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# 'Green above, paler below': descriptions in the literature of the colour in trees from southwest Australia

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## Abstract

This paper outlines descriptions of colour in the literature pertaining to the flora of the South-western Australian Floristic Region, comparing pre-settlement exploration by Dutch, French and English voyagers with modern general texts. It was found that colour has been and continues to be poorly described, preventing any analysis of the biological diversity of colour to enable comparison across or between floras or species. Forthcoming work on more accurate colour description using the Natural Color System of Sweden is foreshadowed.

**Keywords:** Colour description, botanical history, south-western Australia

## Introduction

This paper is a specific survey of how colour has been described in the literature and in early exploration in south-western Australia. This study arose from questions regarding the changing colours of the landscape due to extensive urban development in south-western Western Australia, within a centre of world biodiversity. Perth, Western Australia, has one of the fastest growing urban sprawls in Australia and, while most studies or analyses of urban sprawl on the world scale refer to sprawl as moving into farmland, this is not the case in Western Australia, where expansion is primarily into bushland. Indeed, Seddon (1995) described Perth as 'a city in the bush', whether coastal heath or banksia-eucalypt woodland. Perth's bushland also lies within one of only five Mediterranean-type ecosystems in the world (Beard *et al* 2000), the South-western Australian Floristic Region, and is a designated Global Hot Spot of Biodiversity (Myers *et al* 2000; Hopper & Gioia 2004).

Trees were the major focus of the colour survey described here as tall trees have dominated the conservation debate in Australia for more than a century (Bonyhady 2000, Griffiths 1996, 2002) and trees are most missing from new residential subdivisions in south-western Australia (Farrelly 2003). In newer subdivisions clear-felling or strip-clearing is common. With increasing urbanisation, and in-fill housing of older suburban areas, endemic trees which survived older suburb creation are likely to be lost. Farrelly (2003) found that exotic species comprised more than 86% of new plantings in new suburbs in south-western Australia. With the loss or impoverishment of larger endemic trees in suburbia, and their extensive replacement with exotics, whether from outside Australia or from other regions within Australia, are the colours of Australian flora being lost at the regional level?



Colour is an aspect of biological diversity not addressed previously, although with suburban development and changes of species in suburban Australia the colours and textures of vegetation are changing. Yet the colours particular to Australia have long been part of the national psyche, as much as the 'emerald' of Ireland and the 'green and pleasant land' of England. For the indigenous people of south-western Australia, the region remains the land of the Rainbow Serpent - a Dreamtime spirit who brought the gift of colour to the world (Nannup, pers.comm.). Settler poets and storytellers, who have fashioned feelings towards Australia both within and without the country, have written famously of the "*sunburnt country*" (Mackellar 1907), with its "*vision splendid of the sunlit plains extended*" (Paterson 1895), and that "*this is the land of colour, burning colour*" (Ingamells 1951), with "*million-coloured*" gumtrees (Ingamells 1945).

Early descriptions of Australian trees are those by natural historians and botanists. It was enticing to ask if plant colour was remarked upon, and how, and how tree colour was recorded historically. Thus this first paper on colour is a specific historical literature survey and focuses on tree colour described in early accounts and then in currently existing scientific, educational, and general texts on the flora of south-western Australia. The jump from historic to present has been used as a method of quickly assessing any change in accuracy in two hundred years, or any attempt at a methodology of colour description towards more detail and precision in more recent years. This paper can be seen to be the first stage in a study which seeks to examine and codify colour description in one part of a flora. A forthcoming paper will describe the colours of leaves and trunks of tree species in south-western Australia, using the Natural Color System of Sweden and colour methodology developed by Anter (1996) and these will later be compared with non-endemic species planted in the region.

## Methods

Two main methods were used in the study, a search of early historical colour descriptions of trees in the landscape, and a literature search of currently available works on trees from southwest Australia. This is based on asking how trees were first seen by explorers, botanists, and artists, and how they are currently described in the botanical literature. References were taken from readily obtainable published sources only, and no systematic search has been made of ephemera and unpublished journals or notes.

Trees selected for this study emphasised the Myrtaceae as it contains the most conspicuous and characteristic group of Australian trees, particularly in the sub-family Leptospermoideae which includes *Eucalyptus*, the most important genus of Australian trees, and *Melaleuca*. Melaleuca's very name is from the Greek *melas* (black, dark) plus *leucon* (white); it is believed that the first species described had white papery bark with a stocking of burnt trunk (Boland *et al* 1984).

The study went beyond the range of trees within the immediate metropolitan region of Perth, in order to gain greater insight into the manner in which Australian trees are described, but does restrict itself to those species most common, visible, or famous in southwest Australia. Additionally included were some eastern states endemics that are widely planted in Perth as street trees or as replacements for south west endemics in parks. In some cases 'colourful' trees have been selected deliberately as a comparison with what might be construed as 'plainer' trees, and the grass tree, the monocot *Xanthorrhoea preissii*, is included in this list as it has been increasingly used as a 'designer tree' in the southwest by landscape architects and other garden designers. Species were grouped alphabetically, and not in plant associations, which are complex.

With regard to historical accounts by naturalists and explorers well before the establishment of the first settlement in southwest Australia at Albany in 1826, any description of colour of any part of the flora in the southwest of Australia was sought, and comments also noted about the general colour of the wider southwest landscape. In the course of this study comments regarding the eastern seaboard made, for example, by Banks, Solander, and Cook in 1770, were excluded in order to confine this investigation to a manageable scale and with a south-western focus. A small number of additional contemporary comments from early settlers were included.

Modern texts readily available to the public were searched for descriptions of the colour of the parts of tree species in south-western Australia. Books and other sources were selected and confined to those available from bookshops, academic or otherwise, and major libraries. Journals were excluded on the basis that it is likely that more general texts are based on these. FloraBase (1995), an on-line government compendium, was also consulted.

The colours of juvenile leaves, mature leaves, stems, trunk and bark, flowers, and fruits were recorded. Particular attention was paid to leaf colour and to bark/trunk. The seasonal differences in bark and trunk are especially important in gum-barked (smooth-barked) eucalypts, where the bark is annually deciduous and with shedding of the old bark, the new inner bark (the new layer of functional tissue) is exposed, and this is often highly coloured (Boland *et al* 1984). Seed colour, though described in some detail for some species, for example in the banksias by George (1981), was not listed, as the purpose of this study is not to capture colour in hidden parts but is confined to those parts readily visible in the landscape. As such, it is focused on the inherent colour (Anter 1996) of easily visible parts. Inherent colour is the colour taken from a close distance, and was chosen for this study as the examination of plant parts by botanical taxonomists is done at this distance. This is in contrast to perceived colour, which is that impression given by distance (Anter 1996). It should be noted, however, that in many historical references it is difficult to separate inherent and perceived colour.

It is not unusual for plant common names to celebrate some aspect of their colour and this study also collates some of the major tree species of the south-west that have a common name which reflects in some way the colour of the species, most usually the colour of flowers or trunk.

## History of Colour Descriptions

### Beginnings

This is regarded as a colourful land. The southwest of Australia is the land of the Rainbow Serpent, known as the *waakarl* in Nyoongar, who shed tears, and the rainbow, onto the southwest. The land of the Nyoongar corresponds to that of the West Australian Christmas tree, *Nuytsia floribunda* (related by Len Collard, Nyoongar elder, Conference: *Water: histories, cultures, ecologies*. University of Western Australia, July 2003), a highly distinctive orange-flowered tree, called *mooja* in Nyoongar, and considered by Beard (1990) to be one of the great flowering trees of the world. The Nyoongar seasons are six, that of late winter and early spring being *djilba*, the season of yellow, when *Acacia* species are in flower, and it is the gold and green of acacias that was to be taken up by newer Australians as the country's national colours. This is the season that the poet Dorothea Mackellar would describe as "golden-green…clear-shining after rain". Generally, indigenous Australian languages do not contain many colour words, but usually name colours by the name of the thing which has that colour – for example, while *djilba* is a colour word for yellow-green, it is primarily the word for grass, and *djilba* is the season of grass (Dench, pers.com.). Indeed, it was suggested by Moore (1884) that the word marri (*Corymbia calophylla*) was taken to be the tree by European settlers, but it is also the Nyoongar word for blood, from its red kino.

### Early visitors

While the Dutch ship the *Duyfken* is believed to be the first European ship to sight and also record the Australian coast in 1606 (Wood 1969), and the Dutch were sighting the treacherous western coast and suffering from its dangers on their route to Batavia throughout the seventeenth century, it was not the Dutch who made the first recordings of floral colour in Western Australia. William Dampier visited the north-western

coast in the *Cygnet* in 1688, publishing the account. In this work (Dampier 1697) he described a bloodwood tree, probably *Eucalyptus dampieri* (George 1999), with "*Leaves are of a dark colour*" and "*the Rind is blackish*", and noted the colour and taste of the exuded gum to be like the dragon tree (*Dracaena draco*) of the Canaries. Though regarded as a buccaneer, Dampier was a natural historian, kept detailed and accurate records, and was experienced and skilled in collecting and pressing plant specimens, stating that knowledge "*was the main thing I regarded*" (George 1999).

The Dutch, who had no naturalists on board, were business-motivated, and were searching primarily for precious metals, vegetables, spices, elephants, and Kingdoms, following the Dutch saying of the time that 'Jesus Christ is good, but trade is better' (Edwards 1989). Hence Dutch records give nautical information, some general landscape description of topography as reference points for the sailor, and comments on the aridity of the southern landscape, but little detailed botanical description. Perhaps the very first surviving description of colour in the south-western Australian flora by a European is that made during Willem de Vlamingh's voyage to South Land (the west coast of Australia discovered in 1616 by Dirk Hartog). The upper surgeon Madrop Torst[1], records in his diary on the 12th January 1697, at a landing along Perth's Swan River, that "*several of these trees yielded a kind of resin, almost like lacquer, brownish-red in colour*" (Schilder 1985); this is clearly kino – defensive material produced by a healthy tree to deal with larval attack (Hadlington & Johnston 1977) - of a eucalypt, and is probably either the marri, *Corymbia calophylla,* or the tuart, *Eucalyptus gomphocephala*. Torst was a better recorder of what he saw than his captain Vlamingh (Appleyard & Manford 1979), who was reported by his fellow officer Witsen as often "*under the drink*" (letter cited in Schilder 1985, p. 215). Unfortunately, Torst ate the seeds of the zamia palm, *Macrozamia riedlei*, which are highly toxic (Isaacs 1987) and was so violently ill for the rest of the exploration party's trek inland that he wrote little else about what he saw. The nuts of zamia were seen by early explorers in the camps of Aboriginals, and they presumed that they were edible, but the explorers did not understand that the indigenous people had been employing a complicated process to remove the toxins from the nuts, with archaeological evidence for this process for at least 14,000 years (Smith 1993).

Although two professional artists were engaged for Vlamingh's voyage in order to "*paint whatever curiosity they encounter*" (Schilder 1985), we have no recording of close descriptions of plants, the artist Victor Victorszoon making mostly watercolour sketches of the western coast, with distant sheens of green or blue-green coastal heath, and noting hills and sand-dunes. However, plants were collected, as two specimens are housed in the Geneva Botanic Garden (Sharr 1988; Gooding 1991; citations in Richards 1997, p.6).

[1] Mandrop Torst was upper-surgeon on the hooker-ship, *Nyptangh,* which sailed with the ship, the *Geelvinck,* and the galliot, the *Wezel*, which comprised Vlamingh's fleet. Vlamingh skippered the *Geelvinck*.

A year after Vlamingh, in August 1699, Dampier was back on the northern coast of New Holland in the *Roebuck*, and recorded in his journal (Dampier 1703) a "*large sort of Sampier, which bears a white Flower*" and further noted thick bushes "*full of Leaves; which were mostly long and narrow. The Colour of the Leaves was on one Side whitish, and on the other Green; and the Bark of the Trees was generally of the same Colour with the Leaves, of a pale green. Some of these Trees were sweet-scented, and reddish within the Bark, like Sassafras, but redder. Most of the Trees and Shrubs had at this Time either Blossoms of Berries on them. The Blossoms of the different sort of Trees were of several Colours, as Red, White, Yellow, Etc., but mostly Blue…*". These observations were published in his work *A Voyage to New Holland* in 1703. The blue flowers which predominated on the coast were probably of *Dampiera incana*, *Sceavola holosericea* and *S. crassifolia* (Hopper 2003). During this voyage, Dampier also recorded "*blue and yellow flowers*" and a flower of "*a deep red colour*" thought by George (1999) to be the Sturt Pea, *Swainsona formosa*, which was flowering at that time of the year. Dampier's interest and close annotation of colour, which contrasts with later voyages by others, might well have derived from his experiences in 1675 along the mangrove swamps of the Mosquito Coast in the Caribbean. Following the earlier suppression of piracy by the English in the Caribbean, many buccaneers such as Dampier turned their attention to the gathering of logwood, *Haematoxylon campechianum*, which was used in Europe for the making of black dye (Finlay 2002). There, Dampier noted in his journals the colours of the cut tree, and the colouration of the dye – an interest which was revealed in his colour descriptions in Australia.

Talented professional artists were found in the later scientific expeditions of the French and English. Drawings of both flora and fauna were made during expeditions along the south-western coast during the voyages of George Vancouver (1791), Antoine-Raymond-Joseph Bruni D'Entrecasteaux (1792), Nicolas Baudin (1801–3), Matthew Flinders (1801–1802, 1803), Louis Desaules de Freycinet (1818), Jonathon King (1801–02), and Dumont D'Urville (1826). All may reveal a little more of the European's first forays into the nuances of south-western Australia's botanical colour. St Alouarn (1772) passed by the southwest coast near cape Leeuwin, but did not land until Shark Bay (Godard & de Kerros 2002).

During Vancouver's scientific expedition inland in 1791 the botanist Archibald Menzies, accompanied by Captain Vancouver, commented on plants in full bloom, and that they traversed "*groves of trees hills and valleys forming a rich and picturesque prospect boldly drawn by nature's manly pencil*" (Menzies 1791). Menzies' journal of his visit to King George Sound, Albany, in 1791 gives no report of colour in plants, although he noted detailed colour in a snake. Like the Dutch before him, he noted a "*reddish gum*" produced by a eucalypt, and the "*marks of fire around their bottoms*", but gave no other written detail of colour although he was clearly delighted by the "*beautiful groves of evergreens*" (Menzies 1791).

In 1792 the naturalist Jacques Julien Houtou de Labillardière was a member of the expedition of Bruni D'Entrecasteaux which was searching for the lost

scientific expedition of La Pérouse in the ships *Recherche* and *L'Espérance*. [Note: La Pérouse and his expedition died in the Santa Cruz group in the Pacific. Their failure to return to France caused great consternation. Louis XVI was an active sponsor of French maritime exploration, and collaborated in plans for the expedition of both La Pérouse and D'Entrecasteaux, and was regarded as having added New Holland to the list of geographical priorities to La Pérouse's voyage; his favourite subject was geography (Horner 1995). The wreck was discovered in 1827 by an Irish sealer and confirmed by Dumont D'Urville in 1828 (Marchant 1998, Horner 1995)].

Like Menzies the year before, Labillardière was also clearly enthused and enchanted by much of the country he saw, both in 'Cape Diemen' (Tasmania) and south-western Australia. He writes often of the beautiful plants, gathering "*a beautiful species of leptospermum, remarkable for its silvery leaves, and its flowers of bright red*" (Labillardière 1800, Volume i. p.426; see Horner 1995). Notations of plant colour are rare in his account, however, and this is curious as he describes much more readily the colours of animals, and even records "flies of a fawn colour" (Labillardière 1800, Volume i, p.175). This may be simply because Nicholas Piron, the artist on board, was to draw the plant specimen, or some specimens, while Labillardière was conscientious in his description of plant structure. The emphasis on plant structure can be understood as botanists at the time were very much absorbed with the classification of their new riches, and this is fundamentally based on sexual parts as outlined in 1753 by Linnaeus in *Species Plantarum*. To describe without an emphasis on sexual structure has proved problematic. For example, Robert Brown's later treatments in 1810 and 1830 of all known *Banksia* still hold today except for those species in which he placed too great an emphasis on foliar characters (George 1981). Despite his Linnaean treatment, a few descriptions of plant colour do occur in Labillardière's journal. He found "*a beautiful plant*" which he designated *anigozanthus* (sic.), and, wrote that: "*The corolla presents the form of a tube, divided on its margins into six unequal parts, recurved inwardly; it is covered with reddish hairs"* (Labillardière 1800, Volume ii, p.441), *and noted that "the capsule is nearly spherical, and of the same colour as the flower by which it is surmounted…", and "the top of the stem is covered with reddish hairs, like the flower. I have called this species anigozanthus rufa*." This was the first kangaroo paw described. It's common name is Red Kangaroo Paw.

Green and yellow were earnestly captured by Piron in the botanical plate of *Eucalyptus cornuta,* the yate (see Marchant 1998). *Banksia repens* and *Banksia nivea*[2] were also found, and *B. repens* painted by Redouté (see Marchant 1998). Labillardière describes the former with "*a creeping stem, covered with a thick reddish down*", and *B. nivea* as "*remarkable on account of its long leaves, which are white underneath, and very deeply dentated.*"(Labillardière 1800,Volume ii, p 443–444). Labillardière was the first to describe *Nuytsia floribunda* (Dukyer 2003, p.134) although he did not see it in flower. The species was not recorded in his journal but in his publication *Nova Hollandiae plantarum specium* (1804–1807) (Duyker 2003) which recorded the vast number of botanical specimens collected by the scientists aboard D'Entrecasteaux's expedition. Banks, when examining the collection before it was returned to the National Assembly of France, found a vast herbarium of some ten thousand specimens a "*testimony of an industry all but indefatigable in the Botanists who were employed*" (cited in O'Brian 1987, p.254).

Expeditionary 'artists' were not always as well qualified as Piron to do the job. In Nicolas Baudin's expedition to Terre Australes of 1801–03 with the *Géographe*, Charles-Alexandre Lesueur was a petty officer and had only been appointed "sketcher" for the expedition with the desertion of the artist at the Île-de-France (Mauritius) en route to Australia (Marchant 1998) and likewise Nicholas Martin Petit was an assistant gunner employed as an artist by Baudin. In May 1801 Baudin sailed with Freycinet, Hamelin (who explored Rottnest Island in Baudin's consort the *Naturaliste*), Péron the anthropologist, Leschenault the botanist, Lesueur the gunner and artist, several scientists such as the zoologist Maugé, Riédlé the gardener, and Guichenot and Sautier the assistant gardeners. In May 1801 Baudin was to recount in his diary that sometimes during his voyage along the southwest coast of Australia "*we made out a few plateaux with trees of a rather lovely green, all of which only served to make looking at the parts that lacked them more disagreeable…*" (Baudin, 29 May 1801, p.162). Baudin himself did not describe much in the way of botany that is useful (Marchant 1998), and very little of colour, as he was more concerned with the safety of his men, nautical details, and the problems of running his ship and his often arrogant young officers (Fornasiero *et al* 2004). In an entry dated 31 May 1801 he records near Cape Leeuwin, that "*the most common tree is a type of eucalyptus which grows only moderately high. One also finds quantities of a shrub which grows in clumps. The shape and scent of its leaves are like those of the laurel, but Citizen Riedlé told me that it was a type of Phillyrea" (*possibly *Diplolaena dampieri*, Dampier's Rose; this is a shrub to 2 metres and has aromatic leaves, and is a member of the Family Rutaceae). *"Another tree furnished me with a type of gum, a sample of which I am giving you. Its leaves are rather similar to the vetiver" (*the grass, *Andropogon muricatus) "and form a bunch which sprouts on top of a fairly thick coal-coloured trunk*". This last is *Xanthorrhoea preissii,* the balga. Baudin writes (Baudin, 23 February 1803): "*The botanists were very pleased with the collections that they made. From what he has told me, Citizen Leschenault appears to have gathered roughly two hundred new species of plants that were unknown to him and as many varieties within the species. Guichenot, the gardener, is no less satisfied and has even more specimens"*. Yet few of them survived this expedition, for of the twenty-three scientists who left on the voyage, only three returned due to the ravages of dysentery and scurvy (Appleyard & Manford 1979, p. 100).

François Péron's journal was published with Louis Freycinet as *Voyage de découvertes aux Terres Australes.*

[2] Excluded (George 1981), and now placed as *Dryandra nivea* (Labill.) R.Br., the couch honeypot. *Nivea* refers to its colour, 'snowy' (George 1984b), a reference to its leaves which are white underneath.

The first English language account of his notes regarding the south-west, published in 1809, is considered a very flawed translation and much scientific content was abridged or excluded (Duyker, pers. comm.). Baudin is regarded as a better anthropologist than Péron, who tended to give judgement and theorise without foundation (Fornasiero *et al* 2004). Nevertheless, Péron's most interesting discovery for the seeker of tree colour is of a place where he speculated during a solo walk after he had become separated from the rest of the party (Duyker 2006). Just north of the present-day regional city of Busselton, Péron found a highly-organised space which he styled a 'Garden temple' with twelve large trees which were "*white from the base of their trunk to the extremity of their branches*" (Wallace 1984, p. 46–47). Marchant (1998) took these to be paperbarks (*Melaleuca* species) since they were near the river, although Péron made no mention of the papery nature of the bark, and paperbarks would have been common, not distinctive, in this wetland region of meandering creeks and extensive seasonally wet palusplains. Tuart, *Eucalyptus gomphocephala*, is possibly the tree in question for, although not startlingly white to those familiar with the powderbark eucalypts, they were called 'white gum' by early settlers. Other possibilities relate to Nyoongar tradition. Noel Nannup, a Nyoongar elder, recalls that generations ago seed of jarrah, *E. marginata*, had been planted out of its range to 300km east near Kulin and grown at an important Dreaming Trail site (reported in Beresford *et al* 2001, p.31), and Péron's 'Garden temple' could be another instance of a species planted deliberately outside its range for ceremonial purposes by Nyoongar people. Thus these trees might have been *Eucalyptus laeliae* (though in May the trunk is likely to appear butter-yellow), the Darling Range Ghost gum, or one of the wandoos, *E. accedens*, the powderbark, or *E. wandoo*, wandoo. This site is known of to the Nyoongar people of Busselton as an important site but has been lost through extensive clearing for pastures.

During the Baudin expedition a party from the *Naturaliste* also landed on Carnac Island and reported many large trees, now gone, and plants with red and yellow flowers, which may have been *Eremophila glabra*. Although not found on Carnac Island today, this species is a palatable plant (Mitchell & Wilcox 1994) and might have been eaten out by rabbits introduced to the island by French or American whalers in the 1820s (Rippey & Rowland 1995). The final comment about colour came when, at a site which the French took to be monuments to warriors, spears which had been daubed with red eucalyptus resin were found (Baudin 22 February 1803, p.486–487).

The French expedition of 1801 led by Baudin was engaged in charting the last missing sections of the Australian coastline and studying its natural history. At the same time, and in response to Napoleon's global ambitions, Captain Matthew Flinders of the Royal Navy was doing the same thing in the *Investigator*. Travelling with Flinders were the natural historians - the naturalist Robert Brown, the botanical illustrator Ferdinand Bauer, and the gardener Peter Good (Wege *et al* 2005). They collected plant specimens in King George Sound during the months of December 1801 and January 1802. The British expedition of Flinders, sailing west, famously met up with the French expedition of Baudin, sailing east, near Kangaroo Island in Encounter Bay in April 1802, and shared geographical information and the perils they had both encountered (Fornasiero *et al* 2004). It is not known if they commented on the botany they had both been collecting.

From the British expedition, Robert Brown published his *Prodromus florae Novae hollandiae et Insulae Van Diemen* from 1806 to 1816 and Bauer began to publish his *Illustrations Florae Novae Hollandiae* in 1813, but this work did not meet with sufficient encouragement for the volumes to be continued after the third number (Henrey 1975). Bauer is renowned for the accuracy and detail of his drawings, and was particular regarding colour (see Watts *et al* 1997). His method was to draw in pencil and code the colours according to a colour grid. For his Australian visit he employed a grid of almost 1,000 colours, giving him remarkable accuracy although the drawings were completed much later in London (Hewson 1999; Pignatti-Wikus *et al* 2000a, 2000b). An example of his colouring technique is given in the watercolour of Figure 1.

Although few are extant, the technique of employing a colour grid by botanical artists dates from the 16th century, and can be seen in those of Waller (1686) and Syme (1814) (Fig. 2). The use of grids by botanical and other artists fore-shadows the introduction in the twentieth century of colour grids and patches for colour analysis, such as the Munsell Color System (Munsell 1975), the Royal Horticultural Society, and the Natural Color System of Sweden (Agoston 1979). The extant codes of Brenner (1680) contains 30 colours, that of Waller (1686) contains 119 colours and that of Syme (1814) 108 colours. Bauer used three colour charts and that of his early years is discussed and displayed by Lack and Ibáñez (1997) (shown in Fig. 2), which is of a colour code of 140 colours. Bauer's later colour codes are seemingly lost, and were more extensive. In addition to a numerical code for hundreds of colours in his later codes, Bauer includes Roman numbers, and annotations on his pencilled sheets in both Latin and German, and there is the suggestion that Bauer used more than one colour code for each drawing. Many authors writing about Bauer have been concerned about his colour codes, as noted by Pignatti-Wikus *et al* (2000b). Hewson (1999) considers that Bauer's colour grid in Australia must have been exceptional in its size.

Pignatti-Wikus *et al* (2000a, 2000b) fully describe Bauer's field-drawings made in Australia in pencil and give the colour numbers from his grid. Further, they have outlined the structure of 994 colours and consider that the colour chart's colour sequence followed a combination of three fundamental colours – red, blue, and yellow – with white and black. In this collection, Bauer gives from between a few to three dozen colour numbers per plant, for various plant parts; leaf colour is rarely represented by only one number, even in these mostly shrubby plants collected. For example, in the small Trigger plant, *Stylidium adnatum* R.Br., Bauer notes five sequential numbers, bringing a comment from Pignatti-Wikus *et al* (2000a) regarding the subtlety of colour combinations given by the artist. Again, this level of discernment foreshadows the use of modern colour charts for colour description.


**Figure 1.** *Banksia coccinea* drawn by Ferdinand Bauer from a specimen collected at King George Sound, Albany, on the south-western coast of Australia.

Few expeditions added botanical notes on colour after Bauer. Freycinet returned to western Australian waters again in 1818 in the *Uranie*. Newly married, his artist wife Rose Pinon had been smuggled aboard at Toulon, and sketched the party, who only visited Shark Bay, and recorded no information on colour. Baxter collected on land along the south coast east of Albany as far as Cape Arid in 1823–1825 but no records exist of colour description. Jules Dumont D'Urville in the man-o-war *Astrolabe* collected for eighteen days at King George Sound, during the months of October and November 1826, and carried an official artist, Louis de Sainson, who painted many scenes of the area. No precise botanical colour annotations were made by Sainson regarding colour but in one scene showing men on the Kalgan River, the yellowish smaller trees strongly suggest acacias, whether in flower or with new growth. Rosenthal (pers. comm.) notes the mixed abilities of early European painters to capture the colour and shapes of Australian trees. Further, he points out that while those who made pictures in the early colonial period in Australia were untalented amateurs, the Europeans were struggling at home with the colours and shapes of European trees as well, even amongst their most distinguished landscape artists (Rosenthal 1999). As in England, the problem in Australia seemed to be of mind, palette and technique, rather than any inaccurate reading of the bush. Indeed when viewing Gainsborough - who used broccoli as a prop for his paintings to represent trees (Rosenthal 1999) - in England and early colonial artists it could be claimed that the trees were painted in very much the same manner, with fluffy extrusions, and few could be identified as species or even genera wherever they were geographically located. An exception to this is the view of species given in a drawing by Lesueur in 1807 of the Empress Josephine's Paris Chateau, Malmaison, which was planted with *Casuarina*, *Acacia*, and *Grevillia* under the direction of Péron, and members of these genera can be made out in the view, given in Wallace (1984) because they are depicted correctly regarding the shape of their canopy.

**Early settlers**

The site of Albany on the south coast was settled in 1826. In 1827 Captain James Stirling of the *Success* travelled by ship's boat up the Swan River, where Perth was settled in 1829, as far as Upper Swan, now a growing area of urbanism amongst vineyard country which had been established shortly after settlement. Charles Fraser accompanied Stirling and his glowing report, in which he referred to "*trees clothed in the richest green*" was a major impetus to British settlement. Hopper (2004) gives an outline of post-settlement collections by natural historians. Of note are the reports of Baron Karl von Huegel from his visit in 1833–34 in which he enthused on the great variety of colour in the flora. Huegel noted the same change in colour between the view when perceived at a distance to that of inherent colour when perceived close-up as analysed and described by Anter (1996). Huegel wrote that when viewed close-up "*the cheerless grey-green"* seen at a distance *"changed to the most vivid hues, mingled with brilliant flowers of every kind, in untold numbers…I roamed around this world of colour as if intoxicated*" (Clark 1994).

Once settlement occurred many setters began to annotate colour in the new vegetation around them, as did Charles Darwin who commented on the "*bright green colour of the brushwood*" in his visit in 1836 (Sellick 1997). While a full critique of the enticing question of the early white settlers' responses to the colours of Australia's flora is outside the scope of this paper, some comments can be made of the very earliest settlers. Jane Dodds, an early pioneer who arrived in Swan River colony on the *Rockingham* in 1830, recorded "*dark green trees*" from the boat, with the country near Guildford, upriver from Perth, "*exceedingly beautiful*", with shrubbing trees, "t*he bloom of one being a rich bright orange"*, another "*a bright lemon*", and a third "*rich crimson tipped with white*" (Heal 1988, pp 31 and 45). These describe *Nuytsia floribunda*, possibly *Melaleuca polygaloides*, and *Banksia menziesii*. Mrs E. Millet (Millet 1872), the wife of the Anglican minister at York, 60km east of Perth, noted that "*The white trunks of some of the trees were so much flecked with dark-brown spots"* (probably *Eucalyptus wandoo)… "and … I saw a lizard spotted brown and white, precisely in the same manner as the trees; I therefore concluded that it was of a sort that lived amongst them, and was shielded by its colour from the notice both of its enemies and of its own prey*."

Settlers began to give common names for the new species in the south-west, many of which have survived today. Many common names reflect colour, whether of bark, leaves or flower, and Table 1 gives tree species whose common name employs colour. Some species have two names, the indigenous and the European; in some cases the original European appellation has been largely forgotten and the indigenous name applies in common parlance today. Though it is arguably leaf colour that reflects more than anything the colour which trees impart to their greater environment, bark colour seemed particularly important in perception of the colour of trees; this appears to be especially true of the larger species and perhaps reflects the human viewpoint from the ground. Colour plays a role in keying out plants species in field guides, as shown in keys given in Brooker & Kleinig (2001) for the eucalypts. For example, adult leaf colour is used to separate *E. marginata* into subsp. *marginata* and subsp. *thalassica*. There are other examples where 'adult leaves discolorous' is used to key out from 'adult leaves concolorous'.

Table 2 gives a short representative descriptive range, taken from thirty species examined, of tree species in south-western Australia to indicate the different ways in which colour is described today in existing literature and the issues which arise in colour description. These types of description remain the basis of colour discussion in the taxonomic and general literature on flora. Descriptions distinguish leaves as either dark or light, and if the adaxial and abaxial are different; they compare one species with another in the same genera—for example, *Eucalyptus todtiana* is considered to have leaves of a "paler green" than the other eucalypts of the coastal plain (Seddon 1972), but it does not elucidate which green; descriptions indicate, but do not give, a range of colours and they reveal a desire to convey a range of colour, such as the "white to light brownish" bark of *Melaleuca preissiana*, (Boland *et al* 1984). There is

**Table 1**

Tree species of southwest Australia with a common name reflecting a colour feature of bark, trunk or leaf; sources are various and combined. Indigenous names are given where known. Note that some indigenous names are very site-specific. Primary sources for indigenous names of the south-west Nyoongar are given in Abbott (1983), Moore (1884), or personal communication from Maher[3]. Bennett (1991) gives a recommended name where there is more than one for a species.

| Tree species | Specific name | Refers to | Indigenous name if known |
|---|---|---|---|
| *Acacia cyclops* | Red-eyed wattle, Coastal wattle | Seed; Not seen from afar but when pods open red seed | n/a |
| *A. saligna* | Black wattle Orange wattle | Red-orange bark | *Cujong* |
| *Banksia attenuata* | Candle banksia, Coast banksia | Bright yellow inflorescences | *Biara* and the flower *mangyt* (Moore 1884, p.91, 101); Piara (Abbott 1983) |
| *B. coccinea* | Scarlet banksia | Red inflorescence | *n/a* |
| *B. grandis* | Bull banksia; many banksia species around Australia were early termed 'honeysuckle'. | 'Bull' possibly from indigenous name of *bulgalla/boolgalla*; 'Honeysuckle' from sweet-tasting substance in flowering cone (Moore 1884, pgs.91 & 136) | *Poolgarla, mangite, beera, boolgalla, boorarup* (Abbott 1983; Daw *et al* 1997, p.40); Flowers soaked in water produced a sweet drink known as *mangite* or *mungitch* (Daw *et al* 1997, p.40). |
| *Corymbia calophylla* | Marri, red gum | Marri has copious quantities of kino, which is red when fresh and hardens/ congeals to a darker mark on tree | *Marri, Gardan, Nandap* (Abbott 1983, p.19); Mari is the Nyoongar word for red blood (Maher, pers. comm.). |
| *C. ficifolia* | Red-flowering gum | clusters of red to orange flowers | n/a |
| *C. haematoxylon* | Mountain marri | Greek *haemat*, blood-red, referring to the heartwood | n/a |
| *Dryandra sessilis* | Parrotbush | Attracts colourful birdlife, namely ring-neck parrots, black white-tailed cockatoos, New Holland honey eaters, for nectar or seed | *Pudjak, Budjan, Butyak,* (Abbott 1983) |
| *Eucalyptus accedens* | Powderbark | White 'dust' on trunk which is powdery | n/a |
| *E. albida* | White-leaved mallee | Juvenile leaves; Latin *albida*, somewhat white. Bark also white | n/a |
| *E. arachnaea* | Black-stemmed mallee | Dark grey to grey black bark | n/a |
| *E. argyphae* | Silver mallet | Trunk and bark, especially when wet or in moonlight | n/a |
| *E. astringens* | Brown mallet | Smooth coppery brown trunk with brown shedding bark | *Malard, Mallat* |
| *E. caesia* | Gungurru | Latin *caesius* means 'bluish-grey' refers to leaves | *Gungurru* |
| *E. camaldulensis* | Red gum, River gum, River red gum | Bark colours | *Itara, Piipalya* (Bennett 1991) |
| *E. campaspe* | Silver topped gimlet | Youngest branchlets grey to almost white | n/a |
| *E. carnei* | Carne's blackbutt | Dark bark near the ground | n/a |
| *E. clivicola* | Green mallet | Blue-green leaves | n/a |
| *E. crucis* | Silver mallee | Silver -grey young branches and branchlets | n/a |
| *E. cylindriflora* | White mallee | Trunk | n/a |
| *E. decipiens* | Moit, Red heart | Wood | *Moit* |
| *E. dissimulata* | Red-capped mallee | Operculum bright red near flowering | n/a |
| *E. diversicolor* | Karri | Many-coloured trunk | *Karri* |
| *E. erythrocorys* | Red-cap gum | Scarlet bud cap; Greek *erythros* meaning red | *Illyarrie* |
| *E. erythronema* | Red-flowered mallee White mallee, white-barked mallee | Flowers red, pink or white; trunk powdery white; Bark varies from intense white to purplish-red | n/a |

**Table 1** (cont.)

| Tree species | Specific name | Refers to | Indigenous name if known |
|---|---|---|---|
| *E. falcata* | Silver mallet | Trunk is silver | *Dulyumuk, Toolyumuck* |
| *E. flavida* | Yellow-flowered mallee | Pale yellow flowers | n/a |
| *E. foecunda* | Slender-leaved white mallee | White bark | n/a |
| *E. gardneri* | Blue mallet, blue-leaved mallet | Adult leaves | *Kwoakol* |
| *E. gomphocephala* | Tuart, White gum by some European settlers. | Trunk appears grey; Salvado refers to the wood as being white and extremely hard (Salvado 1977, p. 212). White gum seems odd name except at some conditions of light, particularly in the larger trees in summer, and in trees seasons after fire; but big trees and burning uncommon in the metropolitan area now | *Duart* |
| *E. gracilis* | Red mallee, white mallee | Red-brown bark in late summer, or grey bark at base; seedling stems red | *Yorell*?? |
| *E. griffithsii* | Griffith's grey gum | Bark in older trees | n/a |
| *E. guilfoylei* | Yellow tingle | Trunk colour | *Dingle Dingle* |
| *E. jacksonii* | Red tingle | Bark grey over red brown | n/a |
| *E. kondininensis* | Kondinin blackbutt or black yate | Dark bark on lower trunk | n/a |
| *E. laeliae* | Butter gum or Darling Range Ghost gum | Bark pure white or creamy yellow/butter yellow in autumn; Moore (1884,p. 135) refers to a white or blue gum with bark of a light slate-colour and smooth bark; he noted that some on high ground have a tinge of a rusty colour mixed with French white. [French white is finely textured powder] | Possibly *Nelarak* |
| *E. lane-poolei* | Salmon white gum | Trunk | n/a |
| *E. longicornis* | Red morrel | Trunk | *Moril* |
| *E. macrocarpa* | Mottlecah, blue bush | Leaves and young branchlets powdery grey | *Mudelka* |
| *E. marginata* | Jarrah; called Swan River mahogany by first white settlers. | Mahogany from red wood | *Djara* a general term for bush (Maher, pers. comm.) (The 'djar' sounds as in the little bottle) |
| *E. marginata* subsp. *thalassica* | Blue-leaved jarrah | Bluish leaves | n/a |
| *E. melanoxylon* | Black morrel | Bark is black-grey | n/a |
| *E. nutans* | Red-flowered moort | Flowers red or creamy white | n/a |
| *E. ornata* | Silver mallet | Light grey or silvery smooth trunk | n/a |
| *E. patens* | Yarri, blackbutt | Bark dark at foot | Dwuda |
| *E. pluricaulis* subsp. *porphyrea* | Purple-leaved mallee | Prominent purplish leaves in the crown | n/a |
| *E. pyriformis* | Dowerin Rose | Large bright flowers | |
| *E. redunca* | Black marlock | Trunk; known also as black-barked marlock | n/a |
| *E. rhodantha* | Rose mallee | Brilliant red flowers | |
| *E. rudis* | Blue gum, Flooded gum, Swamp gum | Leaves | Kulurda (Abbott 1983) |
| *E. sepulcralis* | Blue weeping gum | Youngest branchlets grey-red | n/a |
| *E. stoatei* | Scarlet pear gum | Red flower buds | n/a |

**Table 1** (cont.)

| Tree species | Specific name | Refers to | Indigenous name if known |
|---|---|---|---|
| *E. salmonophloia* | Salmon gum | Bark is smooth and white to silver-grey in winter but salmon pink to coppery in summer and autumn; name is from Latin *salmoneus* (salmon-coloured) and Greek *phloios* (bark) | *Wurak* |
| *E. tetragona* | Tallerack, White marlock, silver marlock, white-leaved marlock | Branches are white; Beard (1990, p.141) notes that the tallerack is conspicuous throughout its range and its blue-green foliage give a dominant character to the vegetation. | *Dalyeruk* |
| *E. todtiana* | Coastal Blackbutt or Prickly bark | Black feet | n/a |
| *E. torquata* | Coral gum | Pink flowers | n/a |
| *E. transcontinentalis* | Redwood | Red-brown wood | *Pungul* |
| *E. wandoo* | Wandoo, white gum | White bark; In mature trees the discolouration of the bark is an indication of tree hollows containing water (Daw *et al* 1997, p.32) | *Wandoo, wawnt* |
| *E. woodwardii* | Lemon-flowered mallee | Bright lemon-yellow flowers | n/a |
| *Nuytsia floribunda* | WA Christmas tree; originally cabbage tree by first white settlers. | Brightly coloured at Christmas and weeks preceding | *Moodjah/mungah, mudja;* Particularly known that the spirit of a dead person goes into this tree; is a women's area, often for birthing. Men not allowed at sites with these trees (Maher, pers. comm.). Moore (1884, p.55) notes that it was "very abundant" on the Swan Coastal Plain. |
| *Xanthorrhoea preissii* | Blackboy, Balga | Appearance of aboriginal with spear to settlers | *Balga* or *Palga* for whole plant; also *ballak, galgoyl, yango, tdudtin* (Moore 1884, p.118); leaves *mindar*, inflorescence *waljap* (Moore 1884, p.118). |

[3] Notes: There are several blackbutts not included, all have black feet of trunk. Some indigenous names are simply spelling/alliteration changes but are added to give perhaps greater insight into their pronunciation. "*The bark of many eucalypts is smooth and shed annually, and the new and old bark can make a colourful contrast while this is happening. Other groups of eucalypts have persistent bark of varying texture, examples being the stringybark and ironbark groups*" (Cheifetz *et al* 1999).

a clear attempt to describe colour as keenly as possible, such as the "pale brownish-green" of new leaves of *Banksia attenuata* (George 1984a). However, neither discolorous nor concolorous give a colour within green. 'Green' produces particular problems of colour terminology, and gives rise to adjectives which are not colour descriptors, such as dull, deep, and shiny. Likewise, 'grey' produces further descriptors of light, silver, pale, and grey-white, grey-brown, grey-green, and simply grey. Examples of colours which refer to something else are "elephant grey" for *Banksia littoralis* (Seddon 1972) and "sap green" for new bracts of *B. menziesii* given by the artist Nikulinsky (1992). While it could be asked what species and which elephant, 'sap green' is a pencil-box colour in, for example, Derwent Artists (number 4900) and Faber-Castell (number 9201-167), where it is a standardised combination of colour pigment, minerals, wax, and agglutinant. 'Elephant green' and 'sap green' treat colour description in the same manner of Syme (1814) who refers, for example, to "Duck Green" as found in the "Neck of Mallard" (Figure 2B).

## Discussion

### What do these historical descriptions and lists reveal of colour description today?

Since William Dampier in 1688 noted Colour and two hundred years since the first scientifically-focussed explorers annotated colour in plant species in south-western Australia, descriptions of colour remain poor and variable. They are largely confined to base colours with no level of clarification. Leaves are green, dark, or light green, blue-green, glabrous, or pale. Yet is the green of one species the same as the green in another? In the Linnaean system plant classification is based primarily on sexual parts. Botanists since Linnaeus have sought physical features of high reliability and avoided superficial features in their descriptions. External features like the colours of bark and leaves are subject to variations due to seasonal changes, predation, ontogeny, time of exposure, life cycle of the plant, the nature of the season, varying water budgets, intra-species differences, and the age of the plant, and are thus avoided for


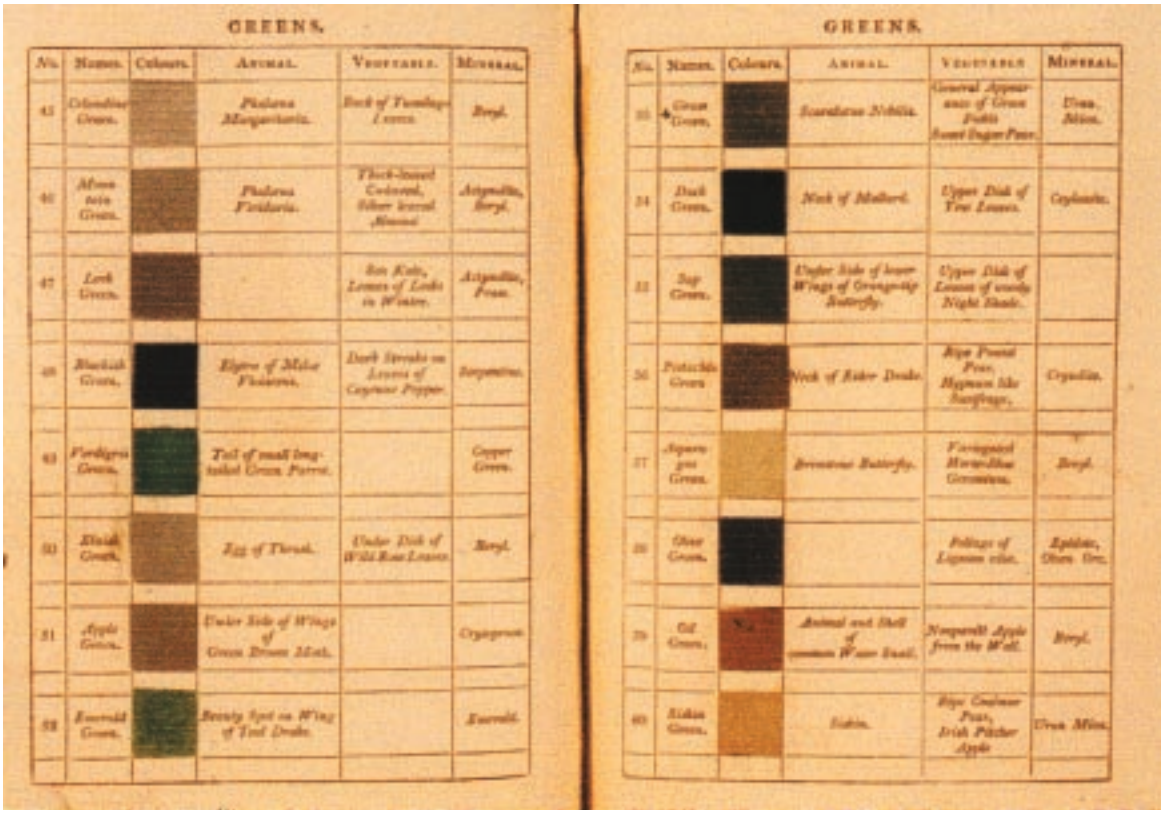


**Figure 2.** An early colour grid of Ferdinand Bauer (Lack & Ibáñez 1997) (top) and part of the colour grid of Syme (1814) (bottom). Bauer's grid has 140 colours. Syme's grid has 108 hand-painted colour samples arranged in groups and including reference to the colour in nature in animal, vegetable and mineral. These colours are no longer true as they have faded with time and altered with reproduction.

**Table 2**

Examples of descriptions of leaf and bark colour in flora of south-western Australia in existing literature to indicate variation in colour description. Fuller descriptions are available from the author for *Acacia cyclops, A. rostelliferra, A. saligna, Agonis flexuosa, Allocasuarina fraseriana, Banksia attenuata, B. grandis, B. ilicifolia, B. littoralis, B. menziesii, B. prionotes, Callitris preisii, Casuarina obesa, Corymbia calophylla, Dryandra sessilis, Eucalyptus accedens, E. argyphea, E. caesia, E. decipiens, E. diversicolor, E. gomphocephala, E. marginata, E. rudis, E. todtiana, E. wandoo, Jacksonia furcellata, Kunzea ericifolia, Melaleuca cuticularis, M. huegelii, M. lanceolata, M. preissiana, M. rhaphiophylla, M. teretifolia, Nuytsia floribunda, Pittosporum phylliraeoides, Santalum acuminatum, Xanthorrhoea preissii.*

| Species | Plant part | Description |
|---|---|---|
| *Banksia attenuata* R Br. | New leaf | Pale brownish-green (George 1984a) |
| | Mature leaf | Deep green and shining above, pale below (George 1984a) |
| *Banksia grandis* Willd. | Mature leaf | Shiny dark green above (Boland *et al* 1984); Deep-green (Seddon 1972); Dark green (George 1984a) |
| *Banksia littoralis* R.Br. | Mature leaf | Undersides are pure white (Powell 1990) |
| | Bark/trunk | Bark of trunk is elephant-grey (Seddon 1972) |
| *Banksia menziesii* R.Br | New bracts | Sap green (Nikulinsky 1992) |
| | Mature leaf | Dull green, pale below (George 1984a); Greyish-green (Powell 1990) |
| | Bark/trunk | Greyish-pink or pale brown (George 1984a) |
| *Corymbia calophylla* (Lindl.)K.D.Hill & L.A.S.Johnson | Mature leaf | Green, strongly discolorous (Boland *et al* 1984); Dark green, strongly discolorous (Chippendale 1988); Green to dark green above, pale below (Powell 1990); Strongly discolorous, dull, dark green above (Brooker & Kleinig 2001); Dark green above, distinctly pale green below (French 1997) |
| | Bark/trunk | Dusky-brown or reddish (Moore 1884, p.135); In young trees bark is grey but with age becomes brownish to dark grey, and is frequently stained in patches to a reddish hue by the kino which exudes from the tree (Boland *et al* 1984); Grey, but coarser and darker than the bark of tuart, and may be stained a rusty colour from exuded kino (Seddon 1972); Bark grey (Marchant *et al* 1987); Grey or grey-brown (Chippendale 1988); Bark grey, often exudes a reddish-brown gum from trunk or branches (Powell 1990); Grey to grey-brown (French 1997) |
| *Eucalyptus accedens* W. Fitzg. | New leaf | Greyish-blue to glaucous, concolorous to slightly discolorous; in intermediate stage dull, bluish green or grey-green, concolorous (Boland *et al* 1984); More or less glaucous (Marchant *et al* 1987); Grey-blue or glaucous, concolorous (Chippendale 1988) |
| | Mature leaf | Dull, bluish green or grey-green, concolorous (Boland *et al* 1984); Blue-green or grey green (Chippendale 1988) |
| *Eucalyptus gomphocephala* DC | New leaf | Green, discolorous; green concolorous at intermediate stage (Boland *et al* 1984); Blade light green (Marchant *et al* 1987); Green, discolorous (Chippendale 1988); Light green above, paler below (French 1997); Discolorous, light green (Brooker & Kleinig 2001) |
| | Mature leaf | Green, concolorous (Boland *et al* 1984); Light green, dull sheen (Holliday & Watton 1980); Grey-green (Marchant *et al* 1987); Greyish mid-green (Powell 1990); Grey-green (Rippey & Rowland 1995); Shiny green; slightly discolorous to concolorous even on same tree (French 1997); Slightly discolorous to concolorous, glossy, light green (Brooker & Kleinig 2001) |
| | Bark/trunk | Light grey (Boland *et al* 1984); Silver-grey (Seddon 1972); Grey-brown or grey (Holliday & Watton 1980); Grey (Rippey & Rowland 1995; Chippendale 1988; Powell 1990); Pale grey (Marchant *et al* 1987); Paler patches to pale grey (Powell 1990); Grey to grey-white bark (French 1997); Dark grey (Brooker & Kleinig 2001) |
| *E. todtiana* F.Muell. | Mature leaf | Paler green than the other eucalypts of the coastal plain (Seddon 1972); Dull green (Marchant *et al* 1987); Green (Chippendale 1988); Dull and pale (Powell 1990) |
| *Melaleuca preissiana* Schauer | Bark/trunk | Whitish to light brownish (Boland *et al* 1984); White papery bark (Seddon 1972); White chartaceous (Marchant *et al* 1987); Whitish, papery (Powell 1990) |
| *Santalum acuminatum* (R.Br.) A. DC | Mature leaf | Pale green-yellow (Powell 1990); Yellow-green (Rippey & Rowland 1995) |

taxonomic purposes. For examples, salmon gum *Eucalyptus salmonophloia* appears more salmon as autumn approaches and the trunk of tuart, the white gum *E. gomphocephala*, appears almost black after heavy winter rains. Botanists have thus restricted their descriptions to those features which are not affected by the environment, such as leaf venation, and oil gland patterns, and flower bud characters before operculum shed, such as stamen inflexion and ovule rows. These features are regarded as immutable. And yet, curiously for science since the Enlightenment, this has resulted in an absence of complete description, and a form of colour blindness. Those who simply recorded what they saw, such as Dampier, botanical illustrators such as Bauer, and

settlers such as Mrs Millet, saw more detail in colour than modern texts usually suggest.

Authors are clearly struggling to describe leaf colour. What colour is dull green? What colour is dark green? Deep green? Grey green? Mid green? Green is given in the historic and existing literature as dark, light, mid, and pale, but with few indications as to whether the hue is of yellow, grey, or blue, with no indication possible of how yellow, grey, or blue. An exception is, for example, the note that blue-leaved jarrah *E. marginata* subsp. *thalassica* has bluish leaves. This is a very different colour to that of tallerack, *E. pleurocarpa*, or mottlecah *E. macrocarpa*, both denoted in the modern literature as glaucous. Glaucous itself is a unique and somewhat confusing expression in botany, for although it comes from the Greek *glaukos*– bluish-green, silvery, or grey – its usually means that the surface is covered with a white wax which can be rubbed off. When colour-coded with the Natural Color System of Sweden (NCS), glaucous surfaces fall very clearly in the 'bluish' range (Grose, unpublished) and thus the term remains in this study as an indicator of leaf colour seen by an observer.

Even when leaves are the most telling difference visually to the species, leaf colour is not well described in the either old or modern literature. For example, *E. plurocaulis* is purple-leaved, but it is difficult to define purple, and when blue becomes purple, or when red becomes purple. This difficulty is shown in the comments by Pignatti-Wikus *et al* (2000a), regarding the colour-code of Bauer, that the colour for flower parts given by Bauer's code and that of modern botanical description varies from red to purple. Likewise, the leaves of *Santalum acuminatum* are described as both "green-yellow" and "yellow-green" (Table 2) suggesting in the first an emphasis on yellow and in the latter an emphasis on green, a major distinction in colour systems such as the NCS.

Descriptions in the literature do give indications that several colours might exist in leaves, with the distinction of concolorous (all of one colour) and discolorous (more than one colour). The physiological basis of discolorous and concolorous derives from the nature of the internal arrangement of the photosynthetic tissue within the leaf, with concolorous being those with isobilateral arrangements, but the situation is not always clear-cut (Brooker, *pers. comm*.). While indicating multiple colours, the term discolorous does not inform the reader of what colours might be present. Less clear is the reference to "*slightly discolorous*", as given for *Eucalyptus gomphocephala* (Table 2).

Even when considering adaxial (upper) and abaxial (lower) leaf surfaces, which are often a source of colour differentiation, the description can be 'green above, paler below', such as for *Banksia attenuata* and *Corymbia calophylla* (Table 2). Since the abaxial surface is specialized for gas exchange and is considered as old as land plants themselves and derived from the stem, and the adaxial an innovation in leaf evolution (Cronk 2001), it is enticing to speculate on how the adaxial leaf grew 'darker above' in response to the capture of solar energy during the Palaeozoic.

Trunk descriptions of brown give no indication as to whether the brown is red, yellow-based, or has much black or white, and if white, what white? Even for species noted for an unusual trunk colour, the colour is often not well described. For example, Baudin described *Xanthorrhoea preissii* as having a "*coal-coloured trunk*" (Baudin 31 May 1801**)** but this feature is not mentioned in more modern texts. Even where there has been an accompanying photograph, which might have excused the lack of colour description, it has not been clear whether the plant was in deep shadow, or coal black. Mrs Millet (1872) noted that the colour of *X. preissii* "*…is not naturally black, but brown; nevertheless, most of them are so completely blackened by bush-fires…*", facts supported by the leading *Xanthorrhea* salvage specialist in Western Australia (*Xanthorrhoea preissii* is salvaged from those areas which are under suburban development, and from road-widening areas). It is notable that some more recent descriptions of species do attempt to suggest that there is a range of colour within one trunk, particularly in the trees which shed their bark annually, such as the salmon gum *E. salmonophloia.*

While the expression 'green above, paler below', the title of this paper, tells someone keying out in the field what to look for, it does not allow someone else to compare the colour with a species elsewhere, or to know what the colour might be. Like Bauer, who was able to paint Australian trees from numbers with great confidence and accuracy while in London, a colour 'fingerprint' or 'portrait' would give both a clearer picture of which colours make up discolorous, which colour is found as concolorous, what colour is green, and what colour is 'paler below', and enable comparisons of colour in flora across the globe. However, Table 2 suggests that modern colour descriptions remain at a level which does not allow the scientific rigour of comparison or analysis of this important aspect of the flora.

**Can we examine colour across places?**

While current descriptions acknowledge colour variation to some degree, and are useful for casual observation and botanical description in the field, the level of colour description does not facilitate rigorous comparison between species. Colour hues and nuances are not detailed. Thus, even after two hundred years of collecting in Australia, the literature provides inadequate complexity in the description of the colours in Australian trees. While descriptions of colour remain embedded in botanical description within a classification system based on sexual parts, we remain unable to compare the colours of endemic species, genera, or families, and to determine the range of colour found within one continent, or to perhaps compare Laurasian floras with Gondwanan.

Colour has long been acknowledged as a difficult subject to study (Gage 1993). However, it has also been long recognised as an essential part of description, as exemplified by Syme's (1814) introduction to a discourse on the colour of plants in which he wrote: "*A nomenclature of colours, with proper coloured examples of the different tints, as a general standard to refer to in the description of any object, has been long wanted in arts and sciences. It is singular, that a thing so obviously useful, and in the description of objects of natural history and the arts, where colour is an object indispensably necessary, should have been so long overlooked. In*

*describing an object, to specify its colours is always useful; but where colour forms a character, it becomes absolutely necessary. How defective, therefore must description be when the terms used are ambiguous; and where there is no regular standard to refer to. Description without figure is generally difficult to be comprehended; description and figure are in many instances still defective; but description, figure and colour combined form the most perfect representation, and are next to seeing the object itself. An object may be described of such a colour by one person, and perhaps mistaken by another for quite a different tint…….and often one name indiscriminately given to many colours."* This last has been particularly true of every colour associated with plants.

In this paper on colour description I have attempted to draw out simply the poor level of colour description in the current literature, examining the major and more commonly visible and known trees of one place – the South-western Australian Floristic Region - in a little detail. Descriptions of colour in the region remain relatively unchanged from the early pre-colonial literature, and this situation is likely to be typical of the global picture. As Syme suggested two hundred years ago - at the time of many of the early scientific expeditions to Australia and the use of colour grids for painting - figure, description, and colour combined would form the "most perfect" representation of a plant species. It is colour which has been neglected due to its difficulties. More detailed and precise colour description will enable comparisons to be made between the flora of south-western Australia and others, allow for further discussion on the changing colours of Australian environments with plant introductions, and give attention to colour as an aspect of global biological diversity.

Further, while botanists might learn to use the added external and changeable features of colour to botanical literature as a 'more perfect' representation, artists and those in the design professions might also benefit from specific, reproducible colours of flora to further understand the 'geography of colour' (Lenclos 1989). It is hoped that with more accurate description, more light will be shed on the immense beauty and biological diversity of this south-western Australian flora, and others.

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