2022_54_DoLS_Savolainen: Plant-fungal coevolution and speciation on a remote oceanic island

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Our understanding of how species originate (speciation) has changed considerably since Darwin’s seminal work. One aspect, however, that has been ignored is the role that microbes can play in driving speciation. Here, we propose a new mechanism for the origin of species, whereby coevolutionary divergence in plant-mycorrhizal associations increases local adaptation and leads to the completion of speciation. While it is well known that species can diverge due to geographic barriers such as mountain ridges or oceans, populations can also split in the face of gene flow without geographic isolation, for example through specialisation to habitats or resources. In this context, symbiotic associations that plants have with microbes may be particularly powerful in simultaneously facilitating local adaptation and reproductive isolation leading to speciation.

We will focus on pairs of sister species of plants endemic to Lord Howe Island, a remote island in the Tasman sea, and their interactions with arbuscular mycorrhizal fungi. Using phylogenetic, karyological, and ecological data for the flora of Lord Howe Island, Supervisor Savolainen previously demonstrated that speciation with gene flow may, in fact, be frequent in some instances and could account for one in five of the endemic plant species of LHI (PNAS 108, 13188–93, 2011). These examples, such as Coprosma and Metrosideros, will be studied for this PhD. We hypothesise that soil and soil microbes have affected local adaptation of the ancestral populations, which in turn led to differences in flowering time, and ultimately promoted speciation. Differing levels of mycorrhizal colonisation and gene expression co-regulated in plant host and mycorrhizal associations may have led to the emergence of distinct populations occupying different environments (soil, altitudinal gradient, etc). We will test key hypotheses using metagenomics and RNA-seq combined with field/greenhouse experiments.

The proposed work has the potential to bring drastic rethinking about the mechanisms of speciation and how coevolution contributes to species divergence. The proposed work will unravel some of the most neglected hypotheses in evolution, such as how microbes can drive plant speciation, and hence the link between microbiome and plant diversity. Given the widespread nature of plant-mycorrhizal symbioses, their importance in crop production, and the prominence of soil and plant diversity in ecosystem functioning, our research will also have far-reaching impact in applied ecology and agriculture, beyond evolutionary biology.

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