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Rainforest Seed Propagation

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Summary

Restoring the Sub Tropical rainforests (STRF) decimated in the 1800 and in the early part of 1900s has gathered momentum since the 1970s. Ecological restoration is possible in small remnants, however planting is the only solution in the vast paddocks as just 1% of STRF is left in eastern Australia. Annual plantings grew from mere hundreds in the 1980's to over half a million by 2020's. Over the years it was realised that not only the quantity of plants but also its diversity is important. Hence seedlings have become the planting material for rainforest restoration. As a result seed collection, storage, propagation and growing techniques of seeds of over 450 rainforest species became the cornerstone of research and a multimillion-dollar industry in recent years. Species composition and functional trait representation in these forests is of utmost importance. This paper describes the planning and methods of collection, processing, germinating and establishing seedlings in rainforest restoration and factors to be considered when restoring degraded forest ecosystems.

INTRODUCTION

The goal of rainforest seed propagation is to produce high diversity, high quality stock to grow rainforest. STRF across northern NSW and SE Queensland had mostly been cleared by the late 1800's. The remaining remnants and fragments that survived into the 1900's were largely ignored and unvalued. The interest in rainforest for values other than timber, and the land beneath the trees emerged in the 1970's. By the 1980's rainforest remnants were beginning to be restored by removing weeds and cattle and allowing the natural regeneration processes to repair the ecological function of the forest.

In the Big Scrub, the largest area of STRF in Australia, only 1% of the 78,000 hectares of rainforest remained to regenerate. With 99% ex rainforest country converted to paddocks over a hundred years ago, planting was clearly the only option to restore rainforest.

The interest in growing rainforest from a bare paddock has been increasing over the decades. Some farmers developed an interest; however, an increasing number of people were buying land specifically to plant rainforest trees and restore the rainforest. In the 1980's the individual plantings could be counted in the hundreds of trees, by the 1990's most rainforest plantings were in the thousands. By the 2000's some of the plantings were into the tens of thousands. Today in 2020's the number of rainforest trees planted in Northern NSW and SE Queensland is well over half a million trees per year.

There is clearly an increasing demand to plant rainforest trees. This demand for quantity is coupled with a demand for diversity. STRF are highly diverse and the desire to restore rainforest with broad range of species resembling the original forest is critical to the restoration attempts by the government agencies, landowners, ecologists and restoration practitioners.

GROWING RAINFOREST PLANTS

The vast majority of rainforest restoration plants are grown from seed. This is because it is far cheaper to produce plants by seed than cuttings. Also as the vast majority of plants grown are trees, the bushy form of cutting grown trees is a disadvantage to the management and growth of an emerging rainforest.

The seed collection, propagation and growing techniques for the over 450 rainforest tree and understorey species needed for restoration has developed from a small backyard novelty in the 1980's to a professional multimillion dollar industry. The techniques developed to produce the hundreds of thousands of tube stock needed for restoration have been developed at Firewheel Rainforest Nursery and other smaller nurseries over the last 40 years. All the information is now printed in a CSIRO published Book (Dunphy et al., 2020), (**Fig.** 1).

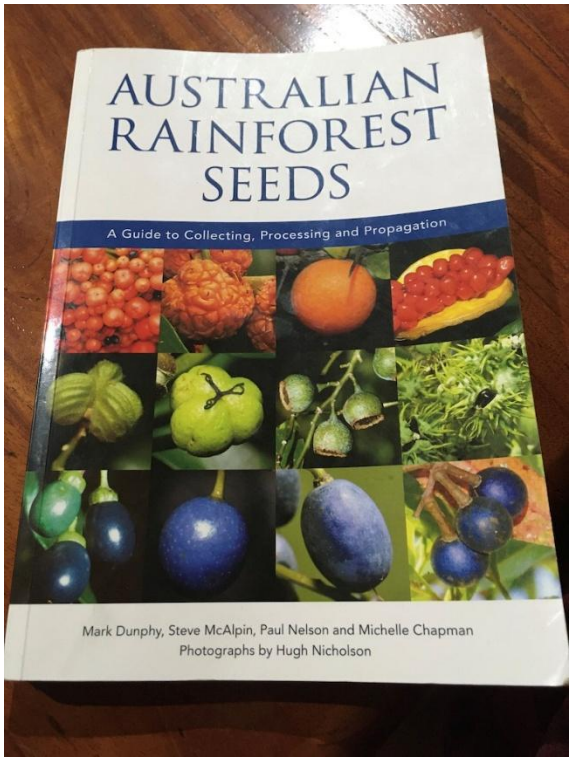

Figure 1. Australian Rainforest Seeds. A Guide to Collecting, Processing and Propagation published in 2020 (Dunphy et al., 2020).

RAINFOREST SEED COLLECTION

The collection equipment used for seed collection is very 'low-tech', that is only basic equipment like secateurs, pole-pruners, rakes, buckets and bags are needed (**Fig. 2**). The skill comes with the ability to identify over 400 species and locate these trees in the landscape. The seed collector then needs to know what time of year they fruit, when to collect the fruit, how to collect the fruit and how to test for viability. This knowledge can take many years to acquire and many more years to become proficient.

Compounding this complexity, the seed collector faces the masting of many rainforest species. Masting mostly occurs with mature phase species and some secondary species and not with the faster growing short lived pioneer species.

This means there are hundreds of species that fruit only every two and up to every six years. However, masting may not be regular or predictable. A species may fruit two years in a row and then not again for 3 years. To add more complexity masting isn't always an all or nothing affair, a species may fruit very lightly, or a smaller number of trees may fruit and the other trees of that species not at all.

Figure 2. Basic tools used for rainforest seed collection.

The seed collector needs to understand genetics, which is difficult as the goalposts seem to be constantly moving as more is understood about this increasingly important science. Without going into too much detail, it is safe to say modern genetic testing has confirmed inbreeding is more of a problem than outbreeding. That is, the strongly held belief of the importance of 'genetic provenance' (i.e. collecting seed locally and planting those plants locally) can cause or increase potential inbreeding depression. Therefore, the seed collector needs to collect widely and not from the

same mother trees every year and ideally not from the progeny of those same mother trees.

PROCESSING RAINFOREST SEED

The fruit and seed brought into the nursery needs to be processed for a number of reasons. These are primarily to;

1. Increase germination rates
2. Reduce germination time
3. Allow the seed to be stored easily and effectively

At Firewheel Nursery there has been decades of research, observation and experimentation carried out to determine the most effective, efficient way to produce large numbers of germinated seedlings. This has been shared with other nurseries as other nurseries have shared their insights with us. There is always more work to be done and with the help of the great people at Mt Annan Botanic Gardens in Sydney we are always trying new ways to improve our germination rates, times and storage. The use of X-ray imaging to understand seed viability of *Acronychia littoralis* is shown in **Fig. 3.**

The overriding guiding question that constantly runs through the process is "what happens in nature?" How does nature process the seed and how can we imitate and speed that process.

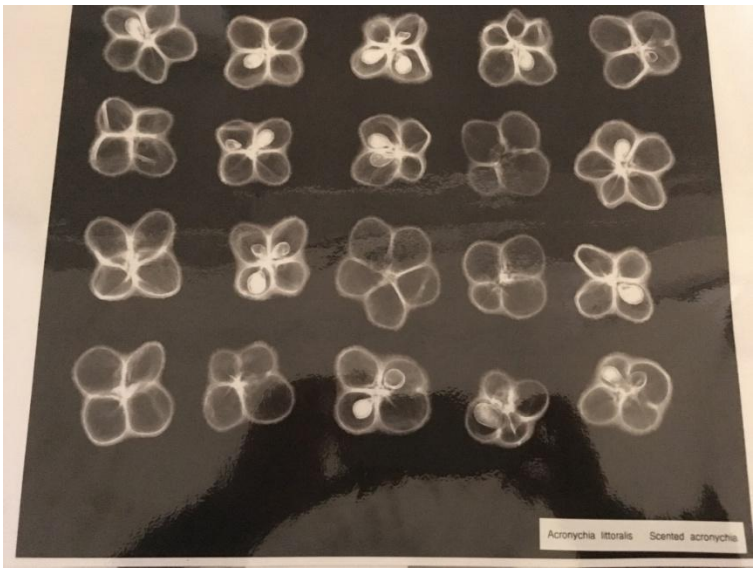

Figure 3. Seed viability testing of *Acronychia littoralis* using X-ray radiography

There are many techniques used to process the fruits and seeds; these are listed below:

- Blending
- Boiling
- Crushing
- De-winging
- Drying
- Fermenting
- Floating
- Leaching
- Macerating
- Manual extraction
- Manual scarification
- Shaking
- Sieving
- Soaking
- Splitting
- Wet and Dry Composting
- Winnowing

These techniques are detailed in the 'Australian Rainforest Seed' Book (Dunphy et al., 2020) and this list illustrates the number of techniques used to unravel the mysteries of rainforest seed propagation. Of course the research, innovation and learning goes on, continuing to improve rainforest seed propagation.

The majority of rainforest seeds are recalcitrant which means they cannot be dried and stored at room temperature or under refrigerated conditions. In fact many species such as White Booyong (*Argyden-dron trifoliatum*) have very short viability measures in days. (**Fig. 4**) This is in contrast to the majority of species that are orthodox and can be dried and stored often for many years.

Figure 4. Many rainforest species have short viability as in White Booyong (*Argydendron trifoliatum*) and many are recalcitrant.

The answer for many rainforest species to this problem of recalcitrant seed is to sow and store the seedlings rather than the seed. This is done by using a nutrient poor medium and germinating the seedlings at high density in a tightly spaced tray to slow and even stop their growth for up to a number of years. These seedlings forced into suspended animation can be potted at any time and grown into healthy trees without any ill effects. (**Fig. 5**)

Figure 5. Recalcitrant seeds are sown in high density in a nutrient poor medium in tightly spaced trays to slow and even stop their growth for up to a number of years. These seedlings can be potted and grown later as needed.

SOWING AND GERMINATING RAINFOREST SEED

Sowing seeds seems like a simple task for any horticulturally trained person, however tens of thousands of rainforest seeds have been lost to incorrect sowing technique. The most common problem is sowing seeds too deep. To compound this, trays are often kept too wet. It would be logical to assume rainforest seeds can handle very wet conditions, however on the bottom of a rainforest floor most seeds germinate on or in the leaf litter rather than in the soil. The necessary water is supplied by the surrounding moisture and humidity.

It is clear that many rainforest seeds can be sown on the surface and kept relatively dry to achieve maximum germination. In fact, the ability to alternate between a few days of the trays being wet and then a few days of the trays being dry seems to break dormancy in many species. This we assume is imitating what happens in nature.

CONCLUSIONS

Collecting rainforest seed, propagating it, growing it on, then planting it and maintaining the trees to form a young rainforest is a relatively new science. We have been moving ahead in leaps and bounds since the 1980's. We are still learning and discovering ways to improve and speed germination, growing on and establishing rainforest.

Native forest and rainforest specifically is being cleared, logged and burnt at an increasing rate around the world. The science and practise of rainforest restoration in northern NSW is moving against the trend and increasing significantly in diversity of species, number of trees planted and area of rainforest established. And, of course, a crucial component to making this process work is the propagation of rainforest seed.

LITERATURE CITED

Dunphy, M., McAlpin, S., Nelson, P., Chapman, M., Nicholson, H. (2020). Australian Rainforest Seeds: A Guide to Collecting, Processing and Propagation. CSIRO Publishing, Clayton, VIC, Australia.