

VISUALISING THE TREE DEATH PROCESS

The way a tree dies is through starvation. It simply does not have enough energy to sustain it. How do we know this is true?

Think about vegetatively propagated plant selections, these may be trees or shrubs selected for a particular reason, flowers, leaf colour, form etc. To retain these features they are vegetatively propagated from parent plants and their successors. So plants selected, say in the early 1700s, are still in production today, centuries after the original parent plant died. All its progeny are still the same plant.

We also know a tree grows a new tree on the outside of the old tree each growth cycle. This is why we can vegetatively propagate plants perpetually. So what causes the tree to starve to death?

Plants and trees produce and use energy. They produce energy through the photosynthetic process wherever chlorophyll is found. The majority of chlorophyll is normally found in the leaves. The energy produced by this process is used and excess is stored in the various specialised storage cells distributed throughout the total tree.

We know that trees are not synchronistic in their processes, not all processes happen at once, rather they follow a progression. The fine feeding roots grow first, often in the autumn when there is warm soil and moisture from the autumn rains. These roots have a close association with specialised fungi, mycorrhizal roots, the tree provides energy – sugar, and the fungi provides water and nutrients absorbed from the soil. These nutrients are transported up the plant, usually within the late wood, and charge the buds and twigs with nutrients. The twigs are also full of stored starch from the last season's growth. These locally stored resources are utilised as the buds expand and grow new shoots and leaves. This all takes energy and the production of energy requires water and nutrients.

We also know that trees are highly compartmented organisms. As a tree is wounded, by for example; Fire, Insect or Pathogen attack, storm damage, poor maintenance pruning, impact etc. the wounded areas are isolated – compartmentalised and any starch reserves within those sections and the storage site itself is lost forever.

An old analogy to describe this is the watertight door in a ship. Punch a hole below the water line in a ship and the watertight doors are closed thereby containing the water into a small isolated section of the ship. Those sections can no longer be accessed and all inside is effectively lost to the daily operation of the ship.

Wounding in a tree has the same effect; those areas that are walled off no longer play a part in the life process. They do still provide structure but even this may gradually diminish as the decay process continues to utilise this isolated food supply.

It is important to understand that storage areas are finite and most importantly starch cannot be stored in tissue that is growing. This means that the current years growth does not store starch until very close the end of the growth cycle. Most starch is stored in the previous year's wood and storage sites.

So now you can see that the protection of storage sites is imperative for the long-term survival of the tree. If the tree suffers too much wounding it cannot store reserves of starch that it would otherwise use in times of emergency.

One simple way to imagine this process is to imagine, the starch stored in the tree's various starch storage organs, as money in the bank.

If you have \$100,000 in the bank and spend \$10,000 per year and you earn no interest or income you will run out of money in 10 years. However, let's say you earn interest and have additional income that amounts to \$5,000 per year. You can then sustain yourself for 20 years.

Ignoring for the moment that a tree manages its resources, which requires energy to achieve, a tree will continue to produce some starch even if it does not get transported down to the roots. The roots will have a reserve of starch and will continue to function. The tree will continue to grow which requires it to up-load starch from its reserves to support new growth. This new growth is effectively parasitic on the tree until its organs are mature and they start to produce starch.

So the tree is in the same situation as we are when we have an income that is less than our annual need. It lives off its reserves to sustain it through the time of less than adequate starch production. If these times are short then the tree may rapidly re-establish its reserves and continue to prosper. If the event continues for an extended period of time, then the likelihood of recovery is substantially diminished.

Why is it the case that protracted stress leads to death? Well as I stated before the tree manages its starch supply and demand side. Therefore, during extended periods of stress it compartmentalises the less productive, over mature, inefficient or dying sections of itself. This is seen as dead wood within the tree. This dead wood is still a stick of sugar, cellulose for insects, decay and pathogenic organisms. They use this dead wood as a food source to attack the tree from another direction. The tree responds producing toxic chemicals that are fungistatic, or gums that flood and suffocate borers within their galleries. The production of these products requires energy, thus the tree diverts energy, starch reserves, to produce these protection systems. This puts a further load on starch reserves driving the process further into deficit.

The root system of a tree can die years before the crown dies. My work with Dr Shigo took us to Western Australia to visit Dr Syd Shea, Chief Scientist with Conservation and Land Management WA. We looked at the cause of Jarrah dieback. We identified that forestry practice had allowed Banksia trees to move in through the forest. This was as a result of opening a closed canopy forest through logging, road and rail access. This was of minimal consequence except in locations where Lateritic concretions below ground formed water-holding pockets and fissures between the concretions were colonised by Jarrah roots that often extended 30m or more down to the water table.

The Banksia trees are highly susceptible to the root pathogen, *Phytophthora cinnamomi* – a water mould, that is a water and temperature dependent pathogen. The problem arises due to the following combination of circumstances:

- Where perched water tables exist on top of the lateritic (rock) layers,
- Heavy summer thunderstorms at the end of a period of extreme heat,
- Where Banksia roots are sharing the fissures between the laterite concretions in close proximity to Jarrah roots,
- The free water, heat and readily available food source provided by the susceptible Banksia roots,
- The Pathogen population rises to extremely high levels.
- The pathogen attacks the Jarrah roots that compartmentalise the attack sites,
- There are so many attack sites within the confined area of the fissures between the laterite layers that the Jarrah ring barks its own roots by compartmentalising all of the attack sites,
- The result is the root below the ring barking is now no longer connected to the supply of starch.
- The Banksia die as they are low storage level pioneer plants,
- The Jarrah root system continues to grow using its available starch but gradually the roots run out of starch, decline and die.
- Nutrients are no longer won from the soil but water still wicks up the root vessels,
- Now the crown is deprived of nutrients to grow and produce starch,
- The crown lives on its starch reserves,
- The tree tries to re-establish its root system, thus using more of its stored energy,
- Its demand and supply are now out of balance so the tree dies back in an effort to balance supply and demand,
- Surface water becomes limited and thus absorption of surface nutrients are reduced,
- The process continues until just after the commencement of a growth flush. The tree "suddenly" dies at the end of a progression that has taken over a decade or two to finally manifest itself,
- The Jarrah was committed to death because of the special circumstances that prevailed. We know it was committed to death because the indicator plant, the Banksia, died and in these circumstances the Jarrah will also die.

Why is this story important? Tree root systems are damaged by all forms of traffic, occurring over many years. Traffic causes compaction of the soil; this has a profoundly detrimental impact on the root system's ability to function properly. Thus just as Phytophthora causes Jarrah roots to compartmentalise, traffic compaction wounds will cause tree roots to compartmentalise. In both cases the roots may become so compartmentalised as to no longer function as nutrient and water transport systems but the crown of the tree will continue to carry green leaves for two or three "Tree Years" twenty to thirty human years.

The process of death in animals is quick and definite; in trees it is protracted and unclear. Current legislation requires the retention of trees committed to death rather than encouraging removal and replanting that would sustain a healthy age demographic of the tree and landscape community.