Casuarina symbionts

This weeks FACTT note is provided by Jack Simpson.FACTT member, retired forester, and President of the Horticultural Society of Canberra.

Work on root /soil interactions are notoriously difficult as it is impossible to observe what is happening without disturbing the site. However there is a body of scientific literature which explores the relationship between the plant and its below ground environment. It is an important aspect of tree growth and should not be forgotten, particularly when the tree is planted in a soil which has not had trees or the particular species for a long period of time, if ever. It is often noticed that a tree will stagnate for a time and then take off. There may be many reasons but almost certainly one is that a symbiotic relationship has enhanced nutrient or water available to the roots. The process involved in the production of available nitrogen is fascinating when one thinks that for us to break the nitrogen double bond requires huge energy inputs. The amount of N produced by Frankia is estimated at about 100kg /ha per year so not inconsiderable.

The comments made in the introduction to the earlier notes apply here namely that I have not included references as it is a quickly written piece for the times. There are no photographs as they are easily obtained by the reader on the net using your favourite search engine.

Casuarina symbionts

Species of Casuarinaceae form three kinds of microbial symbiosis: vesicular-arbuscular mycorrhizas, ectomycorrhizas and *Frankia* nitrogen fixing nodules. All three symbioses can occur on a plant at the same time.

Vesicular-arbuscular mycorrhizas, arbuscular mycorrhizas

Vesicular-arbuscular mycorrhizas (VAM) or arbuscular mycorrhizas (AM) are the most observed kind of mycorrhiza and are estimated to occur on more than 80% of land plants. VAM are formed by members of the phylum *Glomeromycota* in the Kingdom *Fungi*.

This is the oldest phylum of fungi with fossils known from the rhizoids of land plants from the Early Devonian 400 million years ago. There are only about 250 described species in the phylum. Most species have a wide distribution and host range. They form obligate, symbiotic relationships with thalli of bryophytes and roots of vascular land plants, and most cannot be grown in agar culture. VAM fungi grow on and in host roots but do not penetrate host cell membranes. The hyphae are usually aseptate and contain large numbers of nuclei. These fungi are not known to reproduce sexually. Branched structures, arbuscules, are formed in infected plant cells. These are where photosynthates from the host are transferred to the fungus in exchange for minerals and water. The fungus may also produce large vesicles in which to store nutrients. These can be large, 40-800 microns diameter, long-lived and can function as dispersal agents. Host specificity is low, and plants are typically colonised by numerous VAM species. However, distinct fungal communities are associated with different hosts. In undisturbed plant communities the mycelia of individual VAM fungi can extend through the soil over large areas, for example several hectares, and infect roots of diverse unrelated plants, such as *Casuarina*, *Eucalyptus, Acacia* and *Poa*, at the same time. In *Casuarina*, *Ceuthostoma* and *Gymnostoma* the most abundant types of mycorrhiza are VAM and AM.

Ectomycorrhizas

The other kind of mycorrhiza found on trees are called ectomycorrhizas. Here the fine roots are sheathed in fungal hyphae which may extend between the cortical cells of the host but do not infect cells. They are formed by species of the phyla *Ascomycota* and *Basidiomycota* of the Kingdom *Fungi*. The *Glomeromycota* is sister to those phyla. These fungi have septate mycelia, usually with few nuclei per cell, and reproduce both sexually and asexually. Mycelia are usually of limited extent, and colonies of ectomycorrhizal fungi are rarely greater than about 10 metres radius and usually much smaller. They may infect roots of several trees, of the same or distinct species, at the same time. There are

a large number of species of ectomycorrhiza forming fungi, certainly many thousands. Most are host specific, at least at family level but there are many exceptions, for example *Amanita muscaria* on *Pinus*, *Nothofagus*, *Betula* and *Quercus*. Species of *Allocasuarina* are usually ectomycorrhizal but probably all members of the family have this capability. The ectomycorrhizal fungi on *Allocasuarina* are often the same as those on nearby eucalypts. This is likely the case with the other Australian *Casuarinaceae*. However, in New Guinea the associates of *Casuarina oligodon* are from *Castanopsis* and *Lithocarpus (Fagaceae*). In South-east the ectomycorrhizal partners are probably from *Dipterocarpaceae*.

The nitrogen-fixing bacteria associated with *Casuarinaceae* are species of *Frankia*. This is an interesting genus known to infect roots of plants from 8 families and 24 genera including species of *Casuarina*, *Alnus*, *Coriaria* and *Ceanothus*. The nodules are large and woody.

Jack Simpson

Collecting *Frankia* nodules to inoculate seedlings prior to planting out is not as easy as it may seem. I have dug and dug and not found many. Sandy banks are easier but not always fruitful.

Janice Scarabottolo found the following about the origins of Ballat

“Indigenous Australians ate the fruit, used the wood for spear throwers and reportedly used the sap as a treatment for snakebite. They called it Tchimmi-dillen (Queensland), Palatt or Ballot (Lake Condah, Victoria) and Ballee (Yarra).”

SteveThomas
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