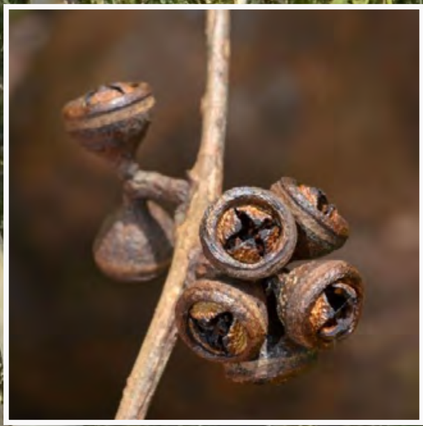
A Field Study of the Eucalypts of North-east Queensland





Donald C. Franklin

A Field Study of the Eucalypts of North-east Queensland

Comprehensive species coverage for north-east Queensland from a little north of Townsville north to Cooktown including islands, inland to Laura, Chillagoe and Georgetown, and south to Cobbold Gorge, Lynd Junction and Paluma. Includes the Wet Tropics and the northern half of Einasleigh Uplands bioregions.

Donald C. Franklin

Maps prepared by Stephen A. Murphy
Published by Donald C. Franklin

Published by the author, DC Franklin, Herberton, Queensland, Australia.
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Web-site provided by the North Queensland Natural History Group (https://www.nqnhg.org/).

Except where acknowledged otherwise in the caption, all photographs were taken by the author.
Other photographers are Deb Bisa, Gary Wilson and Jannie Smit.

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Front cover

Background: mostly Poplar Gum (*Eucalyptus platyphylla*)
Boxes, top row, left to right:
- trees – Range Bloodwood (*Corymbia abergiana*)
- bark – Dallachy's Ghost Gum (*Corymbia dallachiana*)
- leaves – Hyland's Bloodwood (*Corymbia hylandii*)

Boxes, bottom row, left to right:
- flower buds: Lockyer's Peppermint (*Eucalyptus lockyeri* subsp. *lockyeri*)
- flowers: Red-throated Bloodwood (*Corymbia rhodops*)
- capsules: Poplar Gum (*Eucalyptus platyphylla*)

Title page Red-throated Bloodwood (*Corymbia rhodops*)

About the Author

Don Franklin is a wildlife ecologist and field naturalist whose interests include birds, butterflies, eucalypts and Australian native bamboos. He loves being out and about in wild landscapes, is a keen nature photographer, and enjoys interpreting the role eucalypts play in structuring ecosystems and supporting wildlife.

Don retired to the Atherton Tablelands from Darwin in the Northern Territory in 2012, and has also lived and worked in Victoria. He began his professional life as an ornithologist for threatened species conservation projects. He subsequently worked as a research ecologist on a diversity of projects including birds and climate change, mosquito ecology, plant and vegetation ecology, and land management in the Australian monsoon tropics. He taught Wildlife Management and related topics for post-graduate students. Don has authored 120 peer-reviewed papers, half in international journals and half in local natural history journals. He has also authored seven book chapters, and won two publication awards. This is his fourth book.

Photo by Jannie Smit.

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Jannie Smit and Deb Bisa played key roles in creating this book. Jannie created the front cover, title page and front end, and designed a layout for the introductory chapters. Deb designed a layout for the species texts. However, any shortcomings in implementing these layouts are my own.

Finally, I am grateful to the North Queensland Natural History Group for hosting this study’s publication, and to Michael Anthony for implementing this.

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Glory of north-east Queensland: the bark of Lemon-scented Gum (*Corymbia citriodora*)



Colours peak late in the year, about November and December, as old bark is shed to reveal the new.

INTRODUCTION

Eucalypts are the lords of forest, woodland, savanna and scrub in so many Australian landscapes, often growing in fickle climates and clothing infertile soils with a protective olive-green carpet. They provide homes and food for unique wildlife, filter our drinking water, stabilise our soils, store carbon and clean our air, provide us with timber, honey and essential oils ... and fuel wildfires that create occasional havoc and tragedy. Understanding eucalypts should surely be a fundamental part of an Australian education.

Unmistakeable with their olive-green crowns, here eucalypt woodland extends to the horizon and way beyond. *Photographed near Irvinebank in the heart of north-east Queensland.*

But they are not an easy group to get to know. With more than 800 species, they are hyperdiverse, yet the differences between species are at times obscure. Even defining a eucalypt is a deceptively complex question, with genetic studies shedding major new light on old questions (see Box: What is a eucalypt?). Many aspects of their ecology remain elusive, and generalities are challenged by their diversity – and the diversity of landscapes they feature in. Some seem to encourage fire, yet why would a living entity burn itself? Why do some have smooth bark, others rough, and some a mix of the two? Why do some hang their leaves vertically whilst others hold them horizontally? Bud caps seemingly protect flower buds, but why did they evolve so uniquely in eucalypts? Why don't many eucalypts flower annually like most long-lived plants? Why do they hybridise with seeming profligacy apparently contrary to the best interest of adaptation to specific environments? How, or by whom, are they pollinated? Why are their seeds generally so poorly dispersed? And, following from the previous question, how have they moved across landscapes as climates changed during their 65 million years of history, *or* have they moved? What stories of the past do "ghost populations" of hybrids tell, ghost because their parents are elsewhere? How is it that stands of eucalypts frequently comprise two, three or more species sharing a habitat? And why and how is that the co-existing species are usually not close relatives (e.g. there's usually only one ironbark and/or one bloodwood or one box species in a habitat)? Questions are almost endless and our answers often little more than guesses.

A useful starting point is to get to know the species of a given locality or region. Recognising species enables key questions to be posed and given interim answers, beginning the process of making sense of a particular environment. How are these species partitioning the environment? What attributes of, for example, leaves or flowering patterns can be related to environmental variation within regions? What "strategy" does each species employ (strictly, did *evolve*) to cope with and thrive in its particular environment?

Dealing with the species in a region is easier than confronting at once the 800-odd species present nationally and internationally, though a quality national guide to eucalypts – EUCLID – is available online[1]. There's also an online key to Queensland eucalypts[2], though it has the limitation of requiring reproductive material at an early stage of the key, and there's still a large number of species – 220 – to deal with. Regional guides exist for parts of Queensland including Cape York Peninsula[3] just north of the area covered in this study, but until now not for north-east Queensland. This work covers in detail the 66 eucalypt species known to occur in north-east Queensland, offering much more than a means to identify them.

To assist with identification, for each of the 52 species I have classified as being of more than marginal occurrence in the area ("core" species), I have provided sections that include a short ("At a glance") and detailed description, notes on how to distinguish it from similar species, notes on its occurrence in the study area with a map of records, and locations where examples of the species can be seen. For the 14 "marginal" species, this information has been abbreviated. For all 66 species I provide photographs of as many typical field characters as I could obtain, including the tree, bark, leaves (both crown and sapling), flower buds, flowers and seed capsules. To further help with identification, there is a chapter entitled *Field Characters for Identification of Eucalypts in North-East Queensland*. This provides notes on distinguishing eucalypts from related non-eucalypts, illustrates the range of eucalypt traits in the study area, and presents a key to and notes on species groups (natural or apparent) – gums, ironbarks, stringybarks & mahoganies, yellowjackets, bloodwoods, boxes and others including a list of species within each.

For each of the 52 core species I also provide additional material that takes this study well beyond a guide to identification. This includes notes on habitat, a summary of its conservation status, discussion of conservation issues, and a referenced review of information about its ecology, biology and uses. For some species, the review is short or even absent because little or nothing is known; for a few species it is very detailed, as for the much-studied Rose Gum (*Eucalyptus grandis*) and Darwin Stringybark (*E. tetrodonta*).

This study report is intended as a reference work to be used by interested laypeople including field naturalists, secondary and tertiary students, pastoralists and land managers. I hope you will find the style readable and interesting. Yet I have aimed too to be sufficiently comprehensive as to be useful also to professionals including ecologists, environmental consultants and, dare I say, maybe even botanists.

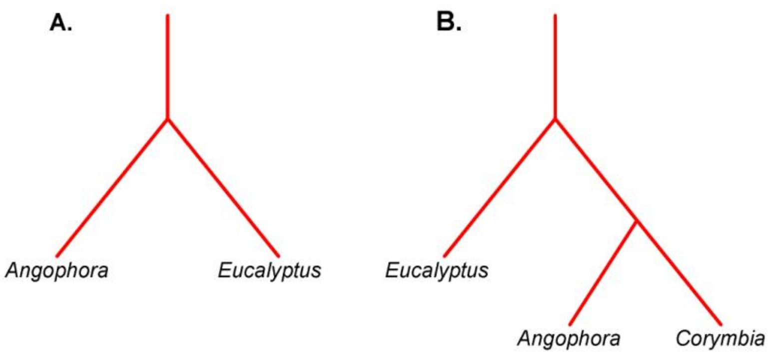
WHAT IS A EUCALYPT?

Eucalypt: any plant (tree, sometimes shrub) in the genera *Eucalyptus*, *Corymbia* or *Angophora*

It used to be straightforward: 'eucalypt' was the common name describing all members of the huge genus *Eucalyptus*. This included bloodwoods, ghost gums, red gums, stringybarks, ironbarks, boxes, mallees and many more. The unity of *Eucalyptus* seemed straightforward; all species lacked petals and had a protective cap (*operculum*) over the flower buds, whereas their sister genus – *Angophora*, the 'apples' – had petals and no cap. Referencing the cap, *Eucalyptus* means 'well covered'. In lieu of petals to attract insects, birds, bats and other creatures as pollinators, *Eucalyptus* flowers had showy male flower parts (*stamens*) and nectar.

Caps (opercula) (left) are a special feature of flower buds in the genera Eucalyptus and Corymbia, shed (right) as the flower opens; variations in shape, structure, size and texture are useful aids to species identification.
*Left – Queensland Peppermint (*E. exserta*); right – Herberton Ironbark (*E. atrata*).*

But there were rumblings among taxonomists that all was not well with this classification. The issue was resolved in 1993 with DNA analysis showing that *Angophora* is embedded within *Eucalyptus* rather than sister to it. Many genetic studies have since corroborated this finding, and none have contradicted it.



Relationships among eucalypts as understood before 1993 (A) and since then (B), expressed as evolutionary trees.
Before 1993, Angophora *and* Eucalyptus *were thought of as sister groups, i.e. distinct but each others' closest relatives (A). However, genetic studies have convincingly shown that* Angophora *is embedded among the eucalypts and sister only to certain eucalypts – bloodwoods, ghost gums and ghost gum allies – that have now been moved from* Eucalyptus *to* Corymbia *to rationalise the arrangement (B).*

As a genus is, by definition, a group of closest relatives, change to genus names was inevitable. One solution, presented in 1995 and now universally adopted by Australian herbaria, was to split *Eucalyptus* in two, moving those more closely related to *Angophora* than to other eucalypts to the new genus *Corymbia*. The name *Corymbia* describes the large corymb-like arrangement of flowers that is a feature of bloodwoods and thought to be an ancestral trait of the new genus.

This new understanding created a conundrum: what to do with the term "eucalypt". The consensus has been to retain it for *Eucalyptus* and those species moved to *Corymbia*, and extend its use to *Angophora*. That is the sense in which *eucalypt* is employed in this study.

This might not be the end of the story. Even with genetic analyses, uncertainty remains about the relationships within the *Angophora* / *Corymbia* group, with a strong hint in only some analyses that bloodwoods are closer to *Angophora* than to ghost gums. The matter is under further investigation. We may yet see the name *Blakella* being applied to ghost gums and their allies which locally include Lemon-scented Gum (*C. citriodora*), Cadaghi (*C. torelliana*), and the yellowjackets *C. leichhardtii*, *C. peltata* and *C. leptoloma*.

The study area

The study area (Fig. 1) comprises the Wet Tropics bioregion of north-east Queensland and its hinter-land. It includes offshore islands, the northern part of the Einasleigh Uplands bioregion, and a small, practical extension north to Cooktown and Laura in the Cape York bioregion (for all the eucalypts of the Cape York bioregion, see John Clarkson's field guide[3]). The area covered is 375 km from north to south, extending west from the east coast by from 150 to 315 km, covering about 85,000 square kilometres. These arbitrary boundaries reflect two issues. Firstly, before embarking on this project in 2016 I had gained some familiarity with the eucalypts of this area and felt I had some hope of covering it in detail. Secondly, this is the area most readily accessible for residents of the populated Wet Tropics coast and Tablelands, and for Cairns-based visitors.

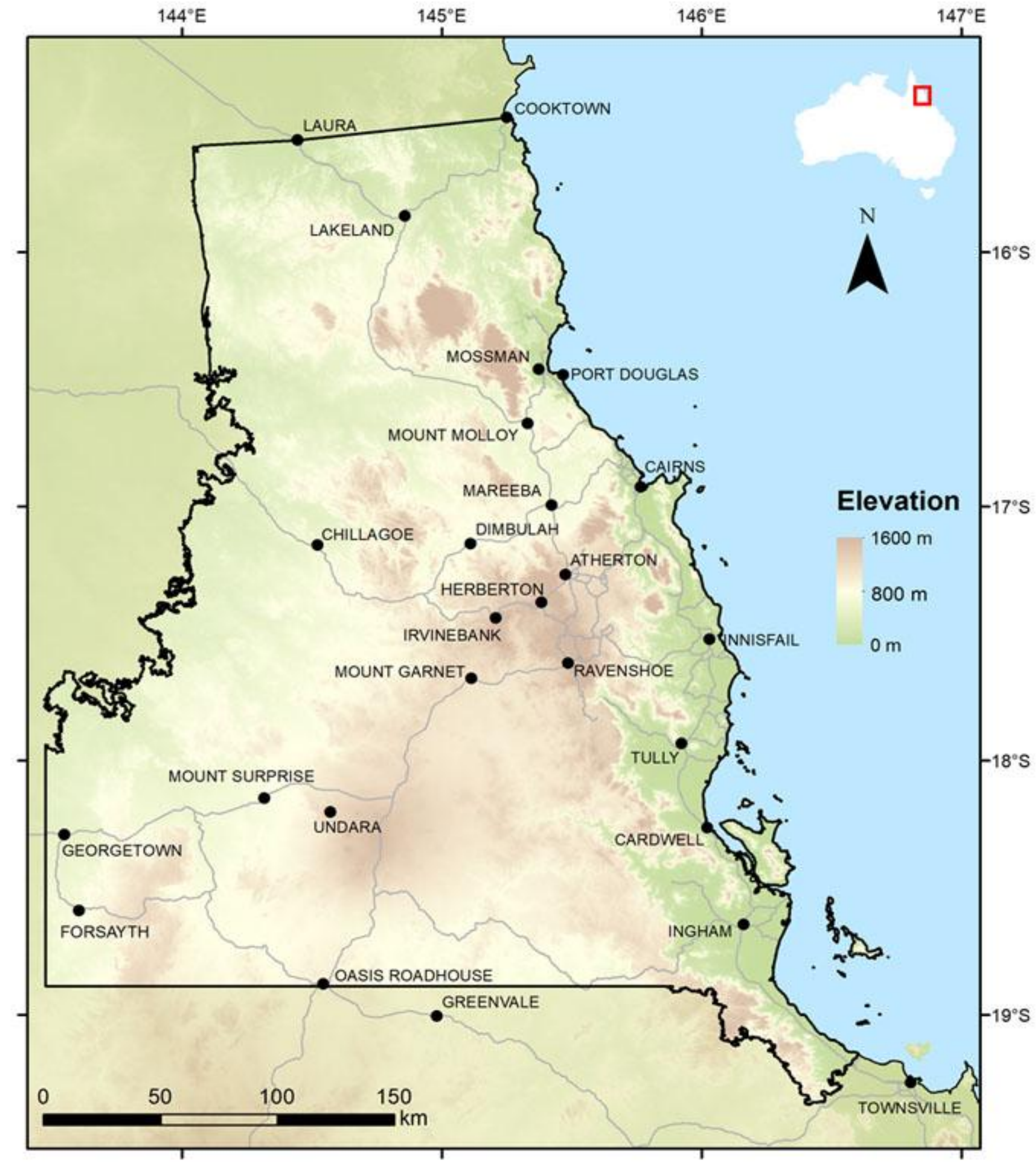
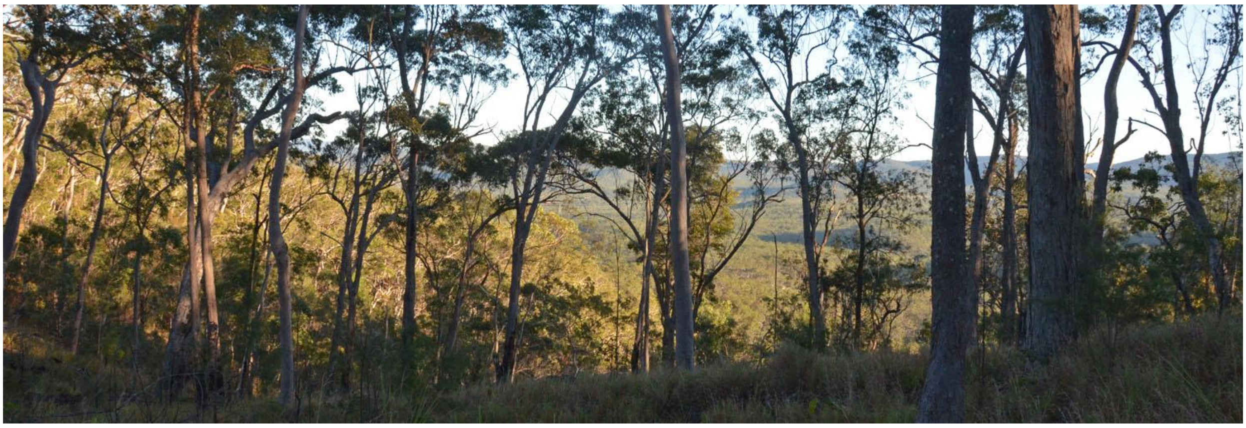


Figure 1. The north-east Queensland study area (black outline), showing major towns and locations (black circles) and main roads (grey lines).

The study area includes remarkable variation in elevation, climate and geology which contributes substantially to the diversity of its eucalypts and other vegetation. Elevations range from sea level to the summit of Mt Bartle Frere, the latter at 1,622 m ASL being the highest mountain in Queensland, though to my knowledge the highest occurrence of eucalypts in the study area is at 1,292 m on Mt Wallum near Atherton. Mean annual rainfall varies from an estimated 10 m (10,000 mm! one of the wettest places on Earth) on Mt Bartle Frere to about 650 mm in the far south-west. Rainfall is strongly seasonal with "summer rain" predominant almost throughout, but grading to almost aseasonal on the wettest peaks and a few coastal areas (Innisfail, Daintree). Most areas are warm to hot throughout the year, the northern lowlands especially so, whilst higher parts of the Tablelands enjoy a mild climate, and Ravenshoe and Herberton experience occasional frosts. Geologically, the study area varies from fertile soils of alluvial and volcanic origin to ancient granitic, metasedimentary and rhyolitic rocks with skeletal and infertile soils (see[4,5] for more information). Whilst parts of the coast and Tablelands are intensely agricultural, they are surrounded by forested hills and mountains now largely incorporated into conservation reserves. In contrast, most of the western two-thirds of the study area is pastoral, being grazed by cattle at low stocking rates on natural wooded pastures.

Eucalypts in north-east Queensland

Most native vegetation in north-east Queensland is dominated by eucalypts, with rainforest the main exception hugging the east coast and near-coastal ranges (see chapter *Eucalypts and rainforest*). From coastal plains to misty mountain ranges, thence west to the vast savannas of pastoral districts, eucalypts variously form tall or shorter open forests, woodlands, and semi-arid open woodlands in a great array of settings: mangrove fringes, fertile and infertile plains some floodprone and some not, steep slopes often with skeletal soils, amongst rock piles, on the fringe of swamps, on sandsheets and heavy clays, and on well-developed soils high in the ranges. Sometimes too they occur in heath and rainforest, and form gallery (riverine) forest or emerge above gallery rainforest.



A eucalypt landscape, foreground and background.
Photographed looking west from the Great Dividing Range near Herberton in north-east Queensland.

North-east Queensland as defined in this project (Fig. 1) supports 66 species of eucalypt, the figure varying only slightly with differing taxonomic systems, while a few species complexes are not fully resolved (see Box: 'Species'). Of the 66, eleven species plus four subspecies are found nowhere else or very nearly so (Table 1). Of the eleven, two rare eucalypts are officially listed as Threatened: Red-throated Bloodwood (*Corymbia rhodops*) and Paluma Range Yellowjacket (*C. leptoloma*). Based on land clearing in the study area or elsewhere, there is a strong case for listing more species.

Table 1. Eucalypt species and subspecies found only within, or virtually only within the north-east Queensland study area.

Scientific name	Common name
Corymbia abergiana	Range Bloodwood
C. ellipsoidea	Sand Red Bloodwood
C. hylandii	Hyland's Bloodwood
C. leptoloma	Paluma Range Yellowjacket
C. rhodops	Red-throated Bloodwood
C. stockeri subsp. *stockeri*	Blotchy Bloodwood
C. torelliana	Cadaghi
Eucalyptus atrata	Herberton Ironbark
E. granitica	Granite Ironbark
E. lockyeri	Lockyer's Peppermint
E. lockyeri subsp. *exuta*	Northern Peppermint
E. lockyeri subsp. *lockyeri*	Lockyer's Peppermint
E. pachycalyx subsp. *pachycalyx*	Pumpkin Gum
E. staigeriana	Lemon-scented Ironbark
E. tardecidens	Mt Carbine Box

North-east Queensland is the most species-rich region for eucalypts in northern Australia[6]. In common with other species-rich areas, eucalypt diversity has accumulated as a product of past climate fluctuations interacting with localised climatic and geological diversity[7]. The 66 eucalypt species are a biogeographic melting pot, representing influences ranging from the tropical savannas to temperate east coast forests (Table 2).

Table 2. Biogeographic associations of the 66 species of eucalypt that occur in the north-east Queensland study area, derived from a classification of known ranges of all species in northern Australia[6].

Biogeographic group	No. of species	Example species
widespread in semi-arid Australia	3	River Red Gum (*E. camaldulensis*)
widespread in tropical savanna	7	Darwin Stringybark (*E. tetrodonta*)
sub-inland north Queensland	21	Dallachy's Ghost Gum (*C. dallachiana*)
north-east Queensland species	12	Cadaghi (*C. torelliana*)
Cape York Peninsula species	6	Melville Island Bloodwood (*C. nesophila*)
Australian east coast	5	Rose Gum (*E. grandis*)
widespread in eastern Australia	11	Clarkson's Bloodwood (*C. clarksoniana*)
Brigalow Belt species	1	Gympie Messmate (*E. cloeziana*)

Species richness of eucalypts also varies greatly within the study area. Considering areas of about 10 km by 10 km (approximately the cells used to map species in this study), the coastal plains support from zero (e.g. around Innisfail) to ten species as fewer species are known from areas that remained covered in rainforest even through drier ice ages most recently about 18,000 years ago[8]. Cells in western pastoral districts generally support 10 to 15 species, with a peak of about 20 species in the Newcastle Range west of Einasleigh. Greatest species richness occurs in the higher, drier ranges, reaching a maximum of about 30 species in the Herberton – Irvinebank – Ravenshoe area. The latter is the highest diversity in northern Australia[6] and is likely the result of a combination of elevational and geologic diversity and that these areas, although elevated, are relatively dry. Elevation suggests that during the last Ice Age they may have been less exposed to severe drought than were the western lowlands. Dryness suggests that even in the moister periods between Ice Ages they probably never supported (in the last two million years at least) the rainforest which suppresses eucalypts – as discussed in the next chapter.

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[1] Slee AV *et al*. 2020. *EUCLID. Eucalypts of Australia. Fourth Edition.* Centre for Australian National Biodiversity Research: Canberra. https://apps.lucidcentral.org/euclid/text/intro/index.html

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[6] Franklin DC, Preece ND. 2014. *The Eucalypts of Northern Australia: An Assessment of the Conservation Status of Species and Communities*. Report to Kimberley to Cape and the Environment Centre NT.

[7] Bui EN *et al*. 2017. Climate and geochemistry as drivers of eucalypt diversification in Australia. *Geobiology* 15: 427-440.

[8] Hilbert DW *et al*. 2007. Glacial and interglacial refugia within a long-term rainforest refugium: The Wet Tropics Bioregion of NE Queensland, Australia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 251: 104-118.

‘SPECIES’

I am an ecologist, conservation biologist and field naturalist, not a botanist or taxonomist. I am not involved in the business of working out appropriate levels of classification. What matters to me is that we identify *ecologically meaningful entities* and maintain *evolutionary potential*[1] within populations.

It follows that I am not entirely comfortable with the species-based approach which I’ve presented, of necessity, in this study. Writing of human evolution (but equally applicable to plants and other animals), palaeontologist and evolutionary biologist Nicholas Longrich wrote:

“The nature of evolution means that living things don't fit into neat categories.”[2]

What we see of all living forms is a snapshot in time (and place) here-and-now. Adding the dimension of evolutionary time to our perspective – which can be a challenge – helps make sense of what we observe. Further, we often perceive and present evolution as a branching tree when – as genetic studies are now showing for eucalypts and many other plant and animal groups – it is often more like a trellis with hybridisation events contributing much to speciation. This is known as *reticulate evolution.*

The evolutionary time perspective on eucalypts is complex. Though they are thought to have arisen as a distinct group about 65 million years ago, a major implication of the time perspective at finer taxonomic levels is that many ‘species’ are in an active phase of evolution, having arisen only in the last few hundred of thousands of years[3] – which is *recent* in evolutionary time for long-lived organisms such as trees – and are in a state of geographic and evolutionary flux following the last Ice Age a mere 18,000 years ago. Moreover and partly as a consequence, closely related eucalypts generally lack isolating mechanisms such as inviability of cross-pollination or of hybrids, or separation of flowering times.

So what are we to make of eucalypt ‘species’? Is it even worth bothering “because they’re all hybrids anyway”? I’ve heard that said more than once, but feel strongly that it is both incorrect and a lazy, destructive conclusion. It is both practically useful and important for our future to think of eucalypt species as ecological, evolutionary and conservation-worthy entities. That is the point of presenting this study. There is no need to expect absolute discreteness of species, and at times it is not possible. Indeed, understanding the limitations of the species concept as applied to eucalypts enhances one’s understanding and appreciation of both the group and the entities within it.

For most of the 66 species presented in this study, the taxonomy and scientific names *recently* employed is consistent among authorities, but for six species it is not. The protocol adopted in this study, and currently held variations to it, are presented in the Explanatory Notes to the species texts. In each species text, current and recent alternative scientific names are presented immediately beneath the species title. Relationships among close relatives, taxonomic issues and its recent history, and evidence suggesting widespread past and perhaps ongoing hybridisation (i.e. not first generation hybrids) are discussed in the *Notes* section of each species text. As an alternative to *hybrid* or *hybridisation* I prefer the descriptive terms *intermediate* or *intermediacy* to avoid pre-empting conclusions about processes.

[1] Crandall KA *et al.* 2000. Considering evolutionary processes in conservation biology. *Trends in Ecology & Evolution* 15: 290-295.

[2] https://www.bbc.com/future/article/20211008-what-if-other-human-species-hadnt-died-out, *viewed 17 April 2022.*

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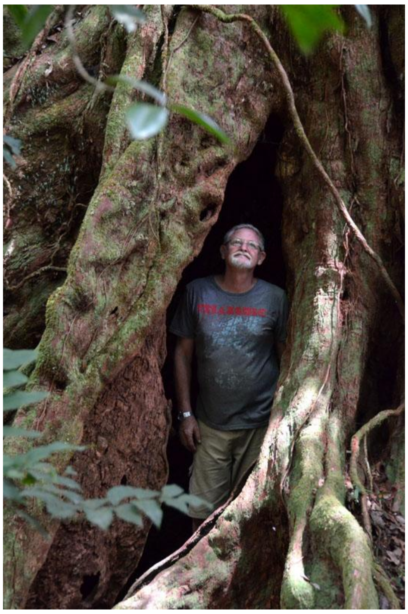
EUCALYPTS AND RAINFOREST

There is an irony to studying and writing about the eucalypts of north-east Queensland, for it is here that rainforest – the forest type most capable of excluding eucalypts – occurs most extensively in Australia (the land of eucalypts). But in this irony there is virtue, for we can see replayed in our lifetimes the dynamic story of eucalypts as trees that have "duelled" with rainforest for space over much of their evolutionary history. It is only quite recently – at geological timescales – that Australia has dried out and eucalypts have come to dominate forests and woodlands as the ultimate survivors on infertile soils prone to fire and drought.

Suggesting that eucalypts emerged from rainforest, their four nearest living relatives are all rainforest trees[1]. Two of the four occur in Australia: An-binik (*Allosyncarpia ternata*) is a tree of ravines of the Arnhemland Plateau in the Northern Territory, whilst Stockwellia (*Stockwellia quadrifida*) is a rare tree of the very wettest rainforests in north-east Queensland (see box). The other two occur in New Caledonia, New Guinea and the Moluccan Islands, distributions that likely reflect dispersal events that occurred long after eucalypts appeared on the scene.





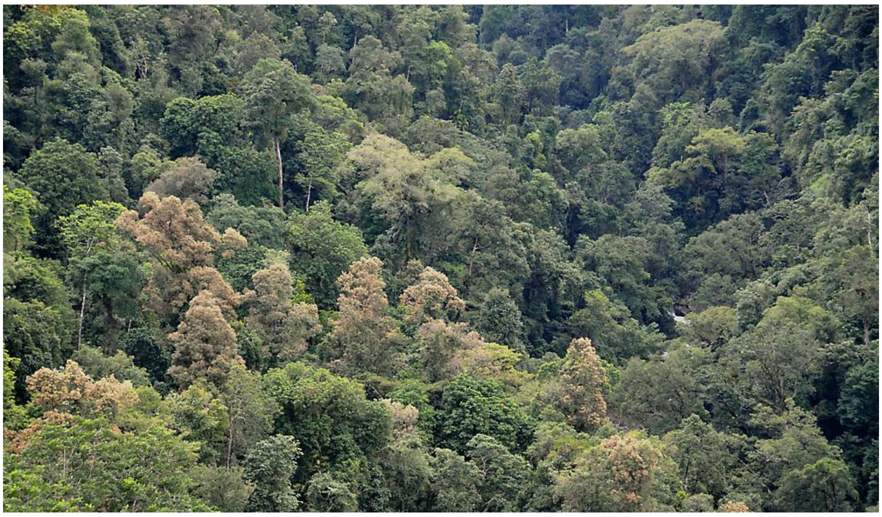
Stockwellia (**Stockwellia quadrifida*****) is amongst the closest living relatives of eucalypts.***
It is known from a small number of stands in the vicinity of Mts Bartle Frere and Bellenden Ker, where it grows in rainforests that likely receive rainfall of more than 5,000 mm per year and are devoid of eucalypts. Stockwellia commemorates its discoverer, the late forest ranger Victor Stockwell. Stockwellia was not formally named until 2002 though Stockwell found the species several decades earlier.

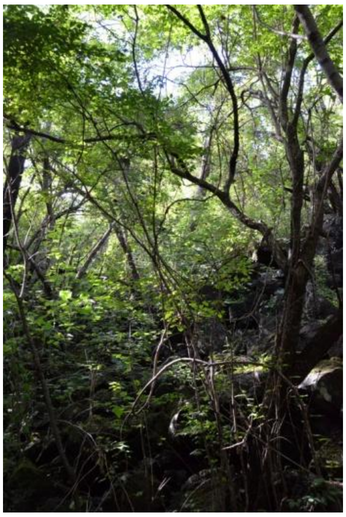
However, molecular dating suggests that eucalypts first appeared about 65 million years ago in a landscape of fire-prone monsoon forest[2,3]. This was at south-polar latitudes which then had a much warmer climate than prevails today, though the thought of eucalypts surviving winter in prolonged darkness is distinctly challenging.

A few millions years later the climate became wetter, marking the beginning of the Palaeogene period in which rainforests dominated the last neighbourly portions of the Gondwanan supercontinent – Australia, Antarctica and southern South America and, already more distant, New Zealand. The Palaeogene persisted for almost 40 million years, by the end of which Australia had moved northward well away from its former neighbours. The Palaeogene might have been a “Dark Age” for eucalypts in another, non-wintry sense in which they persisted as fringe-dwellers on sites where conditions were particularly harsh for rainforest. The oldest known fossil eucalypt leaves and seed capsules are five species from southern South America, dated to 52 millions years ago[4,5]. A rich collection of plant fossils from the site tell a story of a long-gone rainforest and a volcano, with eucalypts occupying the zone where rainforest stopped and the impact of the volcano started – the link with fire being obvious. Fossil pollen that may have come from eucalypts, and which is dated to about the same time, is widely dispersed through those last portions of Gondwana[2]. Mountain ridges might have provided sites where soils were skeletal and infertile and exposed to lightning-induced fire; one can also envisage a niche on the edge of swampy plains where grasses carried fire, and parts of what is now central Australia may then have been dry enough to carry occasional wildfire. During this period, the adaptation of eucalypts to these marginal conditions was doubtless honed by natural selection. Divergence of the two primary groups of eucalypts (*Eucalyptus* on the one hand and *Corymbia* plus *Angophora* on the other) occurred early in the Palaeogene, though the major diversification of species that we now encounter occurred much more recently as Australia dried out[6].

Eucalypts and rainforest in the present-day landscapes of north-east Queensland

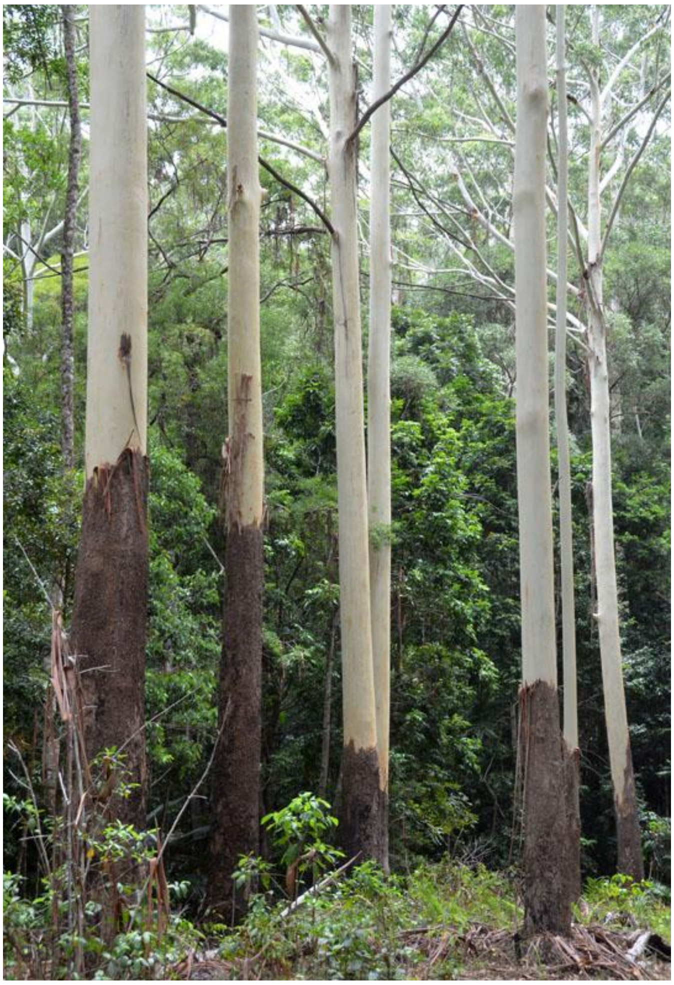
The natural vegetation of the north-east Queensland study area is mostly dominated by eucalypts, but along the coast and coastal ranges, rainforest often predominates. Eucalypts are also rare or absent in some westerly areas where semi-deciduous vine-thickets and vine forests occur in localised pockets, most obviously and extensively at Forty Mile Scrub, within the lava tube at Undara, and around limestone outcrops at Chillagoe. These are floristically ‘related’ to rainforest but are more tolerant of seasonal drought. Coastal vine-thickets on sand, and Hoop Pine forests in rocky gorges also feature rainforest plants and may be devoid of eucalypts. However, at a district scale it is only the very wettest areas that are quite devoid of eucalypts, most extensively around Innisfail, extending inland along the Palmerston Highway and thence north through Mt Bartle Frere and the Bellenden Ker Range. These areas remained as rainforests even through the last ice age when the climate was markedly drier (and cooler)[7].





No eucalypts: lowland tropical rainforest, Wooroonooran National Park (left); and lava tube vine-thicket, Undara Volcanic National Park (right).

With some notable exceptions discussed later in this chapter, eucalypt forest and rainforest usually exclude each other. The boundary between these forest types is often remarkably abrupt, a matter of a few metres, though at times there is a more gradual transition. Sometimes it seems obvious why one site is clothed with rainforest while another close by supports eucalypts, but at other times the reasons are obscure. The environmental conditions across the boundary may appear to be on a gentle gradient even where the vegetation boundary is abrupt. Establishing generalisations that hold across our landscape is a substantial challenge.



Abrupt boundary between Rose Gum (**Eucalyptus grandis*****) forest in foreground and rainforest behind.*** *Photographed in the Lamb Range (Dinden National Park), north-east Queensland.*

A useful starting point is this: when eucalypt forest abutts rainforest, the eucalypt forest occupies ground that is drier or less fertile, or the site is more prone to fire, or a combination of these. But this proposition is often a circular argument because both these forest types generate and perpetuate the conditions that suit them[8]. Rainforest shade helps retain the moisture that renders fire less likely to spread; deep shade also prevents the grasses that readily carry fire from growing, and eucalypt seedlings from establishing (see next section). In the absence of fire, fallen leaves and other forest debris decompose and accumulate as topsoil, improving soil fertility and moisture retention and even altering soil chemistry[9]. In contrast, the open canopy of eucalypt forests facilitates the growth of grasses, and that along with eucalypt leaf litter that does not so quickly decompose expose the forest to a greater risk of fire, so reducing the likelihood that decomposition will promote development of topsoil. These processes are known as feedback loops, creating self-reinforcing vegetation types.

Feedback loops take time to operate, and the perspective of time adds immensely to our understanding of these forest boundaries. I provide a time perspective in a later part of this chapter but first concentrate on the prevailing circumstances in which the two vegetation types abutt. These may be thought of as *precursor conditions* for the development of vegetation types and feedback loops.

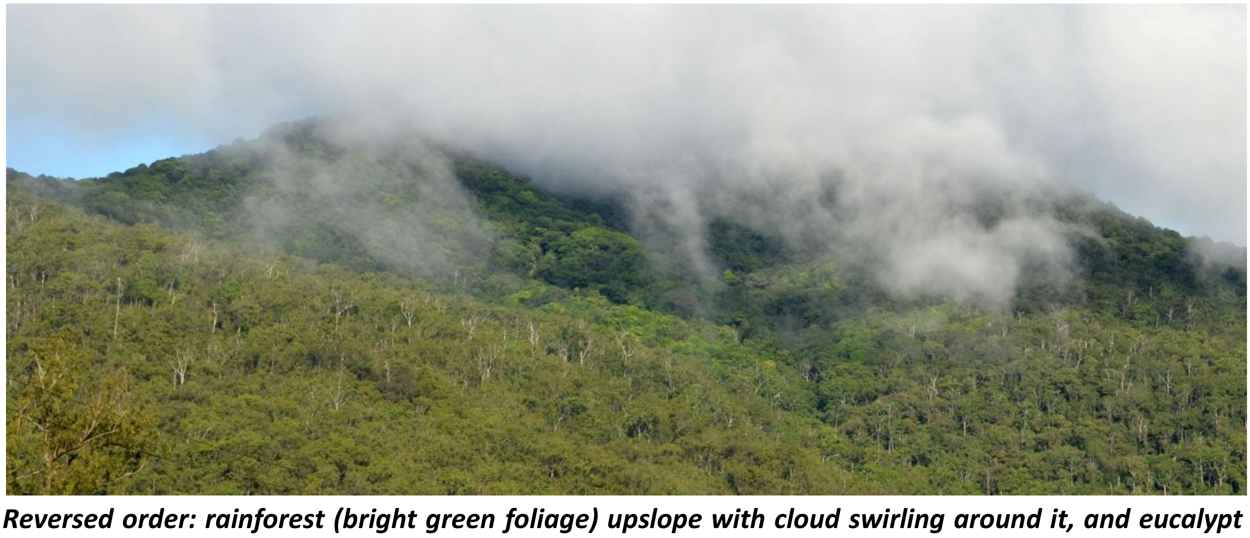
One common scenario in north-east Queensland is for rainforest to occur in valleys, often extending to adjacent slopes but in other situations being confined to the streambank. Eucalypt forest occurs upslope, on ridges, hillsides and at times even on alluvial flats adjacent to the streamside (gallery) rainforest. Due to natural processes of erosion, soils on ridges and slopes are typically shallower, less fertile and retain less moisture than those in the valleys below. Lightning is more likely to strike a ridge than in a valley, and fires spread more easily upslope than downslope. The slope is a gradient which belies the often abrupt vegetation boundary, feedback loops accounting for the abruptness.

Rainforest and open forest interspersed in Wooroonooran National Park, north-east Queensland.
The duller, olive-green vegetation along the spurs is open forest, and the brighter vegetation in-between is rainforest.

In many parts of the study area, however, the upslope – downslope relationship is reversed, with rainforest on the higher peaks regardless of underlying geology. A particularly obvious example occurs along the Mt Spec Road north of Townsville, with eucalypt woodland and open forest extending from the coastal lowlands to the mid-slopes but the upland village of Paluma is tucked within rainforest. It is also evident in the Herberton Range south-west of Atherton (photo) and in many other locations in north-east Queensland. Along the Gillies Highway from Gordonvale to Lake Barrine both processes are present, with rainforest along the floor of the Mulgrave and Little Mulgrave River valleys but eucalypt forest on nearby hills, then eucalypt forest on the lower and middle slopes of the Gillies Range ‘reversing’ to rainforest on the higher slopes.

Rainforest downslope, eucalypt forest higher up. *Murray Falls, Girramay National Park.*

The reversal occurs because elevated sites are cooler and much more often immersed in cloud and mist. Water loss by plants (transpiration) is markedly lower in the uplands[10]. Clouds and mist generate rainfall. Further, this immersion allows trees to "strip rain" from them, with moisture coalescing into droplets on vegetation and dripping to the ground below, tripling effective rainfall during key months of the dry season in montane forests of north-east Queensland[11]. Again, the environmental change occurs on a gradient yet the forest boundary is often abrupt.



Reversed order: rainforest (bright green foliage) upslope with cloud swirling around it, and eucalypt forest (olive-green foliage and pale trunks) on the slope below. *There is no change in geology; both forest types are on rhyolite. Photographed in the Herberton Range near Atherton.*

Sometimes the transition from rainforest to eucalypt forest occurs abruptly with a change in geology. On parts of the Atherton Tablelands, red volcanic soils support rainforest but nearby granitic soils support eucalypt forest. Yet one need not travel far to find eucalypt forest on red volcanic soils and rainforest on granitic ones, the former being in drier areas and the latter in wetter areas. Thus, it is not geology *per se* that is the driver here, but rather soils with greater fertility and/or moisture retention interacting with rainfall that has enabled feedback loops to establish. More fertile soils may enable faster growth rates, enabling rainforest plants to more quickly (re-)establish a feedback loop before disturbance such as fire might disrupt it.

In drier, rocky parts of the study area, the key to the transition from eucalypt forest to rainforest often lies more directly with fire, with rocks providing natural firebreaks. This allows drought-tolerant rainforest-allied species to form vine-thickets and vine-forests in rocky gorges or elevated among boulders, both forms exclusive of eucalypts but surrounded by them in more fire-prone habitats. Vine-thicket also occurs in coastal areas, partcularly on infertile sands which do not support dense grass and are thus less likely to carry fire.

Eucalypt woodland upslope (above) and downslope (below), with rainforest-related vegetation exclusive of eucalypts as the alternative.
Both vegetation patterns are primarily driven by the role of rocks in providing firebreaks.
*Above: Hoop Pine (*Araucaria cunninghamii*) forest in the gorge at Blencoe Falls.*
Below: semi-deciduous vine-thicket on a limestone outcrop at Chillagoe.

Why don't eucalypts (usually) occur in rainforest?

The answer is not as obvious as it might seem. Whilst fire may facilitate germination of eucalypts and the survival of their seedlings, for example by the ash-bed effect of soil sterilisaton and fertilisation[12] and by opening the rainforest canopy[13], it is not in itself essential for either germination or growth. Eucalypt seedlings need light[14], far more than is usually available on the rainforest floor[(see 15)]. However, seedlings of many rainforest trees also require light, regeneration occurring in canopy gaps created by storm damage and the fall of veteran rainforest trees[16], or by other mechanisms such as strangler figs beginning life as epiphytes higher in the rainforest where there is more light. So the question can usefully be re-framed as:

Why don't eucalypts regenerate freely in rainforest canopy gaps?

The answer, I believe, lies with their seed. Eucalypt seed mostly lack mechanisms for dispersal; the general rule of thumb is that most dispersal occurs within one to two times the height of the tree[17,18]. Bloodwoods are something of an exception, most having winged seeds, but the wings appear insufficient to support long-distance dispersal under normal conditions – though there appears not to have been any examination or test of this. The seed of tropical eucalypts also lacks mechanisms to maintain dormancy[17]. The viability of eucalypt seed once on the ground is likely to be less than a year[19] and in tropical areas it is usually much less[20,21]. Further, many eucalypts do not flower each year[22]. These are precisely *not* the set of attributes needed to make frequent use of canopy gaps, as gaps are by nature temporary and unpredictable. To be present or arrive in canopy gaps when or soon after the gap forms, seed needs to be produced both abundantly and frequently, or have prolonged viability, and to be dispersed widely[16]. Either that, or have a specialised mechanism to disperse seeds with precision into canopy gaps ....

The exception among eucalypts illustrates the "rule". Cadaghi (*C. torelliana*) is the one eucalypt which can and has often been described as a rainforest tree, and it has evolved an extraordinary seed dispersal mechanism that is unique among all plants, not just eucalypts. Seeds "hitch a ride" home with stingless bees that build their nests in rainforest canopy gaps. See the *Notes* for that species for details.

Boundaries and interactions, past and present

Since boundaries between rainforest and eucalypt forest are self-reinforcing, they may and often do remain stable for years, decades or longer, at times even in the face of considerable environmental stress and change. But there is a clear record of boundary shifts in both the distant and recent past. With the end of the Palaeogene 26 million years ago and movement of the Australian continental plate towards the equator, Australia became drier and rainforest contracted. Over the last 140,000 years, there has been a general increase in eucalypt forest and decrease in rainforest cover in north-east Queensland[23]. With the cessation of the last ice age about 18,000 years ago, the opposite trend emerged: as rainfall and temperatures increased, the area of rainforest in north-east Queensland is estimated to have more than doubled at the expense of eucalypt forest[7]. For example, when Lake Eacham was formed by volcanic explosion about 10,000 years ago it was surrounded by eucalypt forest, as recorded orally by the Dyirbal (Jirrbal) people[24], but it is now completely surrounded by rainforest. Analyses of pollen obtained from earth cores confirms a similar replacement of eucalypt forest by rainforest since the last ice age at Quincan Crater[25], Lake Euramoo[26] and Lynch's Crater near Butchers Creek[27], all on the Atherton Tableland.

So it should come as no great surprise that there is evidence of change in the position of some eucalypt/rainforest boundaries within our lifetimes. This has been well documented in the form of expansion of rainforest into forests of Rose Gum (*E. grandis*), and the relevant literature is reviewed in the text for that species. Much of this evidence is incontrovertible in the form of comparisons over time of aerial photos and vegetation in marked plots, but an important caution is that the presence of eucalypts within (at least the fringes of) rainforest is not in itself proof of expansion of rainforest. An alternative process, demonstrated on one occasion in the study area[13], is for fire to burn into the fringe of rainforest during severe drought, allowing eucalypts to establish there. The capacity of fire to burn into rainforest during drought was demonstrated on a dramatic scale at Eungella (280 km south-east of the study area) in 2018 with the burning of 11,000 ha of rainforest (including some cloud forest) and vine-thicket[28]. In the study area, a large portion of the extensive vine-thicket at Forty Mile Scrub was burnt in September 2019.

Lack Eacham was surrounded by eucalypt forest about 10,000 years ago, but is now deeply embedded in rainforest.

The presence of eucalypts within rainforest in north-east Queensland is far from limited to Rose Gum (and Cadaghi). In the ranges, Small-fruited Red Mahogany (*E. resinifera*) also often occurs within rainforest[29]. In lowland and foothill tropical rainforests, Large-fruited Red Mahogany (*E. pellita*) and Pink Bloodwood (*C. intermedia*) are a feature in a number of areas, for example at El Arish and Mission Beach. On Dunk Island, what may appear at ground level to be rainforest is mostly eucalypt forest with a well-developed rainforest understorey. In gallery (streamside) rainforest and sometimes elsewhere, Forest Red Gum (*E. tereticornis*) and Moreton Bay Ash (*C. tessellaris*) are locally common, as is River Red Gum (*E. camaldulensis*) occasionally in the north of the study area. Sometimes Poplar Gum (*E. platyphylla*), Clarkson's Bloodwood (*C. clarksoniana*) and even Narrow-leaved Ironbark (*E. crebra*) occur within drier or gallery vine-thickets.

These occurrences may be interpreted as evidence of either change in boundaries or as the product of disturbance which has created a window for eucalypts to establish within rainforest. Disturbance may take a number of forms, potentially including fire as discussed above, but also damage by cyclones, other storms or floods, and the natural attrition of veteran rainforest trees creating gaps in the canopy. The caveat is that in general there must be mature eucalypts close by to provide a seed source, though seed might occasionally be carried longer distances, for example by storms, floods or even animals.

Establishment of rainforest within eucalypt forest can occur with an amelioration of the conditions that promote maintenance of the eucalypt forest feedback loop. In the longer term this might include an increase in rainfall, which could promote germination and growth of rainforest trees directly and also reduce the frequency and/or intensity of fire. In the shorter term, the actions of people in reducing the impact of fire might promote the expansion of rainforest. Lack of fire in moist eucalypt forest near rainforest is often attributed to the cessation of Aboriginal burning[e.g. 30,31], though grazing reduces fuel loads and thus fire frequency or intensity, as demonstrated in the Mossman area[32].

Another possible driver of rainforest expansion has received much less attention: elevated levels of carbon dioxide (CO_2) in the atmosphere associated with recent human-induced climate change. Alternative chemical processes of plant photosynthesis (known as C_3 and C_4 respectively) are affected differently by change to the concentration of CO_2 in the atmosphere. It has been argued with supporting evidence that elevated CO_2 favours rainforest over grassy forest and that the effect may even override decreased rainfall and adverse fire regimes[8,33].

Within the study as elsewhere in Australia, there is an abundance of evidence of skillful traditional use of fire by Aboriginal people to protect and promote food and cultural resources. The extent to which these practices influenced eucalypt/rainforest boundaries is much less certain, however. A 30 ha patch of eucalypt forest embedded within rainforest at Cedar Bay in the north-east of the study area, evident to this day (e.g. on Google Earth), is a particularly clear illustration of boundary and habitat maintenance by Aboriginal burning. Burning was undertaken to maintain a critical seasonal food resource not present in rainforest – cycad fruit – for the clan, but also to protect key rainforest trees close to the boundary[34]. At a very much larger scale, though, rainforest has expanded greatly within the study area with climatic amelioration during the term of, and notwithstanding Aboriginal residence. In one case this demonstrably occurred around a camp that was occupied before, during and after the change[35].

Some arguments about the cessation of Aboriginal burning and its consequences for these boundaries verge on circularity: has the cessation of Aboriginal burning allowed rainforest to expand, or is the expansion of rainforest evidence of the cessation of Aboriginal burning? There's also scant consideration of possible alternative explanations and any appraisal of evidence that this burning occurred at the requisite spatial scale. These arguments seem to imply use of fire by Aborigines at a massive scale – the boundaries within the study area must be several thousand kilometres long – which seems inconsistent with either the evidence in north-east Queensland, or of skillful practice. Much remains to be learned.

The age of human-induced rapid change to climate is upon us. We must expect the thresholds of stress that induce forest boundary shifts (and much more) to happen with increased frequency. But the implications of climate change for the direction of change to eucalypt/rainforest boundaries is unclear, with competing effects of heat and drought stressing trees and promoting intense fire on the one hand, and elevated levels of CO_2 in the atmosphere promoting woody vegetation on the other. In order to manage forest boundaries wisely now and in the future, we must learn both from the past and as we go, and also think carefully about our objectives at both a landscape and site-specific scale.

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FIELD CHARACTERS FOR IDENTIFICATION OF EUCALYPTS IN NORTH-EAST QUEENSLAND

Here are some tips about what to look for in the field. The range of variation described **applies only to the study area**. Across all eucalypts, variation can be much greater and is comprehensively described in EUCLID (Eucalypts of Australia), module Learn (this is a free online resource, https://apps.lucidcentral.org/euclid/text/intro/index.html).

In this section and throughout this report I use commonplace terms wherever possible. Where botanical terms are provided they are shown within brackets.

Eucalypts often pose identification challenges. As they almost always reproduce sexually, no two individuals are the same. Being rooted to their spot, trees also respond to site conditions and may have limited gene flow which creates local as well as regional variation. Further, hybridisation between species occurs more frequently than in many other organisms, though the problems this creates for identification should not be over-rated.

Identification challenges can be reduced by adopting this two-step procedure (see also Clarkson 2009, p6*):

1. a stand often comprises more than one eucalypt species (and sometimes non-eucalypts as well). If the species are not immediately distinguishable, start by exploring the stand and letting your mind intuitively sort the eucalypts into species. The mind is very good at this – if you let it.
2. look at many individuals of a species in the area and identify them collectively (or their average) wherever possible, rather than picking out an individual. Context is so very important; individuals can, and often are atypical for the reasons mentioned above.

* Clarkson J. 2009. *A Field Guide to the Eucalypts of the Cape York Peninsula Bioregion*. Queensland Government: Mareeba.

Once you have mastered the typical, you will be much better placed to interpret the less typical.

The formal classification of eucalypt species is based almost entirely on reproductive parts – flower buds, flowers, seed capsules including some traits (e.g. anther and seed shape) visible only under a microscope – and it is a particular challenge when none of these are available. Fallen capsules may be present on the ground and they are well worth looking for.

Getting to know how to interpret vegetative as well as reproductive characters is essential. Much progress with identification can be made based on these characters including growth form, bark and leaves, especially when combined with information about distribution and habitat preferences.

Is it a eucalypt?

Notwithstanding the considerable variation among eucalypt species, they share a number of characters. Recognition of them becomes, with a little practice, quite intuitive. Eucalypt:

- crowns are relatively open;
- leaves are almost always widest much nearer the base than the tip, often lance- or broadly lance-shaped;
- leaves frequently have a scent of eucalyptus, lemon or peppermint when crushed (but may be almost scentless);
- flower buds have caps (*Angophora* excepted);
- flower buds are arranged in discrete clusters (umbels) radiating from a single point; clusters may be solitary or contained within complex, branched structures (but in ghost gums, cluster structure may not be obvious);
- flowers are cup-shaped with showy stamens, and lack petals (except for *Angophora*, which has tiny petals hidden under the stamens);
- fruits are woody or papery capsules that open at the outer end to release seeds.

A few close relatives of eucalypts, sometimes referred to as *eucalyptoids*, may have some of these characters, which sometimes triggers confusion. Those that occur in north-east Queensland are:

Brush Box (*Lophostemon confertus*). In the study area this is a a small to medium tree occurring on rainforest edges and in stunted thickets on rock outcrops embedded within eucalypt forest. It is half-barked, rough-barked below and smooth above, though this generally isn't striking;

Swamp Box (*Lophostemon grandiflorus*), also known as Northern Swamp Mahogany, is a small, rough-barked tree or shrub of rocky watercourses in seasonally dry areas;

Sweet Honey-myrtle (*Lophostemon suaveolens*), also known as Paperbark Mahogany or Swamp Turpentine, is a small to medium tree of eucalypt forests and woodlands in a variety of situations (not just swamps). It is perhaps the species most readily confused with eucalypts. It is a fully rough-barked tree with flaky or somewhat fibrous bark;

Stockwellia (*Stockwellia quadrifida*) is a giant tree found only deep within rainforest where no eucalypts occur. Amongst the species listed here, Stockwellia is the closest relative of eucalypts; see Introduction for details and photographs;

Turpentine (*Syncarpia glomulifera*) is a medium to tall, stringybarked tree of eucalypt forests, most abundant in moist forest in the ranges; and

Water Gum (*Tristaniopsis exiliflora*) is a smooth-trunked, white-barked tree that grows in permanently moist soil beside permanent flowing streams.

Paperbarks (genus *Melaleuca*), which are in the same family (Myrtaceae) as eucalypts but less closely related than are eucalyptoids, might also be confused with eucalypts. They differ in often having thick sheaths of white, cream or pale-yellow papery bark, along with stalkless flowers and seed capsules arranged along the stem such that the flowerheads resemble bottlebrushes.

In the study area, if the tree you are considering has **any one** of the following traits it is almost certainly not a eucalypt, but could be one of the eucalyptoids:

- branchlets that terminate in an enlarged, scaly bud (or several) (Fig. 1);
- leaves with more than one main longitudinal vein (Fig. 2);
- leaves that are widest at the middle or towards the tip (Figs. 3–4);
- leaves that are crowded towards the end of branchlets (Fig. 3–5);
- leaves in groups of three or four (known as 'whorls') (Fig. 6);
- flower buds that lack a cap (except in *Angophora*); the unopened buds may be covered by sepals, but if so then each sepal is distinct, not fused to form a single cap as in *Eucalyptus* and *Corymbia* (Fig. 7);
- flowers with obvious petals (Figs. 8–9; petals present but obscure in *Angophora*);
- flowers with the stamens in bundles or branching from an axis (fascicled) (Figs. 8–9);
- stalkless flowers arranged along a branchlet so that flowerheads resemble a bottlebrush (Fig. 10);
- stalkless seed capsules arranged along a branchlet (Fig. 10); or
- seed capsules fused together, resembling 'little spaceships' (Fig. 11).

Fig. 1. Not a eucalypt because it has enlarged growth buds.
*(*Melaleuca *poss.* nervosa*)*

Fig. 2. Not a eucalypt because there is more than one main longitudinal vein.
(Melaleuca leucadendra)
A few eucalypts from southern Australia only have multiple longitudinal veins.

Figs. 3–5. Not eucalypt leaves both because they are widest at or beyond the middle of their length (first two), and are crowded towards the end of branchlets (all photos).
(sapling Lophostemon grandiflorus*;* Tristaniopsis exiliflora*;* L. confertus*)*

Fig. 11 (next page). Not a eucalypt because the capsules are fused into a syncarpium **(syn –** ***joined;*** **carpia –** ***carpels, the reproductive parts of flowers).*** *(Turpentine,* Syncarpia glomulifera*). Syncarpia are also a feature of Stockwellia (*Stockwellia quadrifida*). Among eucalypts, six species from the south-west of Western Australia only have capsules fused into syncarpia.*

Fig. 6. Not eucalypt leaves because they're in a group of four; this is a frequent feature of Turpentine (*Syncarpia glomulifera*).

Fig. 7. Flower bud without a cap. *All eucalypts except* Angophora *have a bud cap; none of their relatives have a cap. (*Lophostemon suaveolens*)*

Figs. 8–9 (above). Not eucalypt flowers both because the petals are obvious and the stamens are in bundles (left) or diverge from an axis (right). *(*Lophostemon suaveolens*;* L. confertus*)*

Fig. 10 (left). Not a eucalypt because the flowers and seed capsules are stalkless along the branchlet, a feature of* Melaleuca *(paperbarks).
(Melaleuca nervosa)

Fig. 11 (right): caption on previous page.

The characters

Trunk and branches

Though not the most definitive of characteristics for species, form can tell you a lot about which species you are looking at. **Always focus on the stand average.**

- how tall is the tree? Height relative to other eucalypts is more useful than actual measurement.
- does the tree have a slender, average or spreading form? Trees with spreading form may be as wide as tall, though this also depends on how close they are to neighbours.
- does the species have one or several trunks? If the latter, is this "natural" or the result of resprouting from the base after been felled? A few smaller eucalypts, termed "mallees", routinely resprout with several or many trunks from underground lignotubers following fire or other damage.
- is the trunk straight or crooked? If crooked, is it sinuous?
- are the major branches heavy or light? Do they ascend steeply or diverge at a wide angle from the trunk? At what percentage of tree height do the lowest branches emerge?

Bark

As you hone in from stand to individuals, bark type is likely one of the first things you'll notice. With some caution, bark type will usually help you place your species within a group and sometimes even allows identification of species. Mid- or upper trunk (not the base) is a good place to start. Bark develops with the age of the tree and is best assessed on mature trees.

Eucalypt bark can often be recognised as one of six types, one smooth and five rough. Smooth-barked trees occur in both *Eucalyptus* and *Corymbia*. There is much variation within types, intergradation between types, species with several types (usually rough lower down and smooth above), and a few species that don't fit any type. Closely related species may or may not have the same type of bark. For instance, ironbarks are all closely related and all members of that group have ironbark, while all bloodwoods have at least hints of rough tiled bark on the lower trunk but tiled bark isn't confined to bloodwoods.

smooth (gum-barked) (Fig. 12) Species with smooth bark on much of the trunk are generally known as "gums" and include *ghost gums* and *red gums.* In most or perhaps all gums, the smooth bark is shed annually (or at least, periodically) creating patches or curls or ribbons as it is shed. In some species, ribbons accumulate in branch forks. Smooth bark is often white or creamy but can be almost any light or bright colour and, in some species, changes colour markedly with the time of year and/or stage of bark shedding. Some of the gums have a stocking of rough bark on the lower trunk. In a few species, this stocking extends a long way up the trunk but major branches are smooth; such species are often termed "half barks". Further, many species not referred to as gums have smooth bark on smaller branches, and most eucalypts have smooth branchlets (the fine leafy twigs).

ironbark (Fig. 13) The bark is impregnated with resin and very hard. It is typically deeply furrowed and black or grey (on saplings, often brown or yellowish and not so furrowed). Red resin is often evident in the depths of the furrows.

stringybark (Fig. 14) Fibrous and relatively soft (sometimes prickly), usually furrowed and grey-brown to red-brown.

yellowjacket (Fig. 15) Soft, thickly flaky, and distinctly yellow or orange.

tiled (tessellated) (Fig. 16) Scaly or flaky or corky in a more-or-less regular pattern, thick or thin, often a little or even quite soft. The tiles may be squarish or quite elongated vertically along the trunk and branches. Tiles or their outer layers are often dull brown or grey on the surface but in some species are shed patchily to reveal underbark which is often richly red or red-brown. Tiled bark is a feature of the bloodwoods though it varies much between species in how obviously tiled it is. Box bark (next and Fig. 17) can also be somewhat tiled. Several gum trees have a distinctly tiled basal stocking.

box bark (Fig. 17) Rather non-descript, scaly or somewhat tiled or tightly flaky, grey or grey-brown, often fairly thin (or thick only at base of tree).

Figs. 12–17. Primary bark types in north Queensland eucalypts.
Top row, left–right: smooth (gum); ironbark; stringybark. (C.gilbertensis; E. granitica; E. tindaliae)
Lower row, left–right: yellowjacket, tiled; box. (C. peltata; C. ellipsoidea; E. coolabah)

Leaves

First a little background. Eucalypts develop different types of leaves at different life stages; in some species these differences are very noticeable (Figs. 18–21), whilst in others only slightly so. Leaf types are characterised as *juvenile*, *intermediate* or *adult*. The transition occurs at different life stages of the tree in different species. For example, in some species the change from juvenile to intermediate occurs so early that juvenile leaves are rarely seen in the wild, while some retain juvenile leaves through to the mature tree, never developing adult leaves. Further, a few species (especially Cadaghi [*C. torelliana*] and Gilbert River Ghost Gum [*C. gilbertensis*]) routinely, and many species occasionally, have leaves of two different forms within their crowns. Interpreting leaf stages often requires considerable knowledge of a species, so in this study I use the more descriptive terms **sapling leaves** and **crown leaves**. Unless stated otherwise, *saplings* should be interpreted as being about ½ to one metre tall and *small saplings* as less than ½ metre.

Figs. 18–21. Two species pairs showing extreme difference between leaves on small saplings and in the crown (left – sapling leaves; right – adult leaves).
Top pair: Melville Island Bloodwood (C. nesophila).
Lower pair: Tindal's Stringybark (E. tindaliae).
In most north-east Queensland eucalypts the differences are much less, and at times there is no difference at all.

Much can be learned from leaves. First, view the crown. Leaves may be held in one of three ways often characteristic of the species, although crown leaves may be held differently to sapling leaves:

1. pendant (Fig. 22);
2. with the darker side facing out or up (Fig. 23); or
3. pointing stiffly in all directions (Fig. 24).



Figs. 22–24. Left–right: leaves held pendant; darker side facing out; held stiffly in all directions.
*(*C. citriodora*,* C. lamprophylla*,* C. confertiflora*)*

Leaves on small saplings are often held horizontal while crown leaves of the same species are held pendant.

If crown leaves are accessible, examine them closely. If saplings are present close by, examine the leaves on them too, but be wary that they could be of a different species. It may be useful to hold leaves up to the light to see veins and oil glands. Consider the following:

- are the leaves alternating along the branchlet (alternate; Fig. 25), in pairs (opposite; Fig. 26), or in off-set pairs (sub-opposite; Fig. 27)?
- are the leaves stalked or not? Stalked leaves are mostly alternating along the branchlet, while stalkess or near stalkless leaves are mostly in pairs, but there are a number of exceptions. Leaves are nearly always attached to the stalk at their base, but in a few notable cases the join is on the underside of the leaf one or several millimetres from its base (peltate; Fig. 28). The bases of paired, stalkess leaves may also embrace the stem (amplexicaul; Fig. 29).
- are the leaves lance-shaped (lanceolate; much longer than wide, broadest near but not at the base, tapering to a point; Fig. 30) as is so typical of many eucalypts? Is the base tapered, or rounded, or even heart-shaped (e.g. Fig. 31)? Is the tip tapered, rounded or notched? Are the leaves distinctly sickle-shaped with a lop-sided base (falcate; Fig. 32)?
- what size are they? Though there is much variation within species, width especially can be useful in distinguishing between species. **Focus on the average of fully-developed leaves.**
- are they the same colour on both sides (concolorous) or darker on one side (discolorous; Fig. 33)? Leaves that are consistently held facing upwards or outwards are always darker on one side, while most but not all other species have leaves the same colour on both sides. Is the surface shiny or not? Are the leaves bluish and do they or their stalks have a coating of white waxy powder (a glaucous surface; Fig. 34)?
- is the stalk, branchlet and/or underside of the main vein bristly (Fig. 35)? This is more often the case on seedlings. Is the leaf surface smooth (as in most species) or sandpapery (the latter, Fig. 36)?

- are sapling leaves similar to crown leaves or not?
- is there a vein running close to and more or less parallel to the leaf margin (intramarginal vein)? In some cases an intramarginal vein is obvious, but in others the vein is fused with the margin and thus not visible.
- are the main veins that diverge from the mid-vein (the laterals):
  – close packed (parallel), straight and diverging at a wide-angle (more than 60°) from the mid-vein as in a feather (penniveined; Fig. 37)? This form is characteristic of bloodwoods and a few other species, or
  – spaced, branching and/or looping, curved and/or diverging at a sharper angle (often 25 to 60°) (Figs. 38–39)?
- are oil glands evident as pale dots when viewing backlit leaves (Fig. 38)?

Figs. 25–27. Left–right: leaves held alternately and stalked; in pairs and stalkless; in off-set pairs.
(C. citriodora; C. confertiflora *sapling;* E. chartaboma *sapling)*

Figs. 28–29. Less common types of leaf attachment. Left–right: stalks join leaves on the underside (peltate); leaf base embracing the stem (amplexicaul). (C. peltata; A. floribunda *sapling)*

Figs. 30–32 (above). Left–right: leaves lance-shaped (lanceolate); rounded-triangular (deltoid); sickle-shaped. *(*C. rhodops*;* E. platyphylla*;* E. megasepala*)*

Figs. 33–36 (above). Some leaf variations. Left–right: leaves darker on one side; branchlet and leaf stalks with white waxy powder; branchlet and vein on leaf underside bristly; leaves with sandpapery texture. *(*C. nesophila*;* E. microneura*;* C. stockeri *subsp.* stockeri *sapling;* C. setosa*)*

*(*C. intermedia*;* E. brownii*;* E. tereticornis*)*

***Figs. 37–39. Leaf vein variations, left–right: lateral veins at wide angle to the mid-vein, straight and close-packed (feather-like; penniveined); lateral veins at narrow angle, widely spaced and looped, intramarginal vein and oil glands obvious; lateral veins at intermediate angle, widely spaced*, intra-marginal vein obvious**.

Inflorescence

This is a technical term for which I could find no simple vernacular.

> **Infloresence**: the shoot on which reproductive parts – flower buds, flowers and then seed capsules – are aggregated. The inflorescence is usually regarded as commencing immediately beyond the nearest non-flowering structure (either leaf stalk or branchlet in study area eucalypts) (Figs. 40–44).

In study area eucalypts, the inflorescence may be positioned:

- *terminal on branchlets* (terminal), i.e. at the tip (Fig. 42);
- *in leaf axils* (axillary), i.e. arising from the junction of a branchlet and leaf stalk (Figs. 40–41). In some species, the inflorescences may be confined to the *outer leaf axils* (i.e. those nearest the tip of the branchlet); or
- *on leafless branchlets*.

Figs. 40–44. Basics of inflorescence structure and placement. Top row, left–right: simple, in leaf axils; compound, in the leaf axil; compound, terminal on branchlet. Lower row, left–right: simple, arising on older branchlets that have lost their leaves; compound inflorescences arising both terminal on the branchlet and in the two outermost leaf axils. *In Fig. 43, you can see the scars where leaves have dropped, and that the branchlet is older than the inflorescence stalks.*
*(*E. camaldulensis *subsp.* obtusa*;* E. granitica*;* C. leichhardtii*;* E. platyphylla*;* E. granitica*)*

The position of the inflorescence is characteristic of species and often of species groups, though some species may have inflorescences in two positions. For example, all bloodwoods have inflorescences terminal on branchlets but at least one species also has them in the outer leaf axils. A number of ironbarks and boxes have inflorescences both terminal on branchlets and on outer leaf axils (Fig. 44). Members of the red gum group, which includes the peppermints, all have infloresences in leaf axils (Fig. 40) but some might also be on leafless branchlets from which leaves have been shed. Occurrence on leafless branchlets occurs for a number of reasons .... A few species develop all or most inflorescences on older branchlets from which leaves have been lost due to age (Fig. 43). Leaves might have been accidentally lost. Flower buds in deciduous eucalypts (several ghost gums, Poplar Gum) appear while they are leafless, either on old or newly grown branchlets, with leaves subsequently growing or regrowing among them. Flowers in terminal inflorescences are held above or outside the canopy, and can be particularly showy, especially so in bloodwoods in which the inflorescence can be large (Fig. 45; *contra* Fig. 46). Exceptionally, inflorescences may occur in pairs in leaf axils (Fig. 47).

The structure of the inflorescence also varies characteristically between eucalypt species and species groups) so it is a useful character to note. First some background: **the basic unit of eucalypt flower arrangements is the cluster (umbel). Clusters are those flower buds arising from a single point**. Infloresescences may be:

- *simple*, comprising a single cluster (Fig. 40); or
- *compound*, being branched, with each ultimate branch ending in a cluster (Figs. 41–42);

Simple inflorescences usually occur in leaf axils or on older branchlets, whereas compound inflorescences can occur in leaf axils or terminally on branchlets.

Figs. 45–46 (above). Left–right: flowers outside the crown because inflorescences are terminal on branchlets; flowers within the crown because inflorescences arise from leaf axils.
*(*C. intermedia*;* E. miniata *–a species outside the study area but similar to the local* E. chartaboma *)*

Fig. 47 (left). A special case: twinned simple inflorescences in the leaf axil.
*Rare among all eucalypts, in the study area, twinning occurs only in Pumpkin Gum (*E. pachycalyx*).*

Flower buds

If your timing is fortunate and you encounter flower buds, these are very useful for identification.

Flower buds are always arranged in clusters (umbels) arising from a single point. During formation, clusters have a set number of buds. This is almost always an odd number, often a prime number, frequently seven but ranging from three to more than fifteen (Figs. 48–51). Within a species there is limited and characteristic variation in this number. One common combination is for a species to have seven or sometimes three buds per cluster, whilst another common combination is to have seven, nine or eleven buds. Three species always have three buds per cluster (Lemon-scented Gum [*C. citriodora*] and Darwin and Sandstone Stringybarks [*E. tetrodonta* and *E. megasepala* respectively]). Four species nearly always have more than seven buds per cluster (White Mahogany [*E. acmenoides* complex], Reid River Box [*E. brownii*], Gnaingar [*E. phoenicea*] and Tindal's Stringybark [*E. tindaliae*]).

Figs. 48–51. Number of flower buds per cluster (umbel). Top row, left–right: three (with obvious sepals); seven.Lower row, left–right: nine and eleven; many more than fifteen.
*(*E. tetrodonta*;* E. lockyeri *subsp.* lockyeri *[photo by Deb Bisa];* E. tindaliae*;* E. phoenicea*)*

As buds develop some are commonly aborted, so the number present in a cluster may be fewer than the original number, complicating interpretation. The original number can be determined by counting the scars left when buds fell off, but you may need a magnifying glass to do so (Fig. 52). Further losses often occur during flowering and development of seed capsules, reducing the number per cluster even more. Another complication occurs in ghost gums and allied species and in Howitt's Box (*E. howittiana*), in which buds within a cluster may have very uneven stalk lengths and some stalks may grow out to give rise to another cluster.

Fig. 52. Scars evident where flower buds have been lost.
*(*E. pachycalyx*)*

All eucalypts except *Angophora* (see Fig. 62) have a cap protecting the developing bud which is shed as the flower opens. The shape of the bud is strongly indicative of the species (Figs. 53–56); the presence or absence of a scar line marking the base of the cap is also a diagnostic character (Figs. 57–59), as is whether the bud is stalked or not (Figs. 60–61). Interpreting the latter requires some background. In *Eucalyptus* and *Corymbia*, flowers have no petals. Most have no sepals either; only a few species have obvious sepals (Figs. 48, 65), while bloodwoods have tiny and/or deciduous sepals that are hard to see. Over evolutionary time, petals (± sepals) have modified to form a protective cap (operculum) covering the flower bud. This cap comprises either one layer (evolved from petals) or two layers (evolved from petals and sepals). In those with a two-layered cap, the outer layer (evolved from sepals) is usually shed before the bud is fully formed, leaving a distinct scar around the base of the cap (Figs. 58–59). Those with a single-layered cap do not have a scar (Fig. 57) and the exact structure of the cap may only become obvious when it is shed at the onset of flowering. As exceptions, a few single-layered species have a line but not a scar marking the base of the cap, whilst several two-layered species retain both layers until the time of flowering.

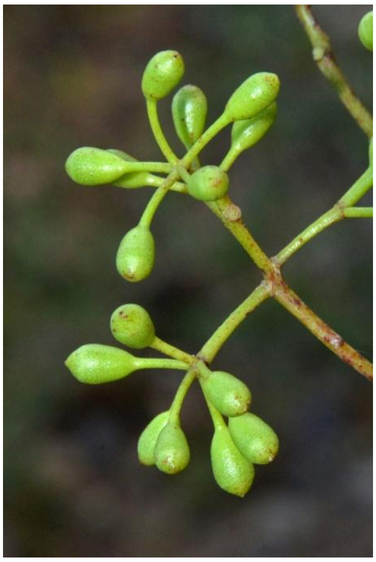
Angophora differs from all other eucalypts in having obvious sepals and small petals, and thus no protective cap (Fig. 62). Some other unusual flowers buds are shown in Figs. 63–66).

If flower buds are available, here are some key things to look for:

- the inflorescence structure and position (see Inflorescence section);
- maximum or initial number of buds per cluster (Figs. 48–51);
- whether individual buds have a stalk (i.e. within the cluster) (Figs. 60–61);
- shape of the bud cap;
- presence or absence of a cap scar (Figs. 57–59);
- overall size of the bud.

Figs. 53–56 (above). Some variations in shape of flower buds and their caps.
(E. exserta; E. camaldulensis *subsp.* simulata; E. cullenii; C. leptoloma)

Figs. 57–59. Cap scars. L–R: absent (bloodwood); present; really obvious.
(C. nesophila; C. tessellaris; E. platyphylla)



Figs. 60–61. Flower bud stalks. Left–right: stalked; stalkless. *(*C. hylandii*;* C. abergiana*) Both are bloodwoods, those at left being more typical of the group.*

Figs. 62–66. Some unusual flower buds. First row, left–right: no cap, obvious sepals (Rough-barked Apple, **A. floribunda*****); buds bristly (Rough-leaved Bloodwood,*** **C. setosa*****) . Lower row, left–right: ribbed, with massive cluster stalk (Queensland Woollybutt,*** **E. chartaboma*****); prominent sepals (Sandstone Stringybark,*** **E. megasepala*****); cluster stalk broad, flattened (Large-fruited Red Mahogany,*** **E. pellita*****).***

Flowers

Eucalypt flowers are a cup with rings of stamens (male parts) arising around the edge (Figs. 67–68). A single style with a terminal stigma (female organ) arises from the centre of the cup and may be short or quite elongated. Nectaries within the cup's inner surface produce nectar available to pollinators (mainly flying-foxes, birds and insects) in the cup.


Figs. 67–68. Left – typical eucalypt flower showing rings of whitish stamens, green cup and central style tipped with a stigma. Right – with greatly elongated styles. *(*E. shirleyi*;* E. tereticornis*)*

Stamens are usually the attractive feature of the eucalypt flower. In almost all the eucalypts of north-east Queensland these are white or creamy-white. The two exceptions – Queensland Woollybutt (*E. chartaboma*; Fig. 69) and Gnaingar (*E. phoenicea*) have bright orange stamens. In most species the inside of the cup is pale yellow or green and may even be hidden by the stamens, but in Red-throated Bloodwood (*C. rhodops*; Fig. 70) and occasionally in two other species it is bright red and likely also serves to attract pollinators.


Figs. 69–70. Unusual flower colours. Left-right: orange stamens; red inner surface to cup.
*(*E. chartaboma*; probably a hybrid* C. rhodops *x* C. stockeri*)*

Flowers vary between species in their position in the crown (see Inflorescence section) and in size. Only Rough-barked Apple (*A. floribunda*; Fig. 71)) has (small) petals.

Fig. 71. Petals (white, partly hidden by green sepals), are present in only one eucalypt within the study area, Rough-barked Apple (**A. floribunda*****).***

Seed capsules

Eucalypt seed is produced and held inside woody, valved capsules coloquially referred to as ‘gum nuts’. Valves at the outer end or inside the rim open as the capsule matures and dries, allowing seed to be shed. Seed capsules are often held on the tree even after seed has been shed, but are eventually (or rapidly in some species) shed and may be found on the ground.

Capsules develop from the flower cup and are cup- or barrel- or hemispherical- shaped (or similar) (e.g. Figs. 72–73). Within the rim of the capsule there is a disc and valves which may be prominently raised above the rim with the valves projecting outwards, or quite hidden within it, or somewhere in-between (Figs. 72–75). The size and shape of capsules, along with the arrangement of the disc and valves, varies greatly between species and is most useful for identification notwithstanding some variation within species. Sizes range from 2 x 2 mm (the smallest *E. brownii* and *E. howittiana*) to 75 mm long by 65 mm wide (the largest *E. chartaboma*). The capsule walls may be thin almost to the point of being papery so that they can be crushed with fingers – as in ghost gums and allied species (Fig. 76), or robustly woody; in a few bloodwoods it is particularly thickened (Fig. 77). Less frequent variations include external ribbing, external tubercles or bristles (Fig. 78), and teeth arising from the rim which are a carry-over from the floral sepals.

It is also useful to note the length of the stalk of the individual capsule, some being stalkless.

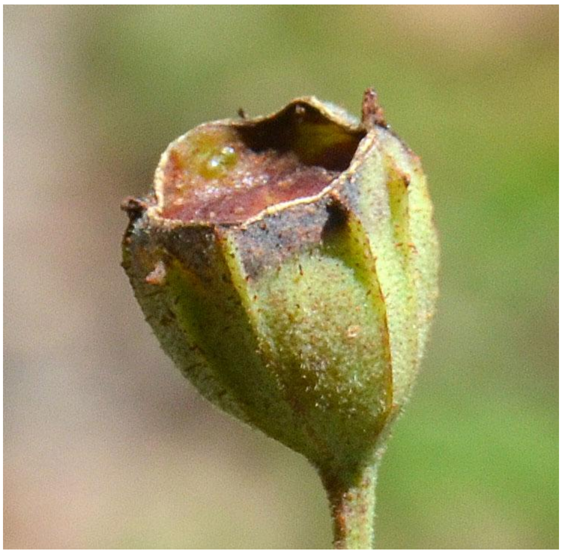
Capsules that are green may not have developed fully (Figs. 79–80) and may subsequently change particularly with respect to the disc and valves.

Figs. 72–73. Seed capsule structures. Left–right: with broad, slightly raised disc and valves obvious (valves broad, widely opened); disc and valves hidden inside the capsules. *(*E. cloeziana*;* C. leichhardtii*)*

Figs. 74–75. Disc and valve variations. Left–right: disc approximately level with rim, valves pointed and projecting strongly (exserted); disc hidden within capsule, valves broad, incurved, projecting well above the rim. *(*E. acmenoides *complex;* E. grandis*).*

Figs. 76–77. Thickness of seed capsule walls. Left–right: thin and papery (ghost gums and allies; exceptionally thick-walled (a few bloodwoods).
*(*C. confertiflora*;* C. abergiana*)*

Fig. 78. Capsule surfaces vary somewhat, but only those of Rough-leaved Bloodwood (C. setosa**) are bristly.**



Figs. 79–80. Capsules not yet fully formed. L–R: valves not developed (also showing ribs and teeth); style persisting after flowering with valves not yet developed. *(*A. floribunda*;* C. erythrophloia*)*

Integration: recognising species groups

Using the characters detailed above, species may be placed in one of seven groups; this is an important step towards species identification that will get you well on the way. If you are not thoroughly familiar with these groups, the following key may help. In it, I have preferenced vegetative characters where possible. Work through it point by point, choosing the most apt of the two options available at each point until the key leads you to a group.

1. – **bark smooth** (Fig. 12) on upper trunk and branches (rough or smooth near the base) **gum trees (gums)**
   – **bark rough** on the trunk and large branches (may be rough or smooth higher up) go to 2.
2. – **rough bark furrowed** go to 3.
   – **rough bark flaky or tiled or irregular or otherwise** go to 4.
3. – **rough bark hard**, often black, blackish or dark grey (Fig. 13) **ironbarks**
   – **rough bark fibrous, not hard**, often grey-brown to red-brown (Fig. 14) **stringybarks & mahoganies**
4. – **rough bark yellow or orange, thick, flaky** (Fig. 15) **yellowjackets**
   – **otherwise** go to 5.
5. – **leaves with veins arranged like a feather** (Figs. 19, 33, 37); rough bark ± tiled (Fig. 16); **inflorescences mostly terminal on branchlets** (Fig. 45); **seed capsules** urn- or barrel-shaped (often like the bowl of a cement mixer) **with the disc and valves hidden inside** (e.g. Fig. 77); **flower buds with no cap scar**, often pear-shaped (Fig. 57) **bloodwoods**
   – **otherwise** (differing in at least two of the emboldened characters) go to 6.
6. – **rough bark box-type** (Fig. 17) **boxes**
   – **otherwise** **miscellaneous**

Some of these groups and sub-groups subsequently described are natural and some are not, as specified. By ‘natural group’ I mean that, among the eucalypts present in the study area, members of the group are each other’s nearest relatives. In the group or sub-groups, I’ve listed all species in the study area, generally listing those species common in eastern districts first.

Gum trees A large group that is *not natural*, but it includes two natural sub-groups and some others.

<u>Red gums and allied species</u> A natural sub-group, all named hereunder though not all have smooth bark. This group have in common:

– seed capsules with a prominently raised disc and strongly exserted valves (Fig. 81);
– flower buds with a cap scar and an elongated cap (markedly longer than base) that is conical or horn-shaped (Figs. 40, 49, 53–54);
– inflorescences comprising a single cluster of buds in leaf axils (Figs. 40, 54); and
– crown leaves the same colour on both sides and with an obvious intramarginal vein (Fig. 39) (leaves alternating along branchlets, stalked, lance-shaped)

- Forest Red Gum (*E. tereticornis*) – forests & moister woodlands; bark mostly smooth
- River Red Gum (*E. camaldulensis*) – smooth-barked tree of watercourses
- Lockyer’s and Northern Peppermint (*E. lockyeri* subspecies) – small; drier hills
- Queensland Peppermint (*E. exserta*) – small; rough-barked; drier hills in south
- Cape York Red Gum (*E. brassiana*) – half-barked; mainly around Cooktown
- Sandplain Red Gum (*E. ammophila*) – rare; on sandstone; usually a mallee

Fig. 81. Capsules typical of the Red-gum sub-group – disc raised above rim; valves exserted.
(E. lockyeri subsp. lockyeri)

<u>Ghost gums and allied species</u> A natural sub-group. All have pale, usually white smooth bark on the branches and, in some, on the entire trunk. Leaves vary greatly between species. Their common features are:

– seed capsules that are so thin-walled you can crush them with your fingers, with the disc and valves contained within and not readily apparent (Fig. 76) (note that one fully rough-barked bloodwood – C. nesophila – also has rather thin-walled capsules);
– inflorescences (usually?) developing with a flush of new growth in late 'spring'; and
– flower buds that are more-or-less pear-shaped and with a cap scar (Fig. 58).

- Moreton Bay Ash (*C. tessellaris*) – has a tiled stocking
- Dallachy's Ghost Gum (*C. dallachiana*) – widespread; bark mostly smooth
- Broad-leaved Carbeen (*C. confertiflora*) – leaves paired, ± stalkless; extensive stocking
- Large-leaved Cabbage Gum (*C. grandifolia*) – leaves broad; no stocking
- Gilbert River Ghost Gum (*C. gilbertensis*) – short stocking; rock screes and outcrops

<u>Other gums, with smooth bark from the ground up</u> These are not a natural group.

- Poplar Gum (*E. platyphylla*) – rounded to triangular, long-stalked leaves (Fig. 31)
- Lemon-scented Gum (*C. citriodora*) – leaves lemon-scented when crushed
- Pumpkin Gum (*E. pachycalyx*) – paired simple inflorescences (Fig. 47)

<u>Other gums, with rough bark on the lower trunk</u> These are not a natural group.

- Rose Gum (*E. grandis*) – tall tree with a distinct stocking
- Cadaghi (*C. torelliana*) – smooth bark often green
- Gympie Messmate (*E. cloeziana*) – distinctly half-barked
- Queensland Woollybutt (*E. chartaboma*) – flaky, honey-coloured stocking
- Mountain Coolabah (*E. orgadophila*) – rare in study area, found only in south
- several bloodwoods (esp. *C. erythrophloia*, *C. serendipita*) in group below

Ironbarks Branches below *c.* 2 cm diameter are often smooth and whitish. Rough bark develops with age, so saplings may not be easily recognised. This is a natural group. Within it, three (possibly natural) sub-groups are fairly readily recognisable.

Paired (opposite) leaves that are stalkless or nearly so, often bluish and rounded

- Shirley's Ironbark (*E. shirleyi*)
- Silver-leaved Ironbark (*E. melanophloia*)

Crown leaves stalked, alternating along the branchlet; silvery bluish new growth; white waxiness present on sapling branchlets and often also on fresh crown branchlets and flower buds

- Herberton Ironbark (*E. atrata*)
- White's Ironbark (*E. whitei*)
- Lemon-scented Ironbark (*E. staigeriana*)

Crown leaves stalked, alternating along the branchlet; green new growth; no white-waxiness on any parts (crown foliage can sometimes be quite grey)

- Narrow-leaved Ironbark (*E. crebra*)
- Cullen's Ironbark (*E. cullenii*) – capsules with obvious disc and exserted valves
- Granite Ironbark (*E. granitica*) – broader, darker leaves than *crebra*

A few other eucalypts sometimes develop bark resembling ironbark but usually only on the lower trunk and never extending to mid-sized branches.

Stringybarks & mahoganies Not a natural group. Bark of some is classically long-fibred and furrowed, some less so.

- Tindal's Stringybark (*E. tindaliae*) – smooth bark on smaller branches; lop-sided leaves
- White Mahogany (*E. acmenoides* complex)
- Darwin Stringybark (*E. tetrodonta*) – leaves in pairs or almost so, sickle-shaped
- Sandstone Stringybark (*E. megasepala*) – leaves in pairs or almost so, sickle-shaped (Fig. 32)
- Large-fruited Red Mahogany (*E. pellita*) – inflorescence stalk strongly flattened (Fig. 66)
- Small-fruited Red Mahogany (*E. resinifera*) – tall tree of moist upland forests
- Rough-barked Apple (*A. floribunda*) – flower buds without cap (Fig. 62); flower with petals (Fig. 71); leaves in pairs or almost so, darker on one side; very localised occurrence

Yellowjackets The distinctive bark extends to the branches. The first three species are a natural group but the others are not.

- Leichhardt's Yellowjacket (*C. leichhardtii*) – bark sometimes brown
- Rustyjacket (*C. peltata*) – round leaves stalked, stalk attached to underside
- Paluma Range Yellowjacket (*C. leptoloma*) – glossy leaves; near Paluma only
- Brown Bloodwood (*C. trachyphloia*) – bark often brown but can be bright yellow
- Queensland Yellowjacket (*E. similis*) – uncommon, only in west
- Gnaingar (*E. phoenicea*) – bark becomes blackish with age; rare, far north only

Bloodwoods This natural group is large and, whilst the group is readily recognised with a little practice, the species within it can be challenging to identify. For identification purposes, two non-natural sub-groups may be recognised.

<u>Leaves more or less the same colour on both sides, not shiny</u>. All except *C. setosa* have smooth bark on at least some branches and often on the upper trunk.

- Common Red Bloodwood (*C. erythrophloia*) – widespread
- Sand Red Bloodwood (*C. ellipsoidea*) – in centre-west on sandier soils
- Western Red Bloodwood (*C. pocillum*) – mainly far south-western areas
- Desert Bloodwood (*C. terminalis*) – western areas
- Newcastle Range Bloodwood (*C. serendipita*) – sandstone & ironstone outcrops in west
- Rough-leaved Bloodwood (*C. setosa*) – paired, sandpapery leaves (Fig. 36)

<u>Leaves distinctly darker green on one side, somewhat to very shiny on the darker side</u>. All except *C. serendipita* have rough bark on at least the trunk and large branches.

- Pink Bloodwood (*C. intermedia*) – upright tree of moist forests
- Clarkson's Bloodwood (*C. clarksoniana*) – often straggling form with sparse canopy
- Melville Island Bloodwood (*C. nesophila*) – far north; neat canopy
- Long-fruited Bloodwood (*C. polycarpa*) – central-west and south-west; neat canopy
- Range Bloodwood (*C. abergiana*) – large flower buds (Fig. 61) and capsules (Fig. 77)
- Brown Bloodwood (*C. trachyphloia*)
- Hyland's Bloodwood (*C. hylandii*)
- Blotchy Bloodwood (*C. stockeri*) – narrow, shiny leaves
- Red-throated Bloodwood (*C. rhodops*) – flowers with red centres (Fig. 70)
- Shiny-leaved Bloodwood (*C. lamprophylla*) – rare; new growth very shiny (Fig. 23)
- Newcastle Range Bloodwood (*C. serendipita*) – sandstone & ironstone outcrops in west

Boxes Grey or grey-brown box-type bark is present either throughout or at least on the trunk and larger branches. May be somewhat tiled similar to bloodwood bark, but leaves and flowering parts are quite different (e.g. leaves not feather-veined, flowers buds often with a cap scar). Though not a natural group, all boxes are fairly closely related.

<u>Smooth-barked on medium and smaller branches</u>

- Gum-topped Box (*E. moluccana*) – upright tree with leaves often broad and shiny
- Gum-barked Coolabah (*E. coolabah*) – rare tree of black-soil floodplains in south-west
- consider also *E. lockyeri* in Red gum group above

<u>Rough-barked on all branches (but branchlets smooth)</u>

- Molloy Red Box (*E. leptophleba*) – larger leaves, flower buds and capsules
- Georgetown Box (*E. microneura*) – abundant in south-west
- Shiny-leaved Box (*E. chlorophylla*) – leaves often shiny
- Charters Towers Box (*E. persistens*) – small tree of southern areas
- Mt Carbine Box (*E. tardecidens*) – small tree of northern areas
- Newcastle Range Box (*E. provecta*) – small tree of south-western areas
- Reid River Box (*E. brownii*) – shiny leaves; blacksoil plains in south
- Howitt's Box (*E. howittiana*) – broad leaves; slopes of ironstone outcrops in south
- Silver Box (*E. pruinosa*) – broad, bluish leaves; far south-west
- consider also *E. exserta* in Red gum group above

Miscellanous species

- Gympie Messmate (*E. cloeziana*). A distinctively half-barked species
- Gnaingar (*E. phoenicea*). Bark blackish, thick and flaky. Far north only
- consider also Broad-leaved Carbeen (*C. confertiflora*) – in Ghost gum group above
- consider also *E. lockyeri*, *E. exserta* and *E. ammophila* in Red gum group
- consider also *E. pellita* and *E. resinifera* in Stringybark group

Fig. 82: Very different flower buds, infloresence structure, and inflorescence position.
At left, inflorescence simple and in leaf axils, typical of red gums and allies;
at right, inflorescence compound, terminal on branchlet, typical of bloodwoods.
*(*E. lockyeri *subsp.* lockyeri*,* C. intermedia*)*