fig-fig wasp interactions.

2. Plant-fungi symbiosis

Microbes especially fungi are important partners for land plants. Mycorrhizal fungi are indispensable organisms for the most of vascular plants to collect nutrients from soil. Many endophytic fungi live in extensive range of plant bodies and hold positive effects for plant growth and resistance to disease and herbivores. We investigated fungal partner change of plants during the evolution of nutritional forms (such as autotrophy to heterotrophy). We also study the endophyte floras of various wild plants and effects of those fungi to plant lives.

Selected publications

Original papers: ((Arial or Helvetica, 12pt))

1. Ikeda, H., Fukuda, T. and Yokoyama, J. 2016. Endophytic fungi associated with a holoparasitic plant, *Balanophora japonica* (Balanophoraceae). American Journal of Plant Sciences 7: 152-158.

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2. Makino, T. T. and Yokoyama, J. 2015. Non-random composition of flower color in a plant community: mutually different co-flowering natives and disturbance by aliens. PLoS ONE 10(12): e0143443.

3. Sakamoto, Y., Yokoyama, J. and Maki, M. 2015. Mycorrhizal diversity of the orchid *Cephalanthera longibracteata* in Japan. Mycoscience 56: 183-189.

4. Lum Tsai, Hayakawa, H.,Fukuda, T. and Yokoyama, J. 2015. A breakdown of obligate mutualism on a small island: an interspecific hybridization between closely related fig species (*Ficus pumila* and *Ficus thunbergii*) in western Japan. American Journal of Plant Science 6: 126-131.

5. Hayakawa, H., Hayakawa, C., Kusumoto, Y., Nishida, T., Ikeda, H., Fukuda, T. and Yokoyama, J. 2014. *Cephalanthera falcata* f. *conformis* (Orchidaceae) forma nov.: a new peloric orchid from Ibaraki Prefecture, Japan. Acta Phytotaxonomica et Geobotanica 65 (3): 127-139.

6. Yoshida, M., Hayakawa, H., Fukuda, T. and Yokoyama, J.2013. Incongruence between morphological and molecular traits in *Viola violacea* (Violaceae) populations in Yamagata Prefecture, northern Honshu, Japan. Acta Phytotaxonomica et Geobotanica 63: 121-134.

7. Ogura-Tsujita, Y., Yokoyama, J., Miyoshi, K. and Yukawa, T. 2012. Shifts in mycorrhizal fungi during the evolution of autotrophy to mycoheterotrophy in *Cymbidium* (Orchidaceae). American Journal of Botany 99: 1158-1176.

8. Nukatsuka, Y. and Yokoyama, J. 2010. Environmental factors and land uses related to the naturalization of *Bombus terrestris* in Hokkaido, northern Japan. Biological Invasions 12: 795-804.

9. Yukawa, T., Ogura-Tsujita, Y., Shefferson, R. P. and Yokoyama, J. 2009. Mycorrhizal diversity in *Apostasia* (Orchidaceae) indicates the origin and evolution of orchid mycorrhiza. American Journal of Botany 96: 1997-2009.

10. Dohzono, I., Kawate Kunitake, Y., Yokoyama, J. and Goka, K. 2008. Effects of an alien bumblebee on native plant reproduction through competitive interactions with native bumblebees. Ecology 89: 3082-3092.

11. Yokoyama, J., Koizumi, Y., Yokota, M. and Tsukaya, H. 2008. Phylogenetic position of *Oxygyne shinzatoi* (Burmanniaceae) inferred from 18S rDNA sequences. Journal of Plant Research 121: 27-32.

12. Yamamoto, N., Yokoyama, J. and Kawata, M. 2007. Relative resource abundance explains butterfly biodiversity in island communities. Proceeding of the National Academy of Science, U.S.A. 104: 10524-10529.

13. Inoue, M. N., Ushijima, J. and Yokoyama, J. 2007. Effect of *Weigela hortensis*

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(Caprifoliaceae) floral morphology on pollinator behavior. Plant Species Biology 22: 77-86.
14. Inoue, M. N. and Yokoyama, J. (2006) Morphological variation in relation to flower use in bumblebees. Entomological Science 9: 147-159.

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