Conserving Madagascar’s orchids

Recent research into orchid mycorrhizal fungi, and why this work is crucial for orchid conservation and habitat restoration in Madagascar, is revealed by Kew scientist Kaz Yokoya.
Madagascar’s threatened orchids

There is an urgent need to document and safeguard the ecological network of organisms in this age of extinction. Orchids are a particularly relevant group of plants given their dependency on mycorrhizal fungi and specialised insect pollinators to complete their life cycles (Swarts and Dixon, 2009). Of Madagascar’s 10,000 to 12,000 vascular plant taxa, roughly 1 in 10 are orchids, most of which are endemic (Tyson, 2000; Moat and Smith, 2007). The Itremo Massif within the Central Highlands is considered a ‘micro-hotspot’, home to more than 50 orchid taxa of which the majority are endemic and some locally endemic.
Unique flora and fauna

The Itremo Massif consists of a plateau of igneous and metamorphic rock with a mixture of ecosystems - humid gallery forests and moorland habitats nestled between hills and valleys, and separated by savannah grasslands (Cribb and Hermans, 2009). A 273 km² area was given Protected Area status in 2012 thanks to Itremo’s unique flora and fauna, and our study area represents around 13 km², within and adjacent to the protected area.

Orchid mycorrhizal fungi

To date, very little is known about the identity, distribution and ecology of orchid mycorrhizal fungi (OMF) in Madagascar, or their relationships with native orchids. Madagascar’s remote location, coupled with its rugged terrain, poses additional challenges to specialists seeking to gain access to orchid rich habitats. This is especially true for mycologists faced with the challenge of getting fresh tissue samples harbouring viable fungal material to the lab quickly for further study.

The orchid seed baiting technique, first developed by Rasmussen and Whigham (1993) to capture fungal symbionts that support germination in situ, involves the retrieval of strategically distributed packets of seed to recover germinated seedlings. This technique has been applied to a large number of taxa with varied success but the length of period required for successful baiting is a major drawback, necessitating a minimum of two visits to the study site. For critically endangered taxa, use of the seed baiting technique may also be viewed as too wasteful considering that few seed packets typically yield seedlings. We opted to improve our odds for acquiring germination-phase fungi by collecting protocorms and very small seedlings that have germinated spontaneously on natural substrates.
Identification of fungi

Based on their rDNA internal transcribed spacer sequence, we were able to assign 85 Rhizoctonia-like fungus isolates to 12 operational taxonomic units (OTUs): four Ceratobasidium, seven Tulasnella and one Sebacina. Each OTU was shown to have closely related fungi in the GenBank database that were also found as orchid associates. Of the 12 OTUs, three were isolated from different taxa and collection sites, suggesting a certain level of specificity in the association within a background of a diversity of fungi. One of these OTUs was isolated from both lithophytic Angraecum protensum and terrestrial C. purpurea, indicating that at least some of the fungi are able to survive in, and colonise, a range of orchid taxa in a variety of habitats. Due to the limited number of root samples and the extremely low number of plants of some of the rarer taxa that could be collected, it is likely that this does not represent the full genetic diversity within the remit of this study.

Our tally of Rhizoctonia-like fungi suggested that seedling roots of some lithophytic and epiphytic taxa were able to provide good quality pelotons (coiled bundles of fungal mycelium) for isolating Rhizoctonia-like isolates, whereas mature root material of terrestrial taxa was also a good source of isolates. The relative ease with which juvenile roots of some orchid taxa yielded Rhizoctonia-like fungi may be indicative of a greater dependence upon mycorrhizal symbiosis at particular stages of the life cycle. Older plants may be less dependent on Rhizoctonia-like fungi and/or may be switching to different fungi upon maturity.

Symbiotic germination

Based on preliminary results involving in vitro symbiotic seed germination, many of these fungi are capable of initiating germination beyond the protocorm stage. 9 out of the 12 OTUs helped seeds of nine orchid taxa tested to progress, sometimes within weeks, beyond what they would have attained without the fungus. Surprisingly, this was even in combination with orchid taxa other than its original host. However, it is conceivable that some of the fungi, even those isolated from spontaneous seedlings, may not be the same as those that initiated germination in situ as the specific fungi supporting initial seed germination may actually be replaced by other types of fungi around the time that leaves are initiated in the seedling stage (fungal succession).

Reintroduction of hundreds of orchids

We started this study with the goal of producing symbiotic propagules for reintroduction, by understanding the role of mycorrhizal fungi in seed germination, seedling development, and establishment of plants in the wild. In January 2015, several hundred symbiotically germinated seedlings of Cynorkis purpurea and Benthamia cinnabarina were taken back to Madagascar as the first wave of reintroductions of symbiotically grown orchids to Itremo. Consecutive days of heavy rain rendered the roads impassable, so our team was unable to reach Itremo during this visit. Fortunately, Kew’s local presence as the Kew Madagascar Conservation Centre (KMCC) in Madagascar’s capital of Antananarivo means that the plants remain in safe hands, to be returned to their home at a later date.
As the first detailed investigation into the identification of culturable orchid endophytes in Madagascar that are potential OMF, our findings will form the foundation of future research to contribute to ecosystem services, conservation, and phylogenetic studies.

-Kaz-

Further reading


References


Related links

[Kew Science blog](#)

[Kew's Science Strategy](#)
Researchers in Comparative Seed Biology, Wolfgang Stuppy and Aurélie Albert-Daviaud, explain how some Madagascan plants are living on 'borrowed time' following the extinction of their seed dispersers. The island of Madagascar is one of the world's top biodiversity hotspots. Its landmass separated from continental Africa...