Genes in albino orchids may hold clues to parasitic mechanism used by non-photosynthetic plants

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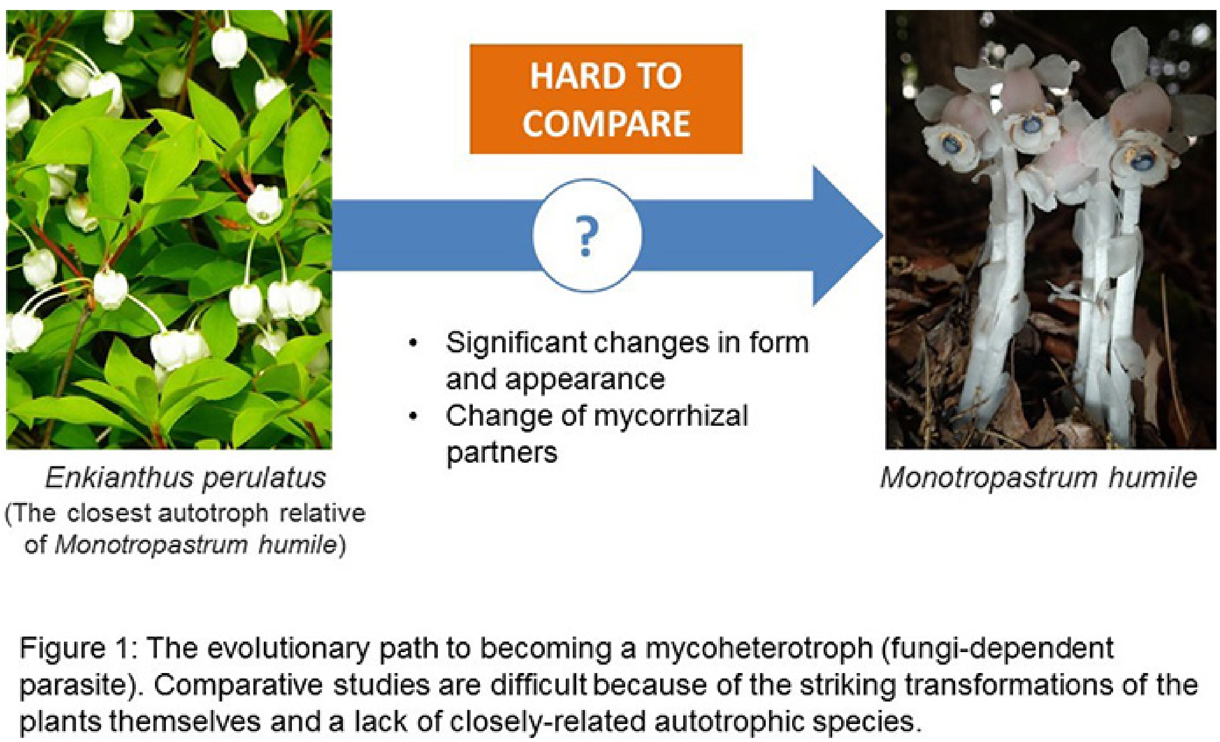

Credit: Kobe University

How do plants give up photosynthesis and become parasites? A research team in Japan are using comprehensive analysis of gene expression in albino and green orchids to investigate the evolution of parasitic plants.

The research was carried out by Project Associate Professor SUETSUGU Kenji (Kobe University Graduate School of Science), Associate Professor KAMINAKA Hironori and Research Fellow MIURA Chihiro (Tottori University Faculty of Agriculture), Associate Professor YAMATO Masahide (Chiba University Faculty of Education), and Special Associate Professor SHIGENOBU Shuji (National Institute for Basic Biology).

Spontaneous mutation resulting in loss of chlorophyll is a phenomenon seen among many plant species. In normal plant species, albino mutations that lack chlorophyll wither after using up the nutrients stored in their seeds, but albinos of semi-parasitic species can continue to grow and even produce flowers. These albino plants, lacking chlorophyll, become totally dependent on fungi for their survival.

Plants that have abandoned photosynthesis and feed off the roots of mushrooms and other fungi are known as mycoheterotrophs. Most mycoheterotrophs are a long way genetically from even the closest autotrophic plants. In addition to the evolutionary adaptation that enabled their parasitic lifestyle, they have various other mutations, making it hard to pinpoint which gene group helped them to gain their parasitic abilities (see figure 1).

Figure 2: Because normal *E. helleborine* is semi-dependent on fungi for nutrients, albino individuals of this species are able to grow and even produce flowers.

Credit: Kobe University

This study focused on the orchid species Epipactis helleborine. Although this species has developed green leaves and at first glance appears to be able to survive from photosynthesis alone, it is semi-dependent on fungi for carbon. Semi-mycoheterotrophic species such as E. helleborine occasionally undergo spontaneous mutations into albino varieties, totally losing their chlorophyll (see figure 2). The green individuals and the albino individuals have almost identical genome sequences, making them ideal candidates for genetic analysis of mycoheterotrophy (see figure 3). Because albino individuals lack chlorophyll, they are thought to depend more on their parasitic abilities than green individuals. This study investigated the possibility that the genes expressing more in albino varieties are related to mycoheterotrophy (parasitism of fungi). The research team focused on these highly-expressing gene groups.

The group carried out transcriptome analysis using RNA extracted from the roots of 3 green individuals and 3 albino individuals of the E. helleborine. The results showed that the gene group linked to mycorrhizal symbiosis in arbuscular mycorrhizal plants and autotrophic orchids is also highly expressed in albino individuals of E. helleborine. Additionally, the expression patterns from multiple genetic groups related to plant hormone biosynthesis showed similarities between albino individuals and plants associated with arbuscular mycorrhizal fungi. These results suggest that mycoheterotrophs may incorporate fungi by using a similar mechanism to those found in other types of mycorrhizal symbiosis. Until now, botanists believed that mycorrhizal symbiosis in mycoheterotrophs used a different mechanism from other types of mycorrhizal symbiosis because of the dramatic partner shift in mycorrhizal fungi. However, this research suggests they may have more mechanisms in common than previously imagined. The findings were published on January 19 in the online edition of *Molecular Ecology*.

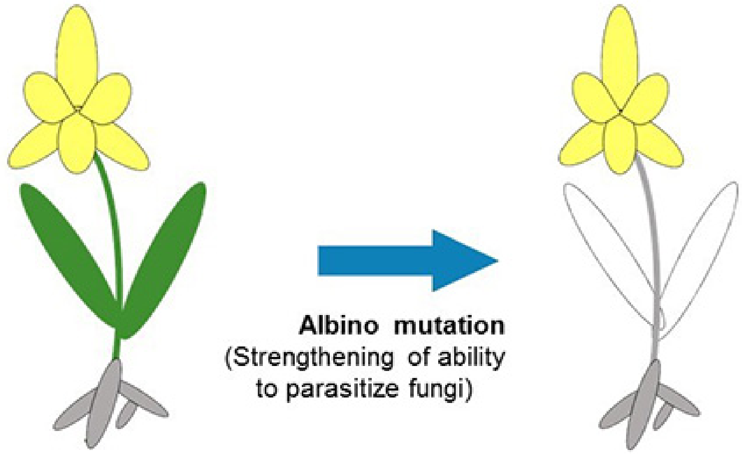

Figure 3: Green individuals and albino individuals of the same species have almost identical genome sequences, so comparing them is a simple way to carry out molecular genetic analysis of mycoheterotrophs.

Credit: Kobe University

More information: Kenji Suetsugu et al. Comparison of green and albino individuals of the partially mycoheterotrophic orchidon molecular identities of mycorrhizal fungi, nutritional modes and gene expression in mycorrhizal roots, *Molecular Ecology* (2017). DOI: 10.1111/mec.14021

Provided by Kobe University

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