Muelleria

43 Genomics Special Issue: 2–4

Published online in advance of the print edition, 21 November 2025

From Mueller to the genomics era: plant conservation at Royal Botanic Gardens Victoria

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Since its founding in the 19th century through to the present day, the story of plant conservation at Royal Botanic Gardens Victoria (RBGV) and the National Herbarium of Victoria has been one of continuity, innovation and restoration. Two centuries after the birth of Ferdinand von Mueller, the first Director of the Royal Botanic Gardens Melbourne, his legacy of scientifically rigorous and country-wide connected botanical research endures in the institution he shaped, and in the collections and community he fostered. Although the challenges have shifted – from cataloguing and describing a largely unknown flora to understanding how best to protect native plants in the face of growing environmental pressures – the role of the botanic gardens in conservation remains a defining constant.

Born in Rostock, Germany, in 1825, Ferdinand Mueller was destined for an illustrious career far from his country of birth. In 1847 he migrated to Australia, initially settling in South Australia before moving to Melbourne in 1851. In 1853 he was appointed Government Botanist, a position he held until his death in 1896. He founded the National Herbarium of Victoria, building a world-class herbarium collection that today is a key State asset for species discovery and plant conservation research. In 1857 he became the first Director of the Royal Botanic Gardens Melbourne. His tenure as Director lasted until 1873, during which time he built a diverse collection of flora from around the world. In 1862 he recorded that the Gardens sent out 42,519 seed packets to public institutions in Victoria and 28,589 interstate (Mueller 1862), illustrating the importance of Melbourne as a centre of plant exchange. More than that, the distribution of seeds around the world highlights the formidable network of people that Mueller built and who contributed to both the herbarium and the Gardens. His diverse collection of living species was inherited by William Guilfoyle and transformed into the gardens we see today.

During Mueller's lifetime he took part in, and was responsible for, several European-led expeditions through Australia, including the Augustus Gregory expedition across northern Australia, where he collected 800 species new to western science (Morris 1974). It is estimated that, over his lifetime, Mueller collected more than 25,000 specimens and coined nearly 8,000 names for Australian plants of which more than 1,500 remain in use and are accepted by botanists as valid concepts today (representing approximately 7% of the Australian flora).

Mueller was not unaware of the impact that colonisation of Australia was having on its native vegetation through his role as a commissioner on the Royal Commission on Foreign Industries and Forests. In a lecture on 'Forest culture in its relation to industrial pursuits', he identified "the forest as an heritage given to us by nature, not for spoil or to devastate, but to be wisely used, reverently honoured, and carefully maintained" (Mueller 1871). One hundred and twenty-four years later, we face a crisis: clearing and fragmentation of ecosystems, introduced animals and plants, and environmental change are pushing native flora and fauna towards extinction. It is a repeatedly stated fact that Australia has the worst record for mammal extinctions on the planet, with 39 species listed as extinct (EPBC Act 1999), but what about plants? An examination of the *Environment Protection and Biodiversity Conservation Act 1999* threatened species list reveals 1,490 threatened plant species, compared to 685 animals. Thirty-five plant species are listed as extinct, including species described by Mueller (e.g. *Musa fitzalanii*, the Daintree river banana), but many more (289 species) are critically endangered.

While plants are disproportionately represented on state and federal threatened lists, actions to conserve them are limited when compared to the investment directed toward animals. Yet without plants there is no life on Earth. Plants produce the oxygen we breathe, the food we eat, provide medicines that heal us, and fibres that clothe us. However, as a society we suffer from what has been termed "plant blindness" (Wandersee and Schussler 1999), an inability to notice and appreciate plants in our surroundings. More correctly, this condition should be called "everything-but-vertebrates bias" (Knapp 2019). Although we recognise the importance of plants, the innate bias towards vertebrates flows through to conservation decisions, where arguably more resources are spent on singular vertebrate species (e.g. the koala) than are spent on all plant species combined, threatened or not. Without investment in plant conservation, our ability to conserve the animals that rely on the vegetation will fail. It has been estimated that we need to increase investment in conservation in Australia by a factor of seven to achieve any meaningful species recovery (Wintle *et al*. 2019).

In 2025, we celebrate the 200th anniversary of Mueller's birth with a special issue on plant conservation genetics. The 2019/2020 Black Summer megafires in Australia burnt more than 8 million hectares of vegetation in the country's south-east alone. These fires affected a wide range of vegetation communities, including rainforests, eucalypt forests and woodlands, as well as shrublands and heathlands, with more than 800 vascular plant species having 50% or more of their populations or ranges burnt (Godfree *et al.* 2021). In Victoria, areas that were particularly impacted include the pockets of warm-temperate rainforest in the southeast of the state, montane grassy shrublands, ironbark forests, eucalypt and banksia woodlands, and heathlands (Geary *et al*. 2021). Management actions for the flora most at risk of extinction (i.e., species already threatened or with substantial loss of habitat) require assessment of population health to provide targeted responses specific to each species (McDonald *et al.* 2015). From a genetic perspective, understanding the patterns of genetic diversity within and between populations of a species is crucial to first evaluating the genetic health of a species and to guiding management strategies such as targeted seed collecting or genetic rescue of at-risk populations (Broadhurst *et al*. 2016). However, much of the Victorian flora has not had the fine-scale genetic analyses needed to effectively inform genetic risks that would guide management actions.

The advent of high-throughput molecular sequencing has opened up new tools for conservation and approaches that can be implemented at scale. One such example in Australia is the *Restore and Renew* program developed by the Research Centre for Ecosystem Resilience at the Royal Botanic Gardens Sydney (Rossetto *et al*. 2018). This program uses genomic data to allow restoration practitioners to make informed genetic decisions when putting plants back into the landscape, though with an NSW-specific focus. Based on this model, RGBV has obtained funding to produce similar analyses for some threatened and endangered flora of Victoria.

In this special issue of *Muelleria*, we highlight how, for a relatively small investment, sound conservation management decisions can be made using these DNA technologies. Much like in Mueller's time, delivery of these studies has relied on the researchers developing strong networks of committed land managers who are passionate about saving threatened species. We have brought together six research projects covering a range of taxa, from highly disjunct (*Acacia lucasii*; Simmons *et al*. 2025a) or range-restricted (*Grevillea jephcottii*; Hopley *et al*. 2025a) species with limited gene flow and distinct genetic signatures, to fragmented populations (*Eucalyptus mackintii*; Hopley *et al*. 2025b) with currently high levels of gene flow. Other studies, e.g. Hopley *et al*. 2025c, have documented the patterns of genetic diversity in the landscape for *Grevillea celeata*, but importantly have identified the issues created when decisions are made in the absence of genetic data. The other studies highlight the challenges associated with closely related species, how best to select translocation sites to reduce the risks of hybridisation (Simmons *et al*. 2025b), and how to respond to clonality (Simmons *et al*. 2025c).

Such studies not only provide essential baseline information for the conservation of individual species; by driving the accumulation of such fine-scale genetic data across the Victorian flora, they allow us to extrapolate and provide information to support the conservation needs of entire ecosystems.

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