

National projects

Development of conservation technologies for Australian rain forest fruits and CWR

Kim N. Hamilton^{1,2}, Sarah E. Ashmore² and Cathy A. Offord¹

¹Botanic Gardens Trust Sydney, Mount Annan Botanic Gardens, Mount Annan, New South Wales, Australia

²Centre for Forestry & Horticultural Research, Griffith University, Brisbane, Queensland, Australia

Email: kim.hamilton@rbgsyd.nsw.gov.au

Australia has crop wild relatives (CWR) of many worldwide economically important species including citrus, banana and rice. Over 100 rare and threatened Queensland edible plants (bush foods) and / or CWR were identified in a recent study (Hamilton, 2007). Many of these species are of rainforest and / or tropical origins and may have non-orthodox seed storage behaviour, thus excluding standard seed banking approaches for long-term *ex situ* conservation. There is an urgent need to develop alternative *ex situ* conservation technologies to conserve this diversity. Table 1 lists some of the nationally and internationally significant CWR and bush foods of Australia. These include rainforest genera that contain species that are commercially cultivated (e.g., *Macadamia integrifolia*), CWR of commercially important species (e.g., *Macadamia* spp., *Citrus* spp. and *Musa* spp.), or of local importance as bush foods (e.g., *Diploglottis campbellii* (small-leaved tamarind), *Citrus australasica* (finger lime) and *Davidsonia jerseyana* (Davidson's plum – Figure 1). Table 1 also provides a summary of the percentage of species under threat

(protected under the Queensland Nature Conservation (Wildlife) Regulation 1994) in each genus in Queensland.

Conservation of Australian rainforest fruits and CWR

One of the key risks of projected climate change in Australia is its effect on rainforests, which are one of five natural systems predicted to be vulnerable to damage (Hennessy *et al.*, 2007). Rainforest plant diversity is best conserved by utilizing strategies that combine both *in situ* and *ex situ* approaches.

The seed of orthodox-seeded species can be routinely stored *ex situ* in seed banks using standard desiccation (5% moisture content) and freezing (-20°C) protocols. However, not all species are amenable to these procedures and require the development of alternative conservation technologies, particularly *in vitro* and cryopreservation approaches (i.e., storage at ultra-low temperatures), 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

Table 1. Some Australian genera with likely non-orthodox seed and of socio-economic importance as crop wild relatives (CWR) or bush foods (BF). Numbers and percentages of species in each genus under threat in Queensland are given. Table modified from Ashmore *et al.* (2007)

| Genus | Common name | Category | Fraction of QLD species under threat ¹ | |
|---------------------|-------------------------|----------|---|----|
| | | | Fraction | % |
| <i>Alpinia</i> | Native ginger | CWR | 1/5 | 20 |
| <i>Capparis</i> | Australian caper | CWR | 2/22 | 9 |
| <i>Citrus</i> | Wild limes | CWR/BF | 2/5 | 40 |
| <i>Elaeocarpus</i> | Quandong | BF | 4/27 | 15 |
| <i>Davidsonia</i> | Davidson's plum | BF | 1/3 | 33 |
| <i>Diploglottis</i> | Native tamarind | BF | 3/10 | 30 |
| <i>Garcinia</i> | Wild mangosteen | CWR | 1/6 | 17 |
| <i>Macadamia</i> | Macadamia | CWR/BF | 6/7 | 86 |
| <i>Musa</i> | Wild banana | CWR/BF | 2/3 | 66 |
| <i>Myristica</i> | Australian nutmeg | CWR/BF | 0/2 | 0 |
| <i>Passiflora</i> | Wild passionfruit | CWR/BF | 0/1 | 0 |
| <i>Piper</i> | Wild pepper | CWR/BF | 1/7 | 14 |
| <i>Syzygium</i> | Lilly Pilly, rose apple | BF | 10/49 | 20 |

¹From Henderson (2002). Threatened species are protected under the Queensland Nature Conservation (Wildlife) Regulation 1994.

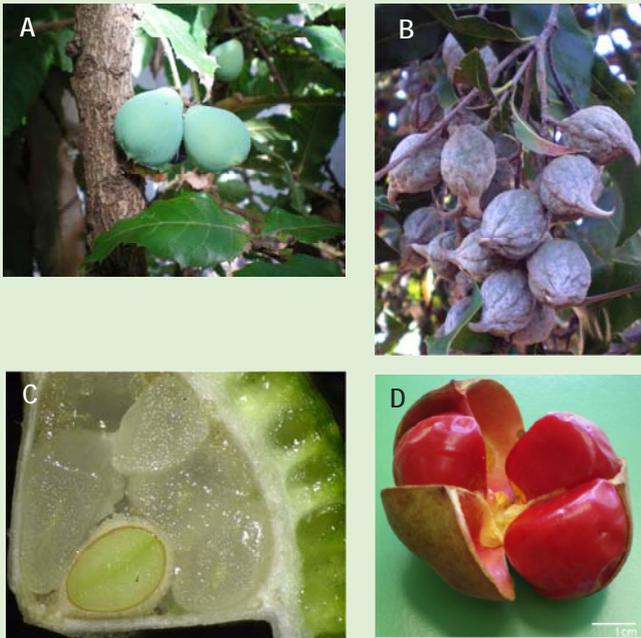


Figure 1. Rare and threatened rainforest fruits of Australia (protected under the Queensland Nature Conservation (Wildlife) Regulation 1994). (A) *Davidsonia jerseyana* (Davidson's plum) (endangered) and (B) *Macadamia ternifolia* (small-fruited Queensland nut) (vulnerable) shown in cultivation at the Mount Annan Botanic Garden. Cut fruits of (C) *Citrus garrawayi* (Mount White lime) (rare) and (D) *Diploglottis campbellii* (small-leaved tamarind) (endangered). Photos: K. Hamilton

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

Target 8 of the Global Strategy for Plant Conservation recognizes the importance of the development of new approaches to long-term *ex situ* conservation for recalcitrant (i.e., non-orthodox) seeded species, stating the need for 'additional resources, technology development and transfer, especially for species with recalcitrant seeds' (GSPC, 2002). Thus, there is an urgent need to develop conservation technologies (e.g., *in vitro* and cryopreservation – see Figures 2 and 3) to conserve the diversity of Australia's rainforest fruits and CWR. Research on the development of conservation technologies in Australia is being undertaken by the Australian Rainforest Seed Project (Botanic Gardens Trust, Mount Annan Botanic Garden) in partnership with Griffith University and the Millennium Seed Bank Project (Royal Botanic Gardens Kew, UK).

Case study: Australian wild relatives of citrus

The International Treaty on Plant Genetic Resources for Food and Agriculture has identified citrus as one of 35 food crops important to humanity for conservation and development of crop diversity (www.planttreaty.org/). Australia has six native species of citrus, the largest number of indigenous citrus species of any country worldwide, and these represent an important source of genetic diversity (Mabberley, 2004). All of these species are limes and five are endemic to Australia. *Citrus inodora* and *C.*

garrawayi are native to Northern Queensland (QLD). They are listed as vulnerable and rare, respectively, and protected under the 2000 schedule of the QLD Nature Conservation Act 1992 (QLD Nature Conservation (Wildlife) Regulation 1994) (Forster, 2002). Australian wild limes have breeding compatibility with commercial cultivars and some species, such as finger limes (*Citrus australasica*), are eaten as a popular 'bush food' and are currently being commercialized.

Citrus germplasm has traditionally been conserved in *ex situ* field collections of botanic gardens and research stations because of its non-orthodox seed storage behaviour. These collections are vulnerable to pests, disease and natural disasters so complementary long-term storage options are needed. Cryopreservation has been reported for seeds of cultivated species of citrus, but has not been fully researched or developed for routine use in seedbanks (Lambardi *et al.*, 2004; Hor *et al.*, 2005).

A recent PhD studied *ex situ* conservation options for three Australian wild *Citrus* species (Hamilton, 2007). Both micropropagation and cryopreservation protocols were developed for these species and can now be used to conserve this important genetic diversity. An example of the findings is given for the rare listed species, *Citrus garrawayi* (Mount White lime). *C. garrawayi* is an edible lime with unique fruits that grows in the monsoon forests and rainforests of the Cape York Peninsula of Australia and in Papua New Guinea. Several complexities hinder the *ex situ* storage and use of seeds of *C. garrawayi*. These include seed availability (i.e., limited access and supply), quality (e.g., maturity) and some desiccation sensitivity (Hamilton, 2007; Hamilton *et al.*, 2007). It was found that seeds at different maturities were amenable to cryopreservation and could also be coupled to a straightforward *in vitro* propagation system (Hamilton, 2007; Hamilton *et al.*, 2008). This example illustrates the use of conservation technologies to create *ex situ* storage options and facilitate propagation for utilization of valuable Australian plant diversity (e.g., horticultural and restoration purposes).

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Figure 2. *In vitro* storage and propagation of *Citrus inodora* (Russell River lime) (vulnerable—protected under the Queensland Nature Conservation (Wildlife) Regulation 1994).

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A. Briggs

Figure 3. Cryopreservation of seeds offers an *ex situ* storage option for important rainforest diversity. Australian native fruits, wild limes and Davidson's plum are pictured in the forefront.

Conservation of *Caesalpinia bonduc* (L.) Roxb. in Benin, West Africa

Achille E. Assogbadjo

Laboratory of Applied Ecology, Faculty of Agronomic Sciences, University of Abomey-Calavi, Cotonou, Benin

Email: assogbadjo@yahoo.fr

The project entitled 'Developing conservation and domestication strategies for the endangered scrambling shrub, *Caesalpinia bonduc* (L.) Roxb. in Benin, West Africa' is financed by the People's Trust for Endangered Species (United Kingdom). It will be coordinated by Dr. Ir. Achille E. Assogbadjo, researcher and lecturer at the Faculty of Agronomic Sciences in Benin and IUCN/SSC CWRSG Regional Leader for Sub-Saharan Africa. *C. bonduc* is a key economic, cultural and medicinal tree naturally found in the tropics and subtropics. The long-term viability of the species is threatened by overexploitation of its roots, which are mainly used against prostate gland disease in traditional pharmacopoeia in Africa. *C. bonduc* faces a very high risk of extinction and was classified as an endangered species in the IUCN Red List of Threatened Species 2000. Unfortunately, there are no known scientific studies from Africa on the species despite its extensive use by rural populations for medicinal purposes. The project aims to provide scientific studies on genetic diversity, ethnobotany and propagation methods for the species conservation and domestication in the parkland agroforestry systems of Benin. At the end of the project, scientific articles will be published in peer reviewed journals and guidelines related to the conservation strategies and propagation methods on *C. bonduc* will be developed for the benefit of local people.