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E: **info@cropwatch.org** T: ++44 (0)7771 872 521

Australian Sandalwood Oil: A tail of Spin & Hype.

- by Tony Burfield & Chrissie Wildwood Feb 2004..

Note: This file, originally issued as *Cropwatch 2* in Feb 2004, has been reproduced from the archives without modification. Apart from containing a high level of fact, it is considered that the contents below have some historical importance, and that lessons from this episode can still be learned, even (or maybe especially-) today.

Summary:
Entrepreneurs have been quick to capitalise on shortages of East Indian Sandalwood oil *Santalum album* L., offering the compositionally different extract of Western Australian Sandalwood, *Santalum spicatum* (R. Br.) A. DC as an alternative. This article critically examines some of the claims made by Australia's developing Sandalwood industry for its products and considers whether rose-tinted spectacles and doubletalk may have been 'de rigeur' in their promotional styles. We also explore the ecological impact of the industry, and question whether the term 'sustainable' is appropriate when applied to commercial wild harvesting of natural stands of slow-growing trees found mainly in the arid regions of Western Australia (a sustainable state is that which can go on forever, without creating a deficit or any other form of imbalance). Moreover, a world expert in the cultivation of sandalwood questions whether the small, newly established plantations, many kilometers distant from where the majority of trees are being uprooted, will flourish or expand enough to replace the harvest from natural stands.

Pacific Sandalwood : A History of Australian exploitation.

Historically, the huge demand for sandalwood as an incense ingredient in China & SE Asia led to mass exploitation of the resource. Indeed, in her book, *They Came for Sandalwood,* Dorothy Shineberg describes the deeds of opportunist traders in the South Pacific (1820-1865), and tells of warring confrontations between European and Melanesian cultures in New Caledonia, the New Hebrides and the Loyalty Islands. To satisfy the English demand for tea, sandalwood became the currency for supplies of tea imported from China. This gave impetus to explorer-traders like Dillon and Towns, who discovered exploitable amounts of sandalwood tree species on many islands, especially

Erromango. By 1860, thousands of islanders had been slaughtered, and the Pacific sandalwood resources were plundered to near extinction. Nowadays, Pacific sandalwood (what little of it remains) is an important source of revenue for some Pacific islanders.

On sandalwood, Septimus Piesse (1855), the famous 19th Century French chemist perfumer notes that "…continuous offerings to the Buddha's have almost exterminated the plant from the Celestial Empire and such is the demand that it is about to be cultivated in West Australia in the expectation of profitable return, which we doubt will be realised."
But to reduce the expense of importing tea into New South Wales, the trading of Pacific sandalwood by Australian merchants, especially at the time Piesse published his book, had been a positive economic factor. The trading volumes since then have had their ups and downs. For example, in 1957 the trade in *Santalum spicatum* was totally shut down. However, in the past few years, and against a background of over-exploitation of *Santalum album* in India, and with the ravages of spike disease causing additional problems, Australia's native Sandalwood resource has once again become an important trading commodity. As we shall see, however, the industry seems to have made a number of errors of judgement….

Australian Sandalwood: the facts without the sales hype.

§1. Sandalwood species

Six *Santalum* species occur in Australia: (*Flora of Australia* vol **22** Austr Govt Publ Service Canberra 1984).

S. *acuminatum* (R. Br.) A. DC.
S. album L.
S. lanceolatum R. Br.
S. murrayanum (Mitchell) C. Gardn.
S. obtusifolium R. Br.
S. spicatum (R. Br.) A. DC.

However, only two species have been economically important. ***Santalum lanceolatum*** (Northern Sandalwood) is the most widespread of the *Santalum* spp. in Australia (Applegate et al.1990), and exports of this species were worth $4.2 million in 1989. The authors preface the article with a quote from Sawyer (1892):

"The trade in this fragrant wood has been going on since the dawn of history and will probably not cease until the connection between the sandal trees and the idolaters existing from time immemorial, shall have been broken up, by one or another becoming extinct as a race as the Archaeopteryx or the Dido."

The authors go on to report, "the first recorded export of Sandalwood was from the State of Western Australia in 1846 when 4 tons were sent abroad for oil production." Interestingly, a colossal 4 tons of aromatic *S. lanceolatum* logs were used for Gandhi's cremation in 1948. Applegate et al. also describe how Unex

industries (Australia) Ltd secured sole rights to purchase sandalwood (*S. lanceolatum*) from Crown Island in Queensland for a period of 20 years, but alleged breaches of contract caused Queensland Forest Services to revoke this contract in 1989. Wood harvesting from Crown Land has been more important and harvesting guidelines have been established to manage the resource for conservation, such that no more than 50% of existing stands are harvested, and limiting the wood harvesting to equal or greater than 12cm. d.b.h. to ensure that the theoretical heartwood recovery constitutes at least 30% of the wood harvested.

Ethno-botanical use of northern sandalwood species by aboriginals is reported by Sansom (1980), through Stateham (1990) and Tonts & Selwood (2002). Here it is revealed that the northern species of sandalwood were, and still are, highly prized by the aboriginals, as the wood and its scent are regarded as fundamental elements in sex-magic.

§2. A brief aromatic history

Australia has a history of marketing raw materials from its aromatic shrubs and trees, spanning the 19th and 20th centuries. Essential oil production was focused on isolating specific perfumery components, until the introduction of cheap synthetic perfumery materials caused a decline, if not virtual abandonment, of the industry. Despite experience in aromatic raw materials production, the development of the perfume manufacturing industry in Australia was never realised to the extent of the prestigious perfume houses of Europe.

The emergence of aromatherapy, coinciding with renewed interest in natural materials specifically for the flavourings market, provided impetus for a regeneration of the Australian essential oils industry. Commodities such as Tea Tree oil became much sought-after ingredients. However, competition between producers became fierce, and eventually individual companies were forced to forward sell their annum production at prices below the cost of production, inevitably leading to a collapse of certain operations. Subsequent competition from Zimbabwe, South Africa and China has combined to keep selling prices low for Tea Tree oil. Accounts of the decline, and how growers subsequently clubbed together to seek tax relief on diesel used in the distillation, can be glimpsed at

http://www.abc.net.au/7.30/stories/s139789.htm and
http://fueltaxinquiry.treasury.gov.au/content/Submissions/Industry/NQEO_100.asp

China continues an aggressive low-pricing sales policy which has limited the potential sales of other essential oils produced in Australia, such as *Eucalyptus globulus* and *Lavandula angustifolia.*

§3. WA Sandalwood

Tonts & Selwood (2002) describe the reinvention of Australia's sandalwood industry and report how the once abundant tree ***Santalum spicatum*** has been largely cleared from areas 300-600m (due to conversion of the natural woodland

to sheep and wheat farming). Although a slow-growing species taking some decades to mature, depending on annual rainfall and other factors, formerly the tree grew optimally in these areas. At a distribution of 1-2 plants per hectare, it is still present in the 42 million-acre arid zone. Unfortunately, susceptibility to fire & ant attack, grazing by wild animals, heartrot - and especially creeping salination - are survival threats. Much has been made of the fact that plantations of *S. spicatum* with integral host species such as *Acacia acuminata* (in the Wheatbelt region) or *Acacia aneura* (in the Golfields region) may help counter the effects of Australia's massive problem of creeping salination, caused by massive land-clearing of native vegetation (Blacklow 2003). However, a study by Woodall & Robinson (2003), working in the Pallinup river catchment area of SW Australia, is revealing. The authors suggest that, in reality, the small size of these sandalwood plantation schemes is unlikely to address the salinity crisis through broad-scale recharge management. Indeed, a source of more biodiverse plantation schemes is required to bring benefits, although it is difficult to know where funding for such a complex project is likely to be obtained – despite pleas for "a cultural change" (Blacklow et al 2003). Meanwhile, land clearance continues.

CALM (Department of Conservation and Land Management) is the Australian agency responsible for administering the 1929 Sandalwood Control Act, awarding contracts to private companies to harvest sandalwood, and overseeing the amount and minimum size of sandalwood that can be removed from individual stands by reference to, and consideration of, its inventory data. CALM also encouraged studies leading to a better understanding of Sandalwood cultivation, such as the report of Lonergan (1990) which describes and eventually summarises the conclusions from the WA Sandalwood research program (1895-1981) in eleven succinct points. Point eleven describes the technique of artificial regeneration of Sandalwood on a planting scale. Lonergan concludes that potential for widescale regeneration and establishment of sandalwood in W Australia is feasible "if the natural limitations on this species are recognised."

McKinnell (1990) describes typical harvesting: "… licensed "pullers "are allocated an annual quota of so many tons of green or dead wood…. Sandalwood "pullers" are permitted to take only those live trees with a girth greater than 40cm at 15cm above the ground. Dead trees of any size are taken. Currently about half the sandalwood harvest is of dead wood, a consequence of periodic drought and a series of large wildfires several years ago (Keally 1987). At present this is restricted to 2,000 tons per year."

In 1995, the marketing monopoly was removed from the Australian Sandalwood Company, allowing the newcomer, Westcorp Sandalwood Inc., to emerge. New Mountain, a Westcorp company, won a contract with the Forest Products Corporation to remove up to 200 tons of Sandalwood per year to make incense sticks to repel mosquitoes (Safstrom 2002). Tonts & Selwood (2002) also describe Mount Romance's establishment in Albany 1999, now having a contract with CALM for 1,000 tons of sandalwood per annum.

Mount Romance was founded by Steve Birkbeck, who rose to some renown in the Australian business world when in 1981 he successfully took charge of a "forgotten peoples" emu company in Wiluna, W. Australia. This formed part of a larger group of indigenous farming enterprises focused on crocodile, turtle and emu products (RIRC undated). Within a few years he became the celebrated pioneer of emu farming in Australia, the birds being exploited for meat and the rendered oil, the latter being used in the cosmetics trade. Opposition to current practises of emu farming by the Australian Royal Society for the Prevention of Cruelty to Animals can be viewed at:

http://www.rspca.org.au/pdf/B_policystatements.pdf

Birckbeck's enterprise based in Albany continues to market health and beauty products based on emu oil, alongside sandalwood-based products. Yet it is noted by the authors with some irony that Mount Romance's aggressive marketing operation has resulted in the company's WA sandalwood oil being sold into "Cruelty Free" products in Australia and the USA.

Earlier on, and apparently talking-up the market, John Fergeus (1990), owner of an Australian essential oils company, wrote an influential article in the trade magazine *Perfumer & Flavourist* entitled "What will be the Next Big Oil from Australia?" With the Australian government seemingly ready to throw any amount of money at essential oils, and with a posse of obedient botanists and University workers in tow, it would seem that the Australian oils trade could not fail to succeed. Writers like Webb (2000), acting as an oil trade publicist, would give glowing descriptions of Australian essential oils, and Australian magazines such as *Aromatherapy Today,* edited by essential oil seller John Kerr, would further worshipfully exalt essential oils and their properties to almost magical status. In all these accounts, almost no critical overview is to be found.

But what of the marketable Australian oils, post Tea tree oils' crash in selling price? Manuka (*Leptospermum scoparium*) and Kanuka (*Kunzea ericoides*) oils, once tipped be successors to Tea Tree's success, failed to sell on the same scale, and anyway are more strictly associated with New Zealand. Rosalina oil from *Melaleuca ericifolia*, a more acceptable and floral oil compared to the aromatic earthiness of Tea Tree, was heavily promoted as "Lavender Tea tree", but in a similar way failed to catch the customer's imagination. *Backhousia citriodora*, an interesting oil comprised mainly of citral and citronellal, had skin safety problems associated with its' high aldehyde/allergens content, which limits its more widespread use in perfumery & aromatherapy.

The rising price and unavailability of East Indian Sandalwood, however, gave the Australian essential oils industry a unique opportunity. Since *Santalum spicatum* logs were already being exported to China (80% of which are powdered for incense sticks [Denham 1998]), and Chinese demand for wood was said to be increasing 50% year on year (Henschke 2000), a lucrative opening would be to produce a highly prized essential oil in addition to shipping timber.

§4. Marketing WA Sandalwood oil.

The opportunist marketing departments of Mount Romance, Australian Botanicals and other oil suppliers have been quick to point out the problems with the supply of East Indian Sandalwood oil (Anon 2002; Fergeus undated). However, the cosmetic trade press, which has featured articles on the oil in question, usually only prints features forwarded by writers representing producers and suppliers, resulting in content which resembles an advertisement, rather than balanced informative articles with a critical overview. Let us continue, therefore, with some issues around WA Sandalwood that the trade does not want to talk about…

§5. Product Definition problems

In an article about Western Australian Sandalwood oil published in *Aromatherapy Today,* Kerr (2000) was decidedly coy about revealing the solvents employed in the production process; Webb's book, *Bush Science* (Webb 2000), cited in the same article, describes the principles of process on pages 16-17, but again declines to identify the solvents. Later however, Valder et al. (2003) give the exact preparation method for Mount Romance sandalwood oil, as featuring hexane extraction, followed by co-distillation with propylene glycol, followed by rectification. Passing over the question of why a readership of essential oil chemists is apparently entitled to know what aromatherapists are not, it is clear that this product then, **is an extract, not an essential oil** since it doesn't conform to the ISO 9235-1997 and Pharmacopoeia definitions of essential oils. The solvent extract (prior to the co-distillation stage), if all hexane was removed, would be defined as a **concrete**; for example Butaud *et al*. (2003) recently describe sandalwood concretes made by solvent extraction using chloroform. Gearon (2002) had already defensively remarked on this issue: "By definition, an essential oil is the volatile oil forming the odorous principle of plants.* Of course, this is open to selective interpretation, depending on motive". Never was a truer word spoken!

Earlier, Gearon (2000), quoted on a commercial oil-sellers magazine page, attempts to justify the extraction process for Australian Sandalwood oil with an attempt to rewrite the definition of "natural" with a confused train of thought, which can be followed at :

http://www.essentiallyoils.com/Newsletters/October_2000_Newsletter/october_2000_newsletter.html

In this feature, Gearon advises the Newsletter that Mount Romance uses a "high grade pure solvent" (which is apparently "removed entirely") to ensure the extracted material "closely resembles the plant matter". She then criticises the steam distillation process for the artefacts it produces due to reaction between the (aromatic) components and hydrogen ions, advising that it cannot be natural.

Comment: EU definitions of "natural flavourings" in 1988, and "natural cosmetics" which include fragrance materials complying with the definitions of ingredients in ISO 9325, have shaped our thinking in the essential oil trade (see EU Council Directives 88/388/EEC and Committee of Experts on Cosmetic

Products, 2000). Therefore a "natural" flavouring process would mean, in legal terms, isolation by purely physical (extrusion, centrifugation, filtration, distillation, extraction, percolation, adsorptive techniques, freezing, drying), enzymic or microbiological process, almost solely from the named source. The internal guidelines of many aroma companies indicate that the use of water or steam to isolate essential oils from aromatic vegetable matter would therefore constitute a "natural" physical process, whereas the use of purified petrochemical products like hexane, or co-distillation with propylene glycol, would not be. However differences in the issue of defining a natural fragrance between Europe, the US & China is to be discussed in the forthcoming CCAFI Seminar in Ghanzou on Mar 4-7 2004, and perhaps any resolutions will be illuminating.

Secondly, Gearon is correct to say that some artefacts may arise from the lowering of pH which occurs in some steam distillations, from liberation of acidic substances during the thermally induced breakdown of plant matter. Artefact formation can however be minimised (if required) by adding buffering agents to the charge, to prevent pH change.

However, some artefacts produced by a natural physical process, such as steam distillation, are positively beneficial. For example, the blue coloured chamazulenes produced thermally from precursors during distillation from *Anthemis nobilis* (chamomile) have useful healing properties, and are used by herbalists and aromatherapists alike.

***The authors dispute this statement represents a true and accurate scientific definition of an essential oil.

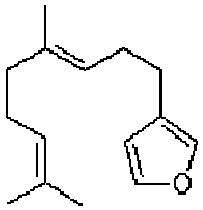
§6. Odour problems

It was a mistaken policy to market *Santalum spicatum* oil almost as a direct substitute for the superior East Indian Sandalwood oil, and perhaps initially producers underestimated the discriminatory olfactory abilities of their customers to spot the differences in odour characteristics. Few traders and producers in Australia had the benefit of employing staff with a classical perfumery education, but this has not stopped them venturing their own opinions on the odour attributes and qualities of their oils!

Kerr (2000) maintains, somewhat bizarrely, that "the farnesol [content]...[modifies] the typical Sandalwood aroma to make it fresher and greener". Webb (2000) quotes an odour description from the classic Arctander text (Arctander 1960) which, forty four years after its publication date, can still be appreciated as a magnificent work, but is quite outdated in many respects. Arctander somewhat generously described the odour profile of Sandalwood Australian as being "…soft, woody, extremely tenacious and somewhat balsamic in its delicate sweetness". He also notes the WA oil top-note is distinctly different from the EI oil, "not as sweet, rather dry-bitter, and is slightly resinous like myrrh, but then describes the dry-out as becoming similar to the East Indian oil" - this is not the experience of many WA sandalwood end-users. The top note of the Sandalwood EI oil is associated in the minds' of many perfumers' minds surely

as having fine precious woody notes and a creamy yielding sweetness, and the relatively second grade "woody and balsamic" descriptors relate more to the WA oil.

Earlier attempts to explain the difference in odour between the WA and EI Sandalwood oils were attributed by GT Walker (1968) to dendrolasin,"which possesses a sweet lemongrass odour". Piggott *et al.* (2003), found a concentration of 2.0% of this substance in the commercial oil of *S. spicatum*.



dendrolasin

The consumer market is still demanding better odoured grades of Australian sandalwood – the word "sandalwood" is after all mentally associated with fine precious wood notes. In order to appease this demand, there are a number of possible recourses:

- Use better odoured fractions
- Find better odoured chemotypes or geographic sources of *S. spicatum*
- Resort to steam distillation or other kinds of processing rather than solvent extraction.

However, solvent extraction of *Santalum album* has been previously tried in India and has a poor track record. Nagaraja Rao (1939), reporting early work using methanol and ethanol, states that the oils produced in this way failed to find favour with the perfume industry, and for many decades solvent extraction of Sandalwood was abandoned.

Gearon (2002) maintains that "the difference between a steam distillate and a solvent extracted distillate* of Australian Sandalwood oil (in odour? in GC-MS profile?), lies mainly in the headspace – the gas chromatograms of oil produced by both processes look extremely similar". ***Comment:*** The idea that a GC-MS trace of a headspace is necessarily predictive of odour character is false. The nose is a far more sensitive detector than any electronic GC detector, and so an olfactogram may be far more useful in this regard than any GC trace. Moreover some groups of compounds in sandalwood (e.g. the terpenic acids, making up 2-3% of the total concentration) are not easily detected by GC-MS without resorting to specific methods of sample pre-treatment.

[*Gearon presumably means to say a steam distillate of the solvent extract, rather than a solvent extract of the distillate].

Gearon continues: “The concentration of volatiles is similar in both processes. Steam distillation generally extracts more sesquiterpene hydrocarbons and early eluting alcohols than solvent extraction. All constituents are natural parts of the oil; their quantification varies with the process used to extract. Hence the olfactory profile, especially in the top notes differs with both processes, although the resultant oils are characteristically sandalwood.” ***Comment:*** **Cropwatch** has seen steam distilled oils of *Santalum spicatum* which smell superior and seem to keep better on storage than solvent extract/co-distilled/rectified oils.

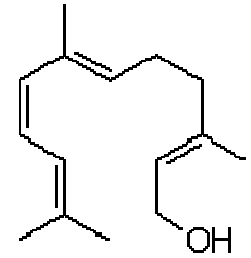
Kerr (2002) also defends the principle of extracts in an editorial following Gearon’s article stating “…many such [presumably hexane] extracts have been passed as safe for human use”. In fact few people are probably aware of the high standards demanded of food flavouring oleoresins (which are solvent extracted spices etc). These are set out, for example, in the FCC IV standard which states for Cardamom oleoresin: Residual solvent: Chlorinated hydrocarbons: not more than 0.003%; Acetone: not more than 0.003%; Isopropanol: not more than 0.003%; Methanol not more than 0.005%; Hexane not more than 0.0025%). Aromatherapy has no such effective regulation or monitoring of solvent residues for its raw materials; but some companies (such as Kobashi) will try in principle not to sell solvent extracted absolutes at all, and seek alternative methods of preparation (Kobashi 2003).

§7. Composition problems.

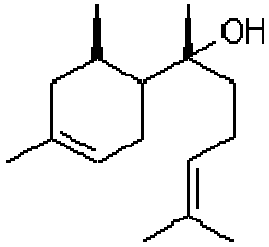
Many different standards operate for Sandalwood oil East Indian, perhaps the most universally accepted one now being the recent updated ISO standard 3518 –2002(E). Unfortunately this new standard, a modification of the 1979 & 1985 ISO 3518 standards, reduces the negative optical rotation requirements for the oil. This in the author’s opinion (TB) is an unnecessary and questionable development, as it now allows the increased possibility of blending in small amounts of *Santalum spicatum* and cheaper fractions from other *Santalum* species with less laevorotatory values (in fact this already occurs in practice). Interestingly *Santalum album* from other geographic areas such as China, and other species of sandalwood may also meet the new ISO figures – for example *Santalum austrocaledonicum* var. *austrocaledonicum* from New Caledonia and Vanuatu. Comprehensive safety information for EI Sandalwood oil can be viewed at http://www.cdc.gov/niosh/rtecs/rj386968.html#Z

Although earlier standards exist for Australian Sandalwood oil - such as BPC 1949 and EOA No 174 - Australian Standards have published a standard for Australian sandalwood oil AS 2112-2003**:** Oil of sandalwood, [*Santalum spicatum* (R.Br) A.DC] for which details are available at http://www.standards.com.au/catalogue/script/details.asp?DocN=AS1201132824 10 - this appears to be based on figures submitted by Mount Romance judging by the information given at http://www.rirdc.gov.au/comp02/eoi2.html). If this is true, we cannot recall another precedent of a national standard being drawn up by an interested party.

Despite assertions by Fergeus (undated) that "Australian sandalwood has a similar composition to Indian sandalwood, rich in α- and β-santalols", Valder *et al*. (2003), admit that, "While East Indian Sandalwood is extensively studied, little is known about another sandalwood quality - West Australian Sandalwood oil". Valder et al. refer to the review of Brunke et al. (1997) for compositional data on EI Sandalwood, and go on to describe their own findings of two new compounds, amongst the seventy identified constituents of the Mount Romance commercial oil, also comparing with oils produced by hydrodistillation and by hexane/acetone extraction/ hydrodistillation from the root chips and butts of *Santalum spicatum*. A further paper by Vader et al. (2003a) describes a further six compounds identified for the first time in WA Sandalwood oil. It is apparent, therefore, that a more complete knowledge of WA Sandalwood oil is only just emerging. However in summary, from what we know already, **the East Indian oil contains a higher level of α- & β-santalols, whereas and the W. Australian oil contains more *E,E*-farnesol, α-bisabolol and α-bergamotol**.



2E, 6E - farnesol



epi-alpha-bisabolol

It was already established by Piggot et al. (1997) that different sections of the WA Sandalwood tree produce different compositions of oil, the *epi*-α-bisabolol content increasing as one goes higher up the tree, whereas the desirable santalols are highest in the buttwood. **Cropwatch** has obtained documents, pertaining to nearly 400 separate analyses, which show variations in the α-santalol content alone from 6.0 - 24.5% according to the exact geographic locality from which the wood of *S. spicatum* was taken within an area of S.W. Australia. The search is on for compositionally higher santalol producing areas of *S. spicatum* trees.

Finally, Piggott suggests that *S. spicatum* and *S. album* may be distinguished by the chiral ratios of β-bisabolol to epi-β-bisabolol (the (6R, 7S)-*epi*-β-bisabolol isomer being favoured in *S. spicatum* and (6R, 7R)-β-bisabolol form being favoured in *S. album*. Unscrupulous producers and traders may blend in W Australian sandalwood oil with the scarcer and more costly EI oil, so the aforementioned may be a useful way of helping to detect adulteration.

It might be instructive to look at some of the published analytical data for some of the components of the oil of *S. spicatum*.

Constituent	Fergeus	Brophy	Brophy 2	Piggott	[*S.*

					***album*]**
β-santalene	2.2%				2.03%
α-santalol	25%	9.1% (Z) -α-isomer		10.0%	44.23% (+)-(Z)- α isomer
β-santalol	14%	5.4% (*Z*)-β-isomer	8.1%	3.8%	23.51% (-)-(*Z*)-β-isomer
α-bergamotol	5%				4.12% (*E*)-isomer
Nuciferols	Σ: 16%	6.5% (*Z*)-(isomer	6.9% (*Z*)-isomer)	2.2%	2.37% (*Z*)-isomer)
(*Z*)-lanceol	2%				1.52%
epi-α- & β-bisabolol	Σ: 7%	10.7% (*epi*-α-isomer)	6.6% (*epi*-α-isomer)	3.1%	
2E,6E-farnesol	5%	31.6%	11.0%	5.3%	

Table 1. Components of oil of *S. spicatum*, according to various sources.

Sources:

Fergeus J (undated pamphlet) = *Australian Sandalwood Aromatic Review* Australian Botanical Products Pty Ltd.

Brophy= JJ Brophy *et al*. (1991) analysing trunkwood oil

Brophy 2= JJ Brophy *et al*. (1991) analysing buttwood oil

Piggott et al. = Piggott et al. (1997) analysing buttwood oil

S. album = T. Burfield (2004) unpublished data, commercial oil

However this appears to be quite different information on *Santalum spicatum* composition from that supplied on Lebermuth's website (which can be seen in full on http://www.lebermuth.com/oilmonth.html) courtesy of John Fergeus, illustrating Kerr's point that "…this has lead to several (aromatically) different essential oils being produced for different markets or purposes" (Kerr 2000).

Compound	S. spicatum %	S. album %
-bisabolol	3%	
cis –santalol	25%	50%
epi –bisabolol	4%	
cis tr – bergamotol	5%	3%

cis -santalol	11%	20%
E,E,- farnesol	5%	
cis nuciferol	11%	1%
trans nuciferol	5%	1% *

Table 2. Comparison of composition of 'oils' of *S. spicatum* & *S. album*, allegedly according to J. Fergeus

* *cis*-nuciferol, surely?

(NB As you can see, the Greek lettering denoting the correct isomers appears not to have survived the transfer, on my browser anyway! For example *cis*-santalol should be *cis*-α-santalol).

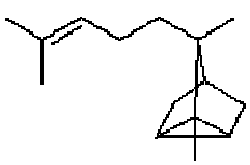
Pigott, looking at the Brophy *et al*.'s results and considering Penfold's earlier work (Penfold 1928 & 1932), speculates that 3 chemotypes of *S. spicatum* might exist, where *epi*-α-bisabolol, farnesol or α- & β-santalols predominate in the oil from the mid-trunk sections upwards.

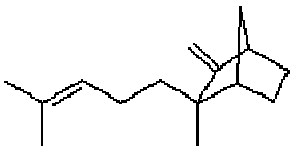
(-)-Z-beta-santalol

(+)-Z-alpha-santalol

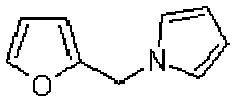
It is generally acknowledged that the santalols add to the fine woody notes of EI sandalwood odour, the term santalols first being coined by Parry (1895). (+)-*Z*-alpha-santalol is however somewhat weak & cedarwoody – the distinguished perfumer Arcadi Boix Camps (2000) notes that the material has a weaker, less floral and more resinous odour (in comparison with a synthetic Sandalwood reference compound: Sandela) and the author goes on to say he considers it's value more fixative than olfactory. (-)-*Z*-beta-santalol is considered the finer sandalwood odoured material, which Arcadi Boix Camps (2000) considers is floral-radiant. Other commentators describe (-)-*Z*-beta-santalol as the santalol isomer having greater olfactory significance (Brunke E-J 1983), or describe superior fine woody notes, especially adding to the animalic urinous character of the oil (Ohloff G 1994) . It should be noted that 40% of subjects are anosmic to this aspect of the oil. Other sandalwood constituents have also been examined for their odour contributions, such as:

(-)-alpha-santalene (weak, woody) and (-)-beta-santalene (cedarwood like) .


alpha-santalene


beta-santalene

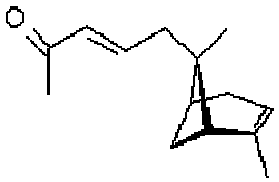
These sesquiterpene hydrocarbons may well be removed in the first fractions of redistillation or rectification together with the unpleasant degradation product 1-furfuryl pyrrole (which has a coffee or popcorn-like odour nuance at extreme dilution). This procedure improves the overall odour profile of the product.



1-furfuryl pyrrole

However Brunke & Hammerschmidt (1980) referring to the work of Demole (1976) who analysed the first runnings of EI sandalwood redistillation, identifying 46 compounds, maintain that these minor components round off the olfactory image and say that "the true value of sandalwood to the perfumer lies in the smell & fixative properties of its sesquiterpene alcohol fraction and is fully realised only in composite fragrances".

One of the more interesting components, probably corresponding to Arcadi Boix Camps term bergamottol (possessing a strong milky oriental aroma), is the investigation and characterisation of nor-α-*trans*-bergamotenone (Brunke & Schmaus 19995). Although only present at 0.01%, its high aroma adds fatty-nutty and milky odour aspects to the top-note of the EI oil (as proven by aroma extract dilution techniques). This is mentioned because it may be another factor in the differing odour profiles of WA as opposed to the EI oil.



nor-alpha-tr-bergamotenone

However it was found by Brunke & Schmaus (1995) that concentration of fractions containing (-)-*Z*-alpha-*tr*-bergamotol (which is present in WA sandalwood oil) and (+)-*Z*-alpha-santalol resulted in mixtures with the strong fatty-nutty and milky odours.

Other components of West Australian sandalwood oil include (*Z*)-nuciferol & (*Z*)-lanceol, which by themselves have both, possess weak woody odours (Sideheswaran & Ganguli 1997).

§ 8. Marketing confusion.

Cropwatch has an undated copy of a 15-page media release (plus many ancillary pages of promotional material) apparently authored by Mount Romance,entitled "*Sandalwood Aroma-chology*". This commercial promotional material by a private company features, on page 9, the biography of Professor Buchbauer, principle researcher of the Institute of Pharmaceutical Chemistry, Vienna, since (page 2:) "In 2002/3 further research will elucidate the

pharmaceutical effects of inhalation of the fragrance and quantification of the increased efficacy of the oil after inducing a psychosomatic connection with deep relaxation". The text seems to be in the future tense, whereas on page 7 we learn that Mount Romance Australia and the Institute of Pharmaceutical Chemistry Vienna "have conducted a human clinical trial in order to confirm the historical & anecdotal physiological effects of Australian sandalwood oil". There does not seem to be a reference to any publication of this work in the document.

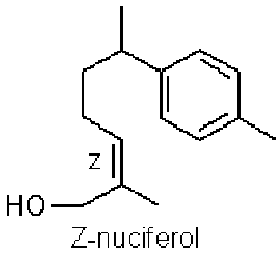
The appendices also feature biographies of Michael Roudnitska, perfumer-son of the famous fragranceur Edmond Roudnitska, and Dr. Stephen Myers of the University of Queensland, who (page 12:) is "Director of the Centre" – perhaps meaning the School of Complementary Medicine, University of Australia. On page 7 we learn that a human trial at the Australian Centre for Complementary Medicine (2002) established that Australian sandalwood applied to human skin induces relaxation. Again I am unable to follow the document sufficiently to understand if a clearly inadequate reference on page 12 refers to this, or to other work.

The layout of this document appears to be somewhat confusing to the author (TB), since esoteric, spiritual and investigative work on *Santalum spicatum* "oils" almost seamlessly combine with the traditional properties and known benefits of *Santalum album*, as if the two materials were exactly the same. Subject to confirmation, in the references to the article, three out of five references cited appear to refer to previous published work on *Santalum album.* In one further reference, again subject to confirmation, an article is cited which refers to the properties of a (synthetic?) version of one particular aroma compound found in the oil of *Santalum spicatum.* In the fullness of time, many of the demonstrable therapeutic effects of *Santalum album* may (or may not) be scientifically proven to be similar in *Santalum spicatum* oils. Meanwhile, presentations such as this seem to trade on "the good name of E.I. Sandalwood." **Cropwatch** is trying to track down many of the specific studies mentioned to critically evaluate them, although they are often referred to as "unpublished" in much of the promotional material released at the time.

§9. Dubious claims.

On page 31 (the page is in fact unnumbered, but is the 31st page in sequence) of *Aromatherapy Today* Vol **20** December 2001, in what appears to be an advertisement, in amongst a total of eight claims, we read that:

- "A recent study concluded that the greatest therapeutic benefit from sandalwood oil was apparent where the santalols and nuciferols were present together. *Santalum album* does not contain the important odour molecule nuciferol."



Z-nuciferol

Comment: in fact we have known for a considerable time that *Santalum album* **does** contain (+)-*cis*-nuciferol (see for example Brunke & Hammerschmidt 1980).

- "*Santalum spicatum* is 25 times more inhibitory to *Staphylococcus aureus* (including MRSA or Golden Staph.) than tea tree oil."

Comment: As *Santalum spicatum* has not been notified in the Annexes of the EU Biocides legislation at the moment of writing, the future for biocidal use for this material in retailed products does not look possible as matters currently stand. Since Australian and US legislation often follows the European model the same situation may well eventually apply outside the EU.

- "Unlike *Santalum album,* ***Santalum spicatum*** is free of solvent and petrochemical contamination and is produced in a manner that most represents the oil in its natural form."

***Comment*:** This is a curious statement. East Indian sandalwood oil is typically steam distilled, re-distilled and then rectified. Whilst solvent extraction of the waste wood residues from the distillation is not absolutely unknown in India, it is not common; it is true that oil produced in this way might on the odd occasion be blended in with the steam-distilled bulk. On the other hand, petrochemical solvents are used in the Mount Romance extraction process, presumably for economic reasons, since McKinnell (1990) notes: "Significant variations exist in the heartwood oil content between the commercially utilised species: *S. album* & *S. yasi* average 5-7 percent, *S. austrocaledonicum* 3-6 percent, depending on source, whilst *S. spicatum* averages 2%. This last is considered too low for distillation under present economic circumstances, and (the wood) is only used for the incense trade."

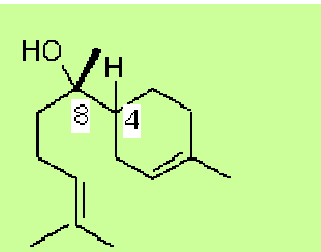
- "That *Santalum spicatum* contains significant levels of the recognised anti-flammatory epi-alpha-bisabolol (the active component in chamomile). *Santalum album* does not contain any *epi*-alpha-bisabolol."

***Comment*.**

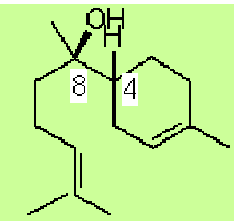
Some facts about the four isomers of alpha-bisabolol:

- Isaac as long ago as 1979 found that (-)-alpha-bisabolol (**not the epi-isomer as stated above**) was present at up to 50% in German chamomile oil (Isaac 1979). Carle et al. (1992) report that the anti-inflammatory compound (-)-alpha-bisabolol is the almost sole component of the cheap, high-yielding essential oil from the Brazilian woody plant

Vanillaosmopsis erythropappa, used buy unscrupulous dealers to adulterate chamomile oil.



(-)-alpha-bisabolol [4S,8S]



(-)-epi-alpha-bisabolol [4S,8R]

- Brunke & Hammerstein (1988) found that alpha-bisabolol (not the *epi*-α-bisabolol isomer) was present in the fresh (1 year old) oil of *Santalum album.*
- The (+)-alpha-bisabolol isomer is found in Poplar buds *Populus balsamifera.*
- The (-)-*epi*-alpha-bisabolol isomer is present in the Australian plant *Myoporum crassifolium.*
- The rarer (+)-*epi*-alpha-bisabolol is found in the oil of African Sage *Salvia stenophylla.*

Kerr (2000) maintains that solvent extraction is (only) utilised to increase the santalols content of the *S. spicatum* extracted product ("oil"). Gearon as project leader for Mount Romance had previously been funded for 3 years by the Rural Industries Research & Development, the aims of the project being described at http://www.rirdc.gov.au/comp02/eoi2.html#MRA-1A. This source tends to support Kerr's statement about intentions of producing enriched fractional extracts of sesquiterpene alcohols at the expense of the non-volatile components. However, it also reveals the intended market for the product: "The pure alcohols or their enriched concentrates will be used in the formulation of value added products such as pharmaceuticals (anti-inflammatory and bacterial agents), cosmetics/toiletries and fine perfumes." Not "complete" oils for aromatherapy you will notice, just specific enriched fractions for industries that use such isolates. However practical the aim of yield optimisation, as we noted above, is also described as, "A secondary, but nonetheless indispensable, objective for the ultimate commercial success of this project is the identification of all parameters influencing the wood oil composition and oil yield."

§10. The Animal Testing Saga.

Scantox (a "pre-clinical safety testing laboratory" near Copenhagen, Denmark) carried out animal testing on the Mount Romance WA Sandalwood "oil" at the behest of the WA government; the results were widely referred to by Mount Romance, and apparently written up (Kauber K. 2000) but never released into the public domain. Requests by the author (TB) to Scantox to have sight of this information have been declined in the past.

Gearon (2002), billed as Scientific Officer for Mount Romance, appears not to acknowledge this testing episode, saying in a critique of Chrissie Wildwood's article, *Spotlight on the Trade in Wild Plants,* "I would like to sight (sic) the reference Ms. Wildwood refers to regarding the painful experiments on laboratory rodents which demonstrate the anti-microbial, fungicidal and anti-inflammatory properties of *S. spicatum*. With respect, this is not correct. The above information is ascertained using internationally standardised in-vitro assays utilising micro-organisms and enzyme systems. There is no animal (well, not macroscopic, anyway) experimentation involved at all."

Before going any further, it is important to mention that, for reasons unknown to CW, the editor of *Aromatherapy Today* failed to print the slightly revised version of her article, wherein the association between animal testing and anti-inflammatory properties had been cut. At no time had CW intended to associate the anti-microbial tests with in-vivo assays, which was a misunderstanding by Gearon. **Before publication of the article in Aromatherapy Today**, CW realised that the animal testing related to the acute oral and dermal toxicity tests, which were referenced in the Mount Romance literature on *Santalum spicatum.* The same reference appeared in publicity material included on the Mount Romance website.

So, having deduced the exact nature of the trials, CW wrote to Gearon requesting confirmation that these particular toxicity tests had indeed been carried out on animals. Unfortunately, there was no reply. As the magazine editorial deadline was imminent, CW persuaded John Kerr, editor of *Aromatherapy Today,* to contact Gearon himself. It was essential for him to know the exact nature of the experiments since he was selling Mount Romance sandalwood "oil" through his vegan essential oil company, Springfields. Indeed, his company was (and still is) listed as such by a number of animal welfare and animal rights organisations in Australia. For example, http://www.choosecrueltyfree.org.au/list.html.

Finally, Mt. Romance obliged by revealing to Kerr the exact nature of the toxicity tests. In the editorial comment of the same issue of the magazine, Kerr makes no reference to CW's role in having revealed the truth about the Scantox tests, but confirms:

"The oil was used in animal tests for oral and dermal toxicity in 2000. The tests were commissioned by the WA government to comply with both Australian and international regulations regarding the use of the oil in therapeutic and cosmetic products". He also remarks, "While I am totally opposed to any form of animal testing, my real anger is towards governments who have such laws and place primary producers in commercially impossible situations." We suggest that Kerr's distress was partially misplaced and should also have been directed at Mount Romance for omitting to mention the animal testing prior to selling the aromatic to companies marketing health and beauty products under the 'cruelty free' banner. Yet even before becoming aware of the animal testing, as a vegan company trading in "cruelty free" products, Kerr could see nothing incongruous about doing

business with a company that also openly marketed emu oil products! (Incidentally, Kerr no longer promotes the Mount Romance sandalwood extract, but sells the steam distilled WA sandalwood oil obtained from a different producer [Kerr 2003]).

The real fact of the matter, of course, is that the EU Cosmetics Regulations reflect an ethical objection to animal testing of which the WA government must have been unaware when they sanctioned the tests. It is interesting to note that all references to the acute dermal and oral toxicity undertaken as described are now removed from Mount Romance's website. However, the reference still remains elsewhere on the Internet; for example, on page 2 of the following online brochure: http://www.bnaturals.com.au/Pdfs/Medicated_Honey_Brochure.pdf**).**

§11. Ecological considerations.

Santalum lanceolatum

S. lanceolatum has been pronounced as endangered in Victoria and has been listed as a threatened taxon under Schedule 2 of the *Flora and Fauna Guarantee Act* 1988 (Flora & Fauna Guarantee Action Statement No. 75 1996) – see the reference for Department of Natural Resources and Environment (1996).

Santalum spicatum

We already know from the experience with *Santalum album* that the heartwood only commences to form at 20 years, and is optimal at 30-50 years when the diameter is 10-20cm; incipient heartwood formation occurring at 10 years when the diameter is 0.5 to 2 cm (Mayar 1988). Since oil content is related to heartwood content, long maturity times have to elapse before any species of Sandalwood trees are worth uprooting for oil; however as indicated elsewhere, maturity time is largely related to rainfall and many other factors. It is not accurately known how long the WA sandalwood trees grown under plantation conditions will take to reach maturity in specific locations. Estimates from producers in Australia have been in the range of 12-15 years upwards, in contrast to Weiss's comment (Weiss 1997) with reference to the Australian situation that in the Kalgoorie district of Western Australia at least, the estimated time to reach legal felling size is 50-100 years. A fuller examination of the rate of growth of heartwood and the changes in oil content over time is required in order to determine the optimum time to harvest the crop.

The Sandalwood Amendment Act passed in 1996 exempted plantations from government regulation. CALM subsequently promotes a share-farming scheme where financial assistance and technical support is given to farmers.

An introduction to *Santalum spicatum* growing for farmers is available (Denham 1998), which also states that the current export quantity of Sandalwood from W. Australia in 1998 was 2200 tons per year (in apparent contrast to the widely quoted 2000 tons CALM imposed limit). Perhaps as a result of this deregulation, Mount Romance is also an agent who will assist the Tropical Forestry Services Ltd (now CALM) in the selling of "Indian Sandalwood" (*Santalum album*) in

plantations on behalf of investors in the Orid River Irrigation Area of Northern Australia.

The financial reports of the Orid River sandalwood project for 1993 end, drawn up by ITC Ltd, show 74 x 1 hectare plots associated with 71 investors, and 162 plots x 0.5 acres assigned to 96 growers. Really then, this is a relatively tiny agro-forestry scheme. The information on the investment pack states that "Tests have shown that Indian Sandalwood trees grown in these circumstances are producing heartwood at 5 years of age, and so long as current growth rates are sustained, trees could be harvestable 12 years after planting." However, the authors are unable to find research material to justify such optimistic predictions, for *Santalum album* cultivation is notoriously difficult and remains in the experimental phase. Radomiljac (2000) describes *Santalum album* plantations in Kimberley growing on Sesbania formosa host trees, and *Alternanthera nana* as pot host. Radomilijac describes trials with other host trees that were not successful.
Even if it turns out to be possible to harvest *Santalum album* within 12 years of planting, the quality of oil produced is unpredictable at this stage of growth. It's also timely to remind ourselves that, according to Bolt (2001), at least one high profile plantation investment company is in receivership as tax deductions made by the company were deemed illegal by Australian tax collecting bodies. In a further article, Tonts (2001) expresses skepticism about plantation schemes in general, the associated monoculture, the excessive use of chemicals, and the turning of large areas of farmland into forest. At first this seems to be in conflict with Pakenham's criticism of loggers and "all the other energetic white Australians" who have reduced the area of virgin forest and increased the fire hazard (Pakenham 2002). What we believe Pakenham is saying is that mature green forests full of large majestic trees are more likely to survive the ravages of fire than immature plantations, which will be destroyed at a sweep.

As mentioned earlier, *Santalum spicatum* is already much less common in the wild as the result of excessive harvesting (Elliot 2002). Additionally, manual seed dispersal systems for *Santalum spicatum* have had to be devised in some areas, since the near extinction of the small marsupial known as the woylie (by foxes and feral cats) has caused severe reduction in numbers of the trees. The recommendation of reliance on seeding systems for *Santalum spicatum* propagation (Lonergan 1990) seem at odds with the Timorese experience of failure rates with this technique, the farmers relying on the equally important vegetative regeneration (McWilliam 2001). Barret (1989) commenting about relationships with suitable host species, remarks "The ecology of natural sandalwood production in Timor (and elsewhere) is therefore complex and is translated into significant variation of growth characteristics and heartwood development across the species. Although there has been significant research on the ecology and silvicultural aspects of the tree, a full understanding of ecological dynamics of sandalwood is some way off" (Barret, 1989). Finally Dey (2002) remarks generally on unsatisfactory aspects of silvicultural seed and vegetative propagation of Sandalwood, noting problems with slowness and

heterozygosity in population. This has lead to the development of biotechnological cloning in bioreactors; Dey, working in Karagpur, India, reporting on the partial successes using the somatic embryongenisis technique, which still suffers drawbacks of producing a proportion of imperfect plants.

Although CALM has allowed 2,000 tons of W Australian Sandalwood to be harvested out of a total estimated national resource of 200,000 tons (CALM 2001), not all voices within the organisation are of one accord. Some producers are claiming that even without a replanting scheme, there is enough sandalwood in the arid regions to carry on exploiting for another 100 years. As Ian Kealley of CALM points out (Kealley 2002), "What is forgotten is that the demand for Sandalwood is likely to escalate as Asian sources continue to diminish and pressure mounts to expand or maintain the harvest, even if it's not sustainable. Therefore such estimates amount to little in a continually expanding market. It will take a strong government to resist the financial incentives. Also, we can't be certain that the new plantations will flourish or expand sufficiently to replace the harvest from the natural stands."

Kealley's views have been dismissed by Aromatherapy trade oil sellers – Kerr (2002) for example saying the remarks are "his personal opinion". This is true – and Kealley is one of the world's leading authorities on *Santalum spicatum* cultivation!

Further, Mulholland (1994) constructed an economic model of the W. Australian sandalwood industry concluding that profit maximisation in an inelastic demand scenario would require the felling of 7340 tons of wood per year. Mulholland further argues the case that in 40 years time sandalwood availability will limit the price to the extent that profitability will cease.

The most important point to remember is that the new plantations of *Santalum spicatum* are sited in the wetter Wheatbelt region, which is at least 1,000 km (620 miles) from where the majority of trees are being uprooted in the parched interior of Western Australia. According to Kealley (2002), sandalwood trees in the arid regions grow extremely slowly. So, for straightforward reasons of economics, they are ***not*** being replanted in the arid regions. Indeed, the state subsidised Australian sandalwood industry is not prepared to wait upwards of 100 years for a return on its considerable investment (see http://agspsrv34.agric.wa.gov.au/progserv/natural/trees/treecrop/SANDALW2.HTM to confirm 100 year maturity information.

Therefore, until the Wheatbelt plantations 'come of age' in about 50 years time, ancient slow-growing trees will continue to be uprooted with absolutely no attempt to replant in the same place. Moreover, no one to our knowledge has even considered the long-term consequences of tampering with this unique and fragile semi-desert ecosystem – all for the frivolous purposes of scent, cosmetics and opportunistic exploitation of the aromatherapy market.

The information supplied above is believed to be accurate, but views, comments, criticisms, corrections or additional material can be forwarded to ***nodice@globalnet.co.uk*** *for consideration in future communiqués in the Cropwatch series.*

Glossary:

BPC: British Phamaceutical Codex
CALM: Dept of Conservation & Land Management
d.b.h. : diameter at breast height.
ISO: International Standards Organisation

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