Development of conservation technologies for Australia's rainforest and tropical native fruits

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Australia's Crop Wild Relatives

Crop wild relatives are native taxa that are close relatives of commercial crop plants and represent the wider genetic diversity of the crop gene pool. They are a valuable source of functional traits (e.g. disease resistance, flood tolerance and medicinal properties) for improvement of food, forestry and medicines. Thus, continuing access to the existing crop wild diversity is important. Australia has crop wild relatives of many species economically important worldwide. Some of the nationally and internationally significant crop wild relatives and bush foods of Australia are listed in Table 1. They include rainforest genera that contain commercially cultivated species (e.g. *Macadamia integrifolia*), crop wild relatives of commercially important species (e.g. *Macadamia* spp., *Citrus* spp., *Musa* spp.) or bush foods of local importance (e.g. *Citrus australasica*, Finger Lime; *Davidsonia pruriens*, Davidson's Plum) (Fig. 1). Table 1 also provides a summary of the percentage of species under threat for their genus in Queensland.

Vulnerability of Rainforests to Climate Change

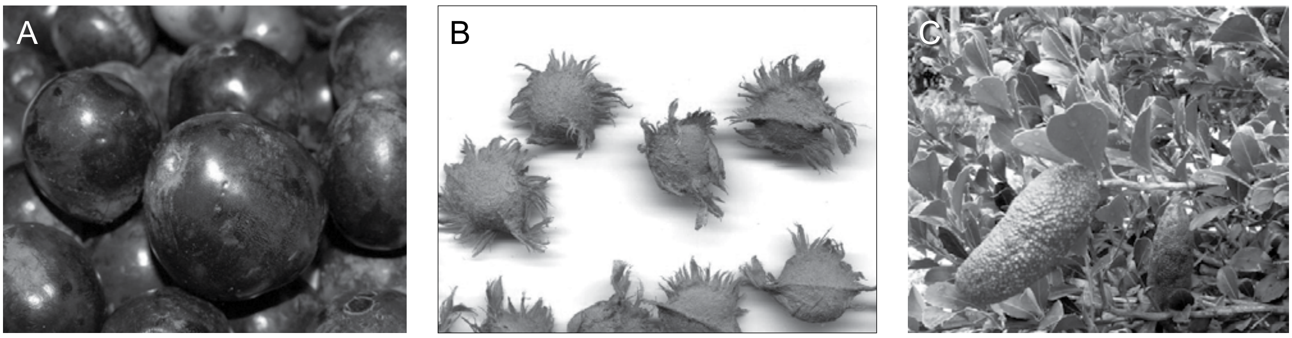
One of the key risks of projected climate change is its effect on Australian rainforests, which are one of five natural systems predicted to be vulnerable to damage (Hennessy *et al.* 2007). Climate change is predicted to interact with other threats, such as weeds and habitat fragmentation, in some of the most vulnerable environments including the Wet Tropics. For example, relative to 1990, about a 50% decrease in montane tropical rainforest area in northern Australia is predicted by 2020 (Hennessy *et al.* 2007).

Conservation of Rainforest Seeds

The seed of many species can be routinely stored *ex situ* in seed banks using standard desiccation (5% moisture content) and freezing (-20°C) protocols; such species have 'orthodox' seeds. However, not all species are amenable to these procedures (i.e. they have 'non-orthodox' seeds) and require the development of alternative conservation technologies, particularly *in vitro* and approaches using very low temperatures (i.e. cryopreservation), before long-term *ex situ* conservation can be achieved (Pritchard 2004; Ashmore *et al.* 2007). Conservation of these species is thus currently restricted to *in situ* approaches or field collections *ex situ*, making them particularly vulnerable to loss.

The number of Australian species with non-orthodox seeds is unknown. Recent studies have estimated that worldwide up to 30% of flowering plants or >80,000 species may have desiccation sensitive seeds and thus not be amenable to standard seed banking protocols. Tweddle *et al.* (2003) estimate that 48% of species in non-pioneer evergreen rainforest world-wide will have seeds that display desiccation sensitivity.

Target 8 of the Global Strategy for Plant Conservation is to achieve "60 per cent of threatened plant species in



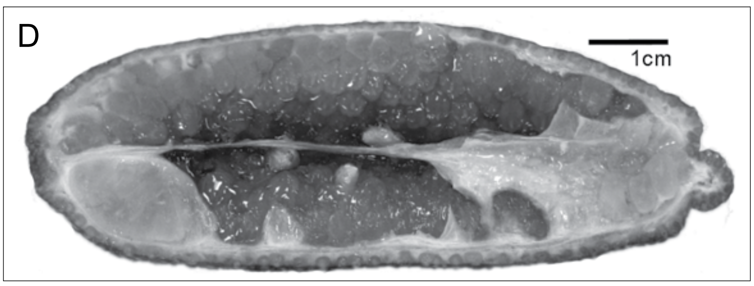


*Figure 1. Rare and threatened rainforest crop wild relatives. Fruit (A) and seeds (B) of Davidson's Plum (*Davidsonia *sp.). Fruit (C) and cut fruit (D) of Mount White Lime (*Citrus garrawayi*). Photos: N. Hall (A,B) and K. Hamilton (C,D)*

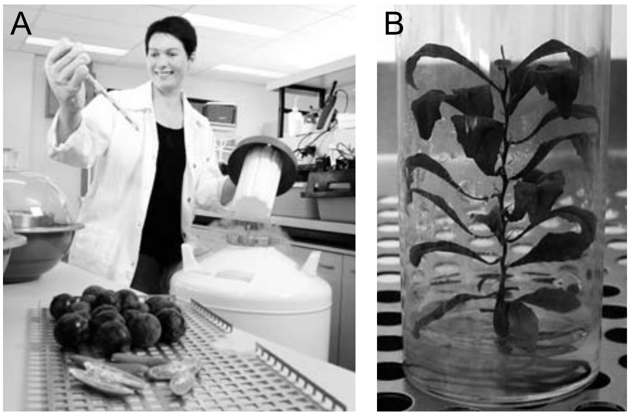


*Figure 2. A: Storage of plant material by cryopreservation in liquid nitrogen (-196ºC). B: In vitro storage and propagation of the Vulnerable Russell River Lime (*Citrus inodora*). Photos: S. Ashmore (A) and K. Hamilton (B)*

accessible *ex situ* collections …" giving clear recognition for the importance of *ex situ* conservation to support *in situ* initiatives. Target 8 also states the need for "additional resources, technology development and transfer, especially for species with recalcitrant seeds" (i.e. non-orthodox seeds). Thus, there is an urgent need to develop technologies (e.g. cryopreservation, Fig. 2) to conserve the diversity of Australia's rainforest species. Many of the rare and threatened crop wild relative species in the genera listed in Table 1 are of rainforest and/or tropical origin with likely non-orthodox seeds.

Case Study

International and national partnerships have been established to develop alternative technologies for the conservation of Australian species with non-orthodox seeds. These include the Millennium Seed Bank Project (Royal Botanic Gardens Kew, UK), the Queensland Seeds for Life project and the Rainforest Seed project (Botanic Gardens Trust, Mount Annan, NSW).

An example is the development of conservation technologies for the rare *Citrus garrawayi* (Mount White Lime), an edible lime with unique fruits (Fig. 1C, 1D) that grows in the monsoon forests and rainforests of Cape York Peninsula, Queensland. The *ex situ* storage and use of its seeds are hindered by seed availability (i.e. limited access and supply), quality (e.g. maturity) and some desiccation sensitivity. However seeds can be stored by cryopreservation and also be coupled to a straight forward *in vitro* propagation system (Hamilton *et. al.* 2008). This example illustrates the use of conservation technologies to create *ex situ* storage options and facilitate propagation for utilisation of plant material (e.g. for horticultural and restoration purposes).

The Future

There is growing recognition of the national and international importance of crop wild relatives as a vital source of genetic diversity, and of the increasing threat to these from habitat destruction and climate change. Thus there is an urgent need to develop alternative *ex situ* conservation technologies, especially for rainforest fruits and crop wild relatives which currently cannot be stored by standard seed banking methods. It is imperative to (i) develop secure conservation collections and (ii) develop conservation technologies such as cryopreservation for the *ex situ* conservation of non-orthodox seeded species. This will contribute to Australia's commitment to the Global Strategy for Plant Conservation and the International Treaty on Crop Genetic Resources.

Table 1. Some Queensland genera with likely non-orthodox seed and of socio-economic importance as Crop Wild Relatives (CWR) or Bush Foods (BF)[1], with numbers and percentages of species in each genus under conservation threat[2].

Genus	Common name	Category	Fraction (%) of species in genus under threat
Alpinia	Native Ginger	CWR	1/5 (20%)
Capparis	Australian Caper	CWR	2/22 (9%)
Citrus	Wild Limes	CWR/BF	2/5 (40%)
Elaeocarpus	Quandong	BF	
Davidsonia	Davidson's plum	BF	1/3 (33%)
Diploglottis	Native Tamarind	BF	3/10 (30%)
Garcinia	Wild Mangosteen	CWR	1/6 (17%)
Macadamia	Macadamia	CWR/BF	6/7 (86%)
Musa	Wild Banana	CWR/BF	2/3 (66%)
Myristica	Australian Nutmeg	CWR/BF	0/2 (0%)
Passiflora	Wild Passionfruit	CWR/BF	0/1 (0%)
Piper	Wild Pepper	CWR/BF	1/7 (14%)
Syzygium	Lilly Pilly, Rose Apple	BF	10/49 (20%)

[1]Table modified from Ashmore *et al.* (2007)
[2]From Henderson (2002)

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