The Good Oil: Eucalyptus Oil Distilleries in Australia

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The qualities of eucalyptus oil have been recognised since the early years of Australia's European settlement, and an industry based on it grew from the mid-nineteenth century to reach maturity by the turn of the century. Eucalyptus distilling has always been a 'struggle' industry, based on the geographic and social margins of Australian society, subject to environmental, market and labour fluctuations, and ultimately largely supplanted by overseas production, an ironic outcome given the essential Australianness of the product. This article traces that history, and the technology of eucalyptus distilling, focusing on a case study of the Queanbeyan district of New South Wales in the 1950s and the archaeological remains of that era.

EUCALYPTUS OIL: ITS USES AND EXTRACTION

Eucalypts, like many other plants, contain volatile oils, called 'essential oils'. In the eucalypts, essential oils can occur in many parts of the plant, depending on the species, but it is in the leaves that oils are most plentiful. Eucalyptus oil is produced and stored in small glands, the leaves of different species containing from 0.1 up to 7 per cent of the fresh weight of the leaves.[1] The essential oils of the eucalypt are readily volatilised (vaporised), and it is this characteristic that produces the blue haze of the Australian forests in summer, gives crushed eucalyptus leaves their distinctive aromatic odour, and allows easy distillation of the oils by heating the leaves.

The volatile oil of the eucalypt has a number of constituent parts, called odorous terpenes, such as cineole, phellandrene and piperitone, which occur in different proportions depending on the species, and can vary within species depending on sub-species and specific environmental conditions.[2] Table 1 lists the principal eucalypt species that have been utilised for their oil, and the type of oil they contain. Of the more than 600 species of *Eucalyptus* less than 20 appear to have been used for the commercial extraction of oil, either in Australia or overseas.[3]

There are three broad categories of uses for Eucalyptus oil: medicinal, industrial and perfumery/flavouring, the latter being little produced in Australia. Medicinal oils are defined by the British Pharmacopoeia as containing not less than 70% cineole; industrial oils contain principally piperitone and phellandrene as their main constituents; and perfumery and flavouring oils contain high percentages of citronellal (a lemon scent) and geranyl acetate (a rose scent). Raw oils are often treated by distillation and blending (known as 'rectification') to produce an oil with the necessary proportions of desirable constituent parts to meet particular commercial needs. This allows the mixing of oil from different species and different qualities of raw oil, to produce a saleable product.[4]

Medicinal oils are used primarily as a decongestant agent and antiseptic in inhalants, sprays, embrocations, gargles, lozenges, emulsions and ointments and other preparations. Industrial oils are used in the manufacture of disinfectants, deodorants, liquid soaps, germicides and in the manufacture of synthetic menthol and thymol. Earlier in the century, eucalyptus oil was also used extensively in the flotation-separation of base-metal ores. Perfumery and flavouring oils

TABLE 1: Eucalyptus species most commonly exploited for oil

Species	Common name	Principle leaf oil constituent and %	Oil yield as % of fresh weight
Medicinal oils			
E. polybractea	blue mallee	cineole 60-93%, & pinene	0.7-5.0
E. cneorifolia	Kangaroo Island gum, narow-leaved mallee	cineole 40-90%	2.0
E. dives (cineol variant)	broad-leaved peppermint	cineole 60-75%, & phellandrine & piperitone	3.0-6.0
E. elaeophora (E. goniocalyx)	long-leaved box, apple box	cineole 60-80% & pinene	1.5-2.5
E. leucoxylon	yellow gum, white gum	cineole 65-75% & pinene	0.8-2.5
E. radiata subsp. radiata	narrow-leaved peppermint	cineole 65-75% & phellandrine & piperitone	2.5-3.5
E. sideroxylon	mugga, iron bark	cineole 60-75%	0.5-2.5
E. globulus	Tasmania blue gum	cineole 60-85%	0.7-2.4
E. viridis	green mallee, red mallee	cineole 70-80%	1.0-1.5
E. smithii	gully gum	cineole 70-80%	1.0-2.2
E. cinerea	argyle apple	cineole?	av. 1.2
E. morrisii	grey mallee	cineole?	av. 1.6
E. consideniana	yertchuk	cineole & phellandrine	
E. amygdalina (E. phellandra)	black peppermint	cineole & pinene & phellandrine	
Industrial oils			
E. dives (phellandrine variant)	broad-leaved peppermint	phellandrine 60-80%, & piperitone & cineole	1.5-5.0
E. dives (piperitone variant)	broad-leaved peppermint	piperitone 40-56% & phellandrine & cineole	3.0-6.5&
E. radiata	narrow-leaved peppermint	phellandrine 35-40% & piperitone & cineole 20-50%	av. 3.5
E. elata	river peppermint	piperitone 40-50%	av. 2.5
Perfumery and flavouring oils			
E. citriodora	lemon scented gum	citronellal 65-80%	0.5-2.0
E. macarthurii	Camden woolybutt	geranyl acetate 60-70%	0.2-1.0

(Sources: Boland et al 1991: 14; Penfold 1933: 5; Kelly 1983: vol 1.; Small 1985:171; Baker & Smith 1902.)

are used either directly as a scenting agent and food flavouring, or in the synthesis of other scents and flavours.[5]

The extraction of eucalyptus oil from the leaves is very simple. The process described here refers to historical, rather than current, distillation practice. Leaves are gathered by cutting branches from the trees then plucking the leaves from the branches, or by mechanical harvesting of low-growing plantation species such as mallee. The leaf is placed in a sealed container, usually a large tank or vat, and steam is introduced. In the most simple stills the steam is produced by directly heating the tank holding the leaf, which has water in its base which is constantly replenished to prevent it running dry. More sophisticated stills have steam produced in a separate boiler, which is then piped into the leaf tank. As the leaf is heated by the steam, the essential oils volatise and are carried with the steam through pipes placed near the top of the tank. The volatised oil and steam is then condensed, either by passing it through a coil condenser, or 'worm', or by simply running it through a pipe that is resting in cool water. The condensed water and oil is gathered in a container at the end of the condenser, the oil floating to the top. The oil is then ready for packaging, or more usually is sent off for rectification by an oil distributor, before sale.

Throughout much of south-eastern Australia, and particularly in New South Wales, oil production was largely by means of simple field stills (sometimes referred to as 'pot stills' or 'stewpot stills'). These consisted of one or two iron tanks, often simply 400 gallon ship-tanks with their tops cut off and refitted as removable lids.[6] Stronger steel tanks, up to 6 feet cubed, and army-surplus steel pontoons were also common still tanks. The lid usually sat in a channel fabricated around the top of the tank, in which mud or clay was placed to create an air-tight seal when the lid was bolted, clipped or wedged closed. The tanks were usually set on slightly sloping ground and heated by a fire set in a shallow trench below them. The back of the hearth was usually connected by a short tunnel (often made of drums with their ends removed) to a drum chimney, to create a draught. The base of the tank had an iron pipe fitted to it that was connected to a 44-gallon drum which held water. This maintained a constant level of water inside the tank, and was replenished by topping up the drum either by hand, or by connecting it with a water supply system such as a race or a pipe from a dam. The leaf inside the tank was kept above the water level by laying logs in the base, or by inserting a steel mesh floor about 9–12 inches (23–30 cm) above the base of the tank.[7] From the top of the tank another iron pipe to carry off the volatized oil ran downslope and along the bottom of a section of water race or trough, which was kept full of water so as to condense the oil in the pipe. The condenser pipe ran through the wall of a small dam at the end of the race, and the condensed oil and water dripped into a collector drum. Quite elaborate water race systems were sometimes constructed to maintain a constant supply of water to the still tank and to the condensing race. The degree of complexity in the construction of field stills varied, ranging from the simple stills described in this article, to more elaborate plant with tanks sunk into brick pits and substantial furnace arrangements, as recommended for use in South Australia in 1919.[8]

The stills were fired with timber, and distillation times varied from 3–4 hours for *E. radiata* to 14–18 hours for *E. dives*.[9] To operate such a still, an area of forest between 1 000 and 4 000 acres (404–1618 hectares) was required, depending on the species. Trees of the target species were cut down about 50 cm above the ground (though in some areas the branches alone were cut from the tree), and the leaves and terminal branchlets removed by hand axe, cane knife, or a 'eucy' hook (a sickle-shaped knife). Regrowth of the stumps could usually be harvested again after two years.[10] In mallee areas the mallee was often rolled and flattened, then dried and burnt-off, the subsequent regrowth being harvested for distilling.[11]

These simple field stills, which represented 90% of the working stills in NSW in the 1950s, were popular because of their low establishment cost, which made them popular with independent distillers, and their portability, an important factor in mountainous country where it was easier to take the still to leaf supplies than it was to transport leaf long distances to the still.[12] Figure 1 shows the schematic operation of a field still of this type.

More sophisticated stills were used in other areas, especially where flatter terrain allowed the easy importation of leaf from a large surrounding district. These stills had external steam sources, often supplied by Cornish boilers, and ranged from simple in-ground brick pits, as in the mallee country of western New South Wales, Victoria, and eastern South Australia, to more elaborate commercial stills in Victoria.[13] Modern oil producers have gone a step further, and now often use portable trailer-mounted still tanks, into which mechanically harvested leaf is fed directly in the field, and the tanks transported back to the steam source for distillation.[14]

An example of the more elaborate still of the nineteenth century is the Hartland still at Bendigo, Victoria, established in 1890, that has an in-ground brick still tank 12 feet (3.6 m) deep and 8 feet (2.4 m) in diameter.[15] Similar stills existed in New South Wales (where they were less common than in Victoria), with in-ground cylindrical tanks 5-8 feet (1.5–2.4 m) in diameter, and 9–14 feet (2.7–4.2 m) deep, holding 2–5 tons of leaf. One such still, supplied with steam at 40 psi from a Cornish boiler, was at Rosewood, near Tumbarumba.[16]

An advantage of stills with external steam sources was that the steam could be delivered under pressure, which dramatically speeded up the distillation process. For example, distilling *E. dives* by the direct-fire field still method took 14 – 18 hours for 800 lbs (362 kg) of leaf, while a still with steam supplied under pressure would take just 3-4 hours to distil 5000 lbs (2268 kg) of leaf or more.[17]

HISTORY OF EUCALYPTUS OIL DISTILLING

First Fleet assistant surgeon Denis Considen, in 1789, is credited as the first to send a sample (1/4 gallon) of eucalyptus oil to Britain for testing. Considen, together with Surgeon-General John White, took a strong interest in testing the commercial potential of the flora of the new colony. The oil was claimed to be better for 'collicky complaints' than the English peppermint, and the tree was therefore named 'Sydney peppermint' *(E. piperita)*.[18] No industry stemmed from this early discovery, despite the setting up of a still in Hobart by Robert Officer in the 1830s, and the report by the Colonial Botanist Mr Fazer in the *Sydney Gazette* in 1839 that he had extracted oil from *E. globifera* and had treated rheumatism with it.[19]

The eucalyptus oil industry had its effective genesis in the activities of Victorian government botanist, Baron Ferdinand von Mueller, and Melbourne pharmacist, Joseph Bosisto. Von Mueller experimented with eucalyptus oils, and at his urging, Bosisto established a distillery on Dandenong Creek in 1854, to gather the oil of *E. radiata*.[20] Bosisto exhibited his oil at seventeen exhibitions between 1854 and 1891, and spread the word about the potential of the industry, probably stimulating the commencement of oil distilling in New South Wales and Tasmania in the 1880s.[21]

As the local industry gathered strength, the chemical analysis of eucalyptus oil began to be put on a scientific basis, with the properties of the *E. globulus* oil being established by French chemist Cloez in 1870.[22] Even at this time, however, the idea persisted that the eucalyptus was a 'fever tree', and if planted in areas affected by fevers such as malaria, would absorb moisture and produce vapours to counter 'miasmas', held to be a cause of fever. This belief was stimulated in part by the known efficacious affects of eucalyptus oil. Joseph Bosisto himself published articles on this subject, supporting the eucalypt as a fever tree by pointing out how few fevers

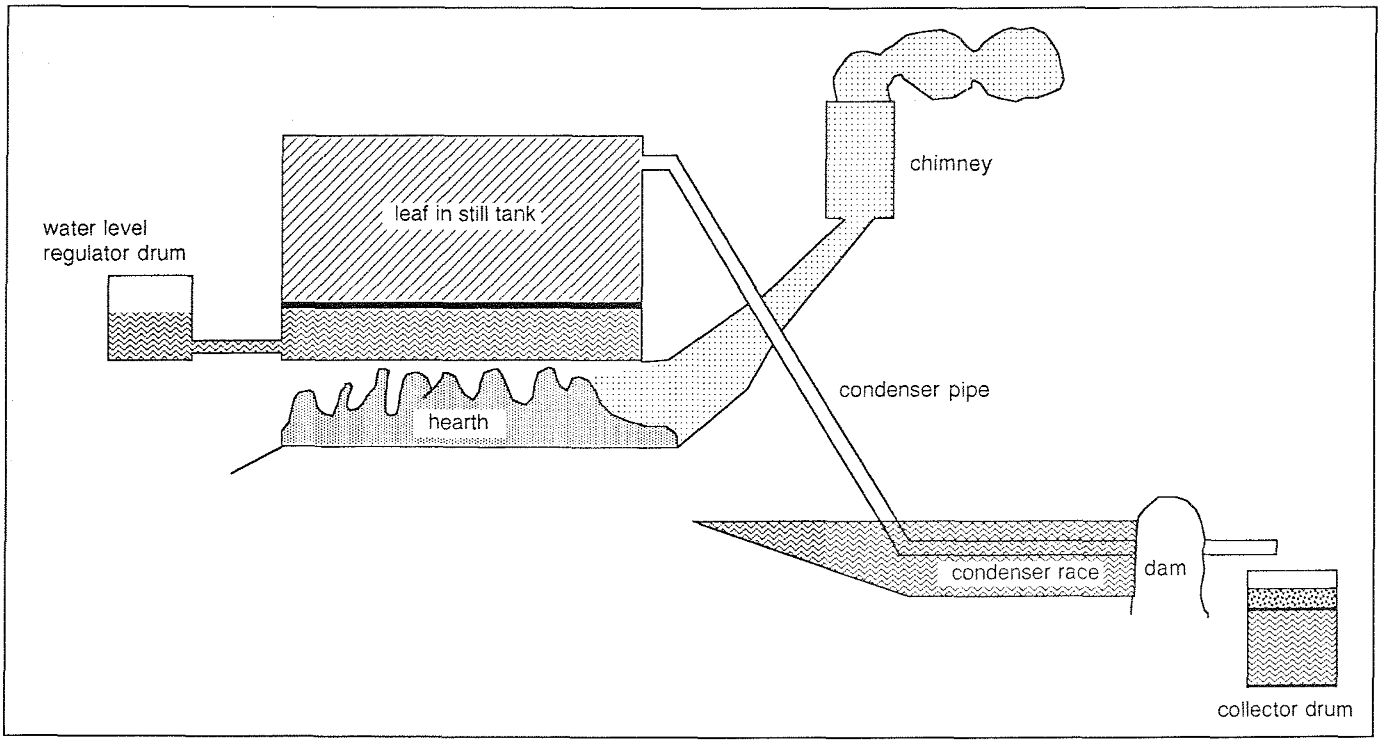

Fig: 1 Schematic cross-section through a simple field still.

existed in Australia![23] Eucalyptus trees had been exported and propagated in California, Italy, France, Algeria, Portugal, Spain, Brazil, Argentina and Hawaii as a malaria-reducing tree from the 1850s, with von Mueller's encouragement. It was not until the late nineteenth century that the true cause of malaria was isolated, by which time eucalypts had become established as an element of the landscape in these countries.[24] Research on the chemical composition of different eucalyptus oils was further progressed by Smith and Baker at Sydney's Technical Museum in the early 1900s, and by Penfold and Morrison in the 1930s.

In the 1880s the first large-scale commercial eucalyptus oil operations commenced in the Mallee-Wimmera area of north-western Victoria. Joseph Bosisto, backed by Melbourne businessmen Alfred Felton and Frederick Grimwade, established the 'Eucalyptus Mallee Company' in 1882, based at the 600 acre Antwerp Station, near the town of Dimboola.[25] By the turn of the century eucalyptus oil was being produced in many places. By 1902 large-scale plants operated at Ockenden's works at Spring Bay, Tasmania (2,000 gallon tank), Bosisto's plant in Victoria, and Faulding's plant at Punyelroo in South Australia (4-5,000 gallon tanks), while smaller field stills were in operation in parts of NSW, Victoria and Kangaroo Island.[26] Bosisto died in 1898, and in 1905 the Felton Grimwade Company bought a leasehold on 40,000 acres at Ki Downs near Euston in NSW, and subdivided the Antwerp property for sale in 1907.[27] The Ki Downs plant had still tanks with a capacity of 4.5 tons of leaf each, but the operation could not compete with independent distillers, and closed in 1908.[28]

Until 1904 eucalyptus oil was used only for pharmaceutical purposes, and only that fraction of oil then called 'eucalyptol' (now called cineole and piperitone) was utilised. In 1904, however, Herbert Lavers of Broken Hill discovered the value of the phellandrene portion of eucalyptus oil in the separation of metallic sulphides in ores, which process he patented in 1909.[29] By 1911 Broken Hill Zinc Corporation was using 600 lbs (272 kg) of oil per day in the separation of 600 tons of ore, most of the oil coming from Kangaroo Island.[30] *E. cneorifolia* was being exploited for oil on Kangaroo Island at this time, with one large still owned by a Mr Burgess able to hold 5,000 lbs of leaf giving 100 lbs of oil per distillation, and 13 smaller plants using field stills operating elsewhere on the island.[31] New South Wales and Victorian distillers shared in the boom. A field still establishment using three field stills, coil condensers and a crane, was set up by George Ashton at Wingello, south of Sydney, in 1912, to produce oil for mineral separation. This still, which has been described in detail elsewhere, utilized oil production methods typical of the period.[32]

The industry continued to boom during the First World War and immediately following, eucalyptus oil being much in demand for medicinal purposes throughout the war and in the world-wide influenza epidemic of 1919. Domestic prices crashed in 1920, however, and production did not boom again until the Second World War. Australia was able to maintain its position in the international market because two companies, Bosistos and H.M. and W.K. Burnside, dominated the bulk production of oil during the 1920s, and Australia retained 90% of the world market, with Spain holding the rest.[33] This situation started to deteriorate during the 1930s as other countries commenced to produce eucalyptus oil from trees initially imported from Australia in the nineteenth century. Australia's export market share began to decline, a situation not helped by the fact that Australia experienced difficulties in guaranteeing consistency of oil quality.

During the Second World War, up until 1943, production increased significantly over the preceding decade, then fell to an annual rate of about half the 1930s average for the rest of the war. This was possibly due to man-power problems, even though eucalyptus distilling was in theory a reserved occupation, at least at the start of the war. Production picked up quickly for a time immediately after the war, 1947 being the industry's record year with 1,000 tonnes of oil produced.[34] Following this Indian summer, however, Australia's market share declined progressively, and by the mid-1970s Australian imports of eucalyptus oil exceeded its exports.[35] By the early 1980s the only areas producing oil were the Southern Tablelands of NSW, the West Wyalong area, and the St Arnaud–Inglewood–Wedderburn area in Victoria. By then Australia's share of the world market was exceeded by China (45%), South Africa (18%), Portugal (17%), Spain (9%), with Australia holding on to only 3% of the world total.[36]

The domestic industry boomed again during the 1950s in

New South Wales, where basic field-still technology remained the mainstay of the industry. The dominance of New South Wales during this period, when it overtook Victoria in oil production, has been attributed to the different expectations of labour in the New South Wales and Victoria, the New South Wales eucalyptus oil workers being more willing to work in primitive circumstances than their Victorian cousins, who had become accustomed to centralised sophisticated stills, and hence working conditions more akin to other areas of industrial operation.[37]

THE INDUSTRY ON THE GROUND

A report written by the District Forester for the Queanbeyan Forestry Sub-District in 1951, described the organisation and economics of the industry in the Queanbeyan district at that date.[38] This report provides a very useful insight into the industry at the local level, and the following description is drawn from it. The species utilized within the district were *E. dives* and *E. radiata* (yielding phellandrene and cineole).

A central factor in the organisation of the local industry were ten oil-purchasing companies, who acted as both facilitators and marketing middle-men for the distillers.[39] These companies held the Forestry Department licenses for oil-producing country, financed individual distillers, and paid the royalties to the government on oil produced on Crown and leasehold lands. Between April and September 1951, for example, 70 licenses were issued in the district for eucalyptus leaf gathering operations. Of these only 22 were issued to individual distillers, the rest going to five oil-purchasing companies, one of which held 28 licenses. The independent distillers would have sold their oil to the same companies. The licenses attracted substantial guarantee deposits, which were paid by the companies. Royalties paid for production of oil under the licenses was based on monthly returns by the companies purchasing the oil, showing amounts of oil purchased from distillers operating on the licensed land. The royalties were based on still-site prices paid for oil, which ranged from 4 shillings per pound (royalty 3 pence per pound), to 5 shillings and 11 pence per pound (royalty 5 pence per pound). That the system was open to blatant abuse by the companies supplying the returns was recognised by the District Forester, one means of avoiding royalties being to claim oil gathered on crown land as coming from private land, where royalties were not demanded.

The oil-purchasing companies also controlled the still-site prices paid to distillers. In the 10 years preceding 1951, prices ranged from 7 pence to 7 shillings per pound of oil, and production fluctuated accordingly. Some protection from monopolistic practices was provided, in that individual distillers were not bound to sell to the company licensing the land or owning the still, and there was considerable competition at the still-site for oil purchases. As competition forced up still-site prices, production and employment in the industry increased, until still-site prices exceeded the price obtainable in the market place, and prices dropped and the industry contracted again. The industry had expanded greatly in the late 1940s due to the high prices for *E. dives* oil, and between 800 and 1,000 men had been employed locally in the industry. In late 1951 approximately 130 plants were operating in the district, employing 500 men, and it was feared that if demand again increased the spread of distilleries might exceed the supply of bush available for production.

The oil-purchasing companies, in most cases, financed the setting-up of a new still, which in 1951 cost about £150. The Customs Department required a guarantee of £100 for each still up to 1951, but reduced that figure subsequently. The individual distiller was then charged for the use of the still, dependent on the current demand for oil. In periods of high demand the companies did not charge for the use of the stills. The life of a still was estimated at 2–5 years depending on the degree of use and maintenance it received, while still tanks (mainly ship tanks or slightly larger) usually only lasted 2 years. The oil-purchasing companies sometimes also financed the purchase of a truck by the distiller, though most distillers still relied on horse and cart.

The District Forester pointed out the general inefficiency of the oil industry in the district, depending as it did on crude distillation processes. He estimated that loss of oil due to bad distillation methods amounted to as much as 33% of total production, pointing out that the output of a 1,000 gallon tank could vary between 10 and 15 gallons per boil using identical leaf. Another result of poor methods was the low grade of oil recovered, due to incomplete distillation of some fractions of the oil. For example, an accepted percentage range for piperitone production was 40-50% of total oil from *E. dives*, whereas the majority of local distillers fell as low as 30% piperitone. A similar situation occurred with cineole distillation. This inconsistency in oil quality increased the cost of rectification in secondary distilling plants, and affected the demand for the local product. The problem of low grade oil was not helped by the alleged practice of adding a gallon of kerosene to each nine gallons of eucalyptus oil as a filler.

It was estimated that the local production could be doubled if the inefficient crude stills were improved. Apart from the poor distillation practices, other problems included generally poor water supplies, which were seasonal, heavy demands on man-power and time in cutting, transporting, loading and unloading stills, cutting fuel and supervising long distillation periods. Many of the local stills did not even have a crude crane pole to assist in the loading and unloading of the leaf. Several plants of the 'improved type' had recently appeared in the district, costing between £300 and £1,000 to set up, but unfortunately these are not described in detail.

Many of the distillers were post-war migrants from central Europe, who found the independence of the industry attractive. A still in the Snowy Mountains, set up at that time by locals and manned by German and Yugoslav migrants has been recently described.[40] The majority of Australians involved in the industry were said to be seasonal workers, who in some instances owned areas of land and combined wool growing with oil production.[41] The lifestyle and working conditions of the 'eucy' workers has been described by a number of authors, of whom Des Shiel stands out.[42]

This description of the eucalyptus industry in the Queanbeyan district in the 1950s provides the context for the discussion of the still-sites described in the next section, which are within the Queanbeyan district and appear to date to this period.

THE ARCHAEOLOGY OF EUCALYPTUS DISTILLING

The eucalyptus distilleries described here are simple field stills, of the type that has been common across the nation since the last century, and were the mainstay of the New South Wales eucalyptus oil industry. The stills are located in or around the Tinderry Nature Reserve, near the town of Michalego, south of Canberra, and were recorded by the author in 1982. They are within the Queanbeyan Forestry Sub-District described in the last section, and probably date from the 1950s and later decades. Precise locational information is not provided here, because of access and management problems this could cause. The stills are described because they are typical and there are likely to be many other examples in other parts of south-eastern Australia.

The stills are of the field still type described at the start of the article, and the typical arrangement is that the still tanks are located within about 10 metres of a seasonally flowing creek. Upstream is a dam or stream diversion, directing water into one or more races, which provide water for the replenishment of the still tank during boiling, and for the trench in which the condenser pipe lies. The site of a bush hut is located near each still site, with clay ovens being a common feature, some attached to what appear to be tent sites. Domestic items such as bottles, tins, billys, kerosene refrigerators, iron bedstead parts, and assorted ceramic, glass and metal fragments, are scattered around the living areas.

Still No. 1 has a steel still tank 215 x 155 square x 146 cm deep (7 x 5 ft x 4 ft 8 in) built into the steeply sloping bank of the creek, the tank being supported on two stone walls which provide a 40 cm high fire hearth beneath the full base of the tank. A steel lid rests beside the tank and what is probably a collapsed crane used to load and unload the leaf, and several beams used to fasten the lid, lie nearby (Figs. 2 and 3). Behind the still and one metre away is a short chimney made from a 44 gallon drum, which is connected by a short tunnel to the rear of the hearth beneath the still.

Seven metres to the north of the still tank is a drum connected to the base of the tank by a 2 inch (5 cm) iron pipe. This provided the water level regulation within the tank, and appears to have itself been filled by hand. From the top of the tank a 2 inch iron condenser pipe, now with missing section, leads steeply down to creek level, where it runs north in the base of a water race for about 40 metres, to where the pipe stops at creek level. The oil collection system has been dismantled and its operation is not clear. The condenser race originates at a washed-out dam site 200 metres south of the still.

The remains of a collapsed hut, 5 x 4 metres, is located 15 metres east of the still. An Electrolux refrigerator and assorted domestic items lie in the hut site, and the engine and chassis of a 1930s vintage Buick truck is a short distance away. About 10 metres to the south are two 1.5 metre square camp ovens, which may have been originally built on the side of tent-huts.

There is no definitive evidence to suggest a date for this site, though the remains are consistent with a 1940s-50s operation. A severe bushfire burnt out the area in 1957, and is said locally to have put an end to many of the local distilleries, by destroying leaf supplies which would take two years to recover.

Still No. 2 has a cylindrical tank of riveted steel plate, 211 cm in diameter and 120 cm deep (7 ft diam x 4 ft deep). The tank is built into the creek bank, and is supported by two parallel stone walls giving a 40 cm hearth beneath the tank. A flue extends from the rear of the hearth, and surfaces through a 44 gallon drum chimney 2 metres behind the tank (see Figs. 4 and 5). A trench extends a further 5 metres west from the chimney, and is possibly an earlier extension of the flue or the collapsed trench of another still tank. The tank is full of leaf, not having been discharged after its final distillation, and the channel around the top of the tank is still full of clay, used to make the seal with the lid. The lid rests against the edge of the tank, and would have been held tight by the four steel stirrups welded onto the tank's side, into which timber beams would have been wedged across the top of the lid. The beams lay beside the tank, as does a 'Y' shaped pole, possible part of a crane used to load the tank.

The water-level regulating drum is located 2 metres west of the tank, to which it is connected by a 2 inch pipe. In this case the regulator drum appears to have been automatically filled by a pipe running from a water race and cistern 7 metres west and slightly above the level of the drum. However, the feed pipe, if such existed, has been removed.

A 2 inch pipe runs from the top of the still tank down-slope 5 metres to a water race, along which the condenser pipe is laid. The condenser pipe runs through three dams which subdivide the race and maintain a sufficient water level in each division. Beyond the third dam the condenser pipe empties into a half-44 gallon drum, about 26 metres from the still. The two water races originate at a dam on the creek about 100 metres south-west of the still.

The remains of a 4 x 5 metre hut lie 15 metres south of the

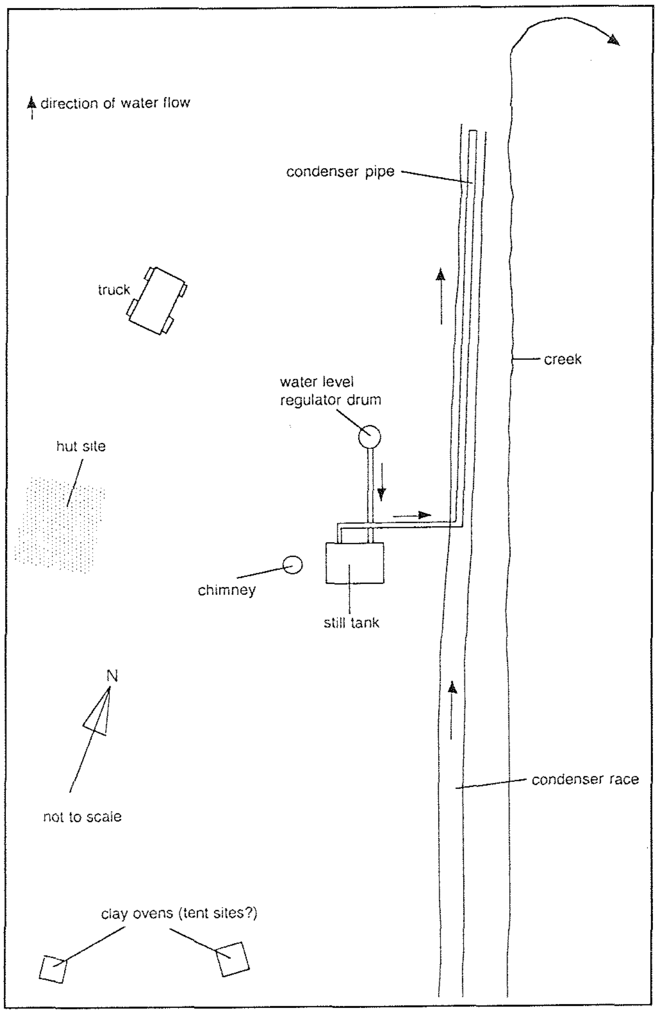

Fig. 2: Still No.1, a simple arangement with single still and hand-filled water level regulator drum.

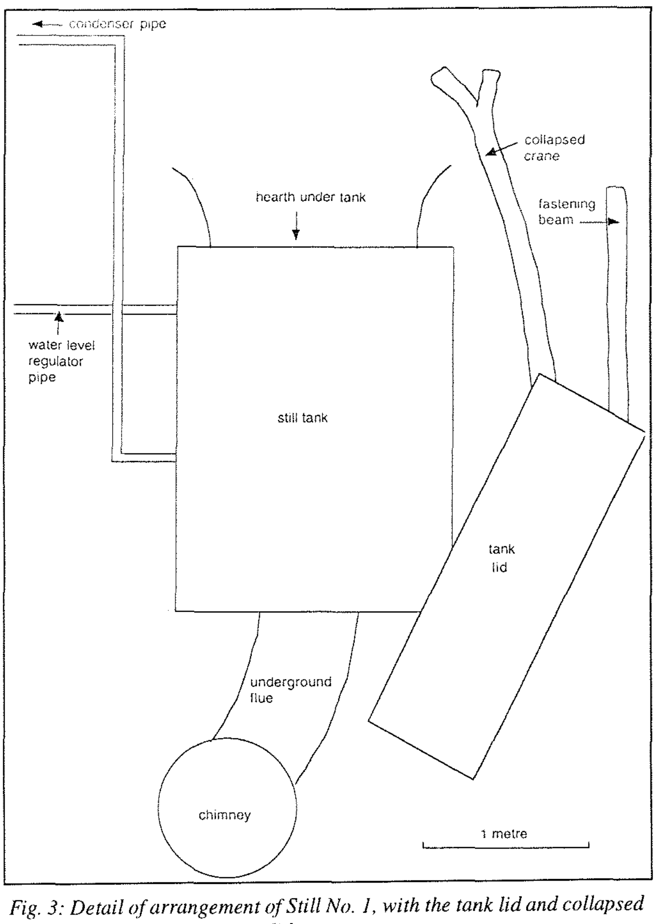

Fig. 3: Detail of arrangement of Still No. 1, with the tank lid and collapsed crane and beam for fastening lid.

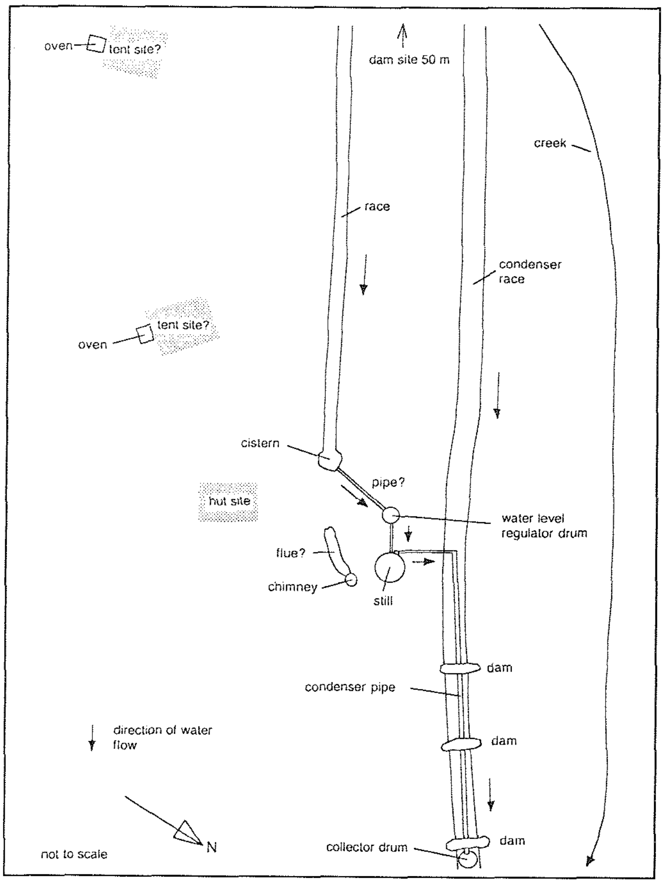

Fig. 4 Still No. 2, with self-filling water level regulator drum, and more complex condenser race system.

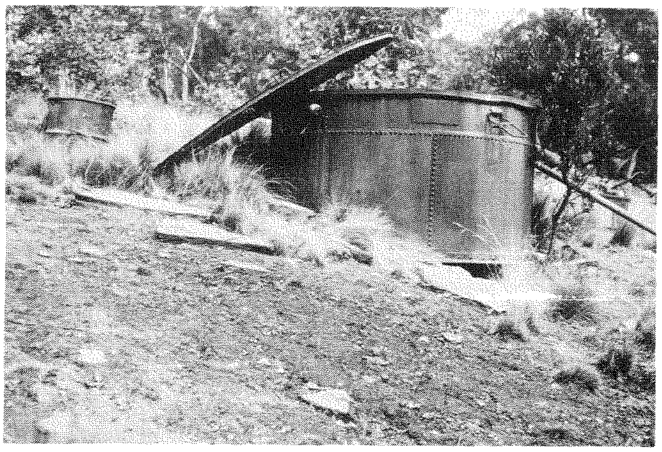

Fig.5: Still No.2, showing lid resting on the tank, the chimney to the left, and the hearth and condenser piupe to the right.

still, and at least two tent-hut sites are benched into a slight slope nearby, with clay camp ovens adjacent to each site. A chicken coop or other animal enclosure is also nearby. Bottles at the site date to the 1940s and 50s, suggesting the operating period of the still.

Still No. 3 is on private land adjacent to the Tinderry Nature Reserve. This site has two still tanks which operated in unison (see Figs. 6 to 9), though only one tank still remains *in situ*, the other being used by the landowner as a feed bin. The remaining tank is steel and is 246 x 125 x 123 cm deep (8 x 4 x 4 ft or 800 gallon capacity). It is built into the sloping bank of the creek, supported by two walls of stone and brick, providing a hearth 40 cm deep which was connected by a flue to a 10 gallon drum chimney 2 metres to the rear of the still.

The sealing channel around the top of the surviving tank is still full of clay, and the lid is still sealed in position, held down with three parallel timber beams wedged into steel stirrups welded at each side of the tank. There is no evidence of a crane being used at this site, so the leaf and lid would have had to have been handled manually. The water-level regulating drum is located 5 metres from the tank, connected to it by a 2 inch pipe which is buried for half its length. The regulator drum is fed by a pipe running from a race-fed cistern 4 metres away. This same cistern feeds an underground pipe which supplies water to the condenser race.

The condenser pipe has a double connection to the top of one side of the tank, and runs north 9 metres to the condenser race (or more accurately, trough), through which it runs for 29 metres before passing through a small dam wall at the end of the trough, and emptying into a half-44 gallon drum.

The second still, now devoid of its tank, was 3 metres from the first, and sat over a hearth cutting 3 x 2 metres and 1 metres deep, with a flue to a 44 gallon drum chimney behind. The water regulator drum is located 6 metres to the north, and appears to have been filled by hand. The condenser pipe for the second still survives, and joins onto the condenser pipe from the first still. With this arrangement, the two stills could have been used independently or in tandem, depending on the supply of leaf and the demand for oil at a given time.

North-east of the still site a wooden bridge crosses the creek, and a rough track leads to a standing hut about 30 metres away. The hut has a bush-timber frame clad in corrugated galvanised iron. A broken cane-knife, of the kind used to harvest leaf, was found lodged in a tree nearby.

The still site is said locally to have been used since the 1920s as a eucalyptus distillery (though the tanks and fittings would not be original), and the current plant was last used in 1980 for a short period.

Even on sites where the still tanks have been removed, there survives a distinctive archaeological signature. The hearth trenches and water races are persistent features in the landscape: 2 inch galvanised iron pipe was used in large quantities and is often left behind: cutting of eucalyptus leaf often resulted in distinctly coppiced trees, branching lower

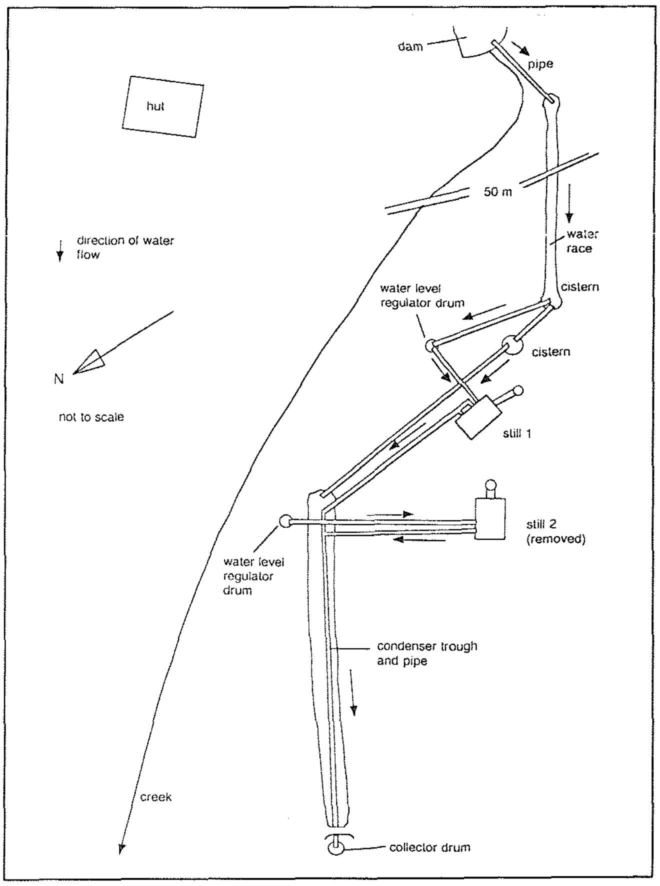

Fig. 6: Still no. 3, with two still tanks, and more complex water race system feeding one of the water level regulator drum and a condenser trough.

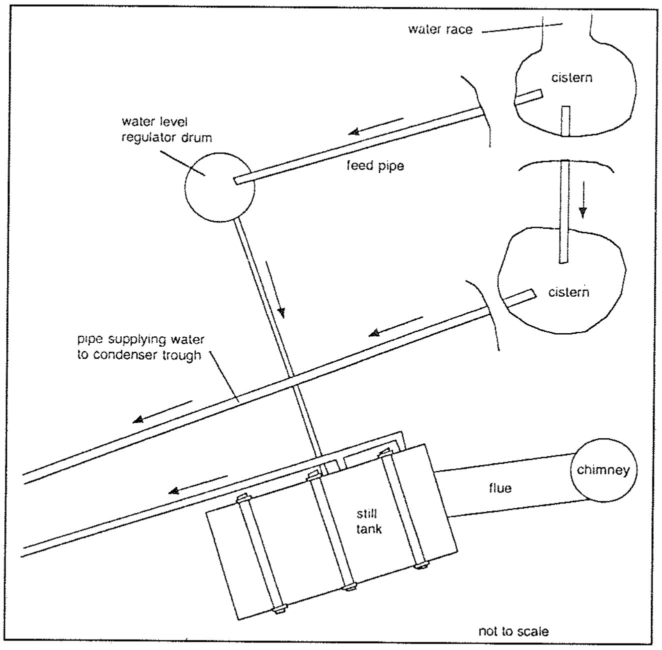

Fig. 7: Detail of the arrangement of one of the still tanks at Still No. 3. The tank is still fitted, with beams secured by stirrups.

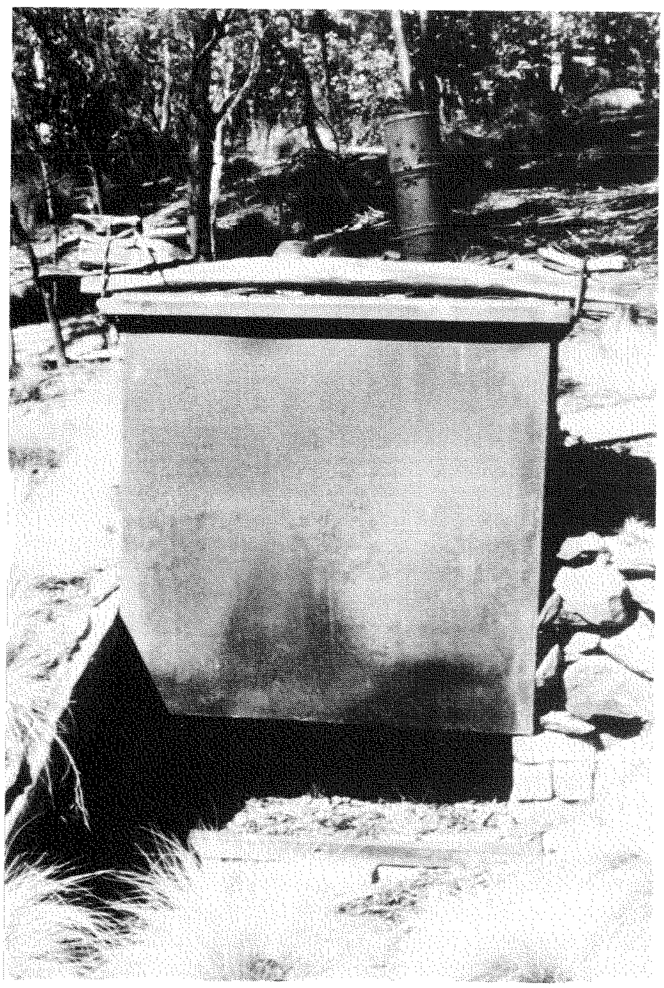

Fig. 8: The surviving tank at Still No. 3, showing the method of securing the lid by means of beams held down by stirrups at the side of the tank. The shallow hearth beneath the still and the drum-chimney at the rear can be seen.

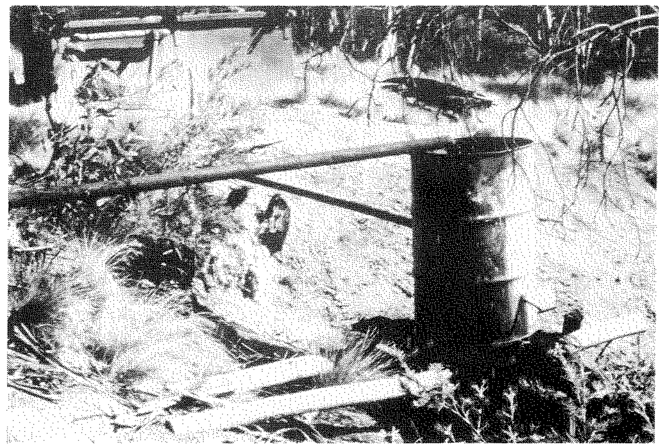

Fig. 9: The water level regulator drum at Still No. 3. The pipe bringing water from a race empties into the drum from above, and the pipe connected to the still exists from the base of the drum. The still tank is seen at the rear, with the condenser pipes showing.

than free-grown trees of the same species: and the living areas are usually able to be identified by the scatter of fragmented domestic artefacts, often little disturbed because of their isolated locations, their absence from maps, and the low density and relative poverty of the material making the sites unattractive to bottle hunters and metal detectors.

DISCUSSION

Eucalyptus distilling is seen today as a somewhat exotic and romantic activity, having shared in the general veneration shown to traditional bush pursuits over the last decade. It has, however, not always been a well regarded industry, as is suggested not least by the absence of a Banjo Paterson or Henry Lawson having immortalised it at an earlier time. Eucalyptus oil workers occupied a lower status than their brothers in other industries, even in other 'bush' industries such as saw-milling. The industry received little of no government assistance, other than the research and publicity provided by the Technological Museum in Sydney early in the century and its recognition by the man-power regulating authorities during WWII, and it was subject (at least in theory) to reasonably hefty government fees and royalties. On the other hand, despite the often arduous nature of the work, it was an attractive option for men seeking independent and flexible employment not requiring particular skills or experience. Both the historical and archaeological contexts of this marginal industry deserve further research.

The eucalyptus oil industry has probably had a more widespread impact on the environment than has been recognised. As shown by the Queanbeyan example, the forested areas of south-eastern Australia were extensively exploited for oil, and the practices of the distillers had a dramatic impact on the nature of the forests. Targeted species were coppiced (cut down low on the trunk and encouraged to bush-out), 'over-mature' trees were ring-barked to provide space for younger saplings, and the practice of ring-barking non-oil-producing species to allow increase in oil-producing species may have been widespread. The long-term ecological impact of this intervention has not, to the author's knowledge been thoroughly researched, and indeed seems to have been totally overlooked in, for example, the attribution of 'biophysical naturalness' to areas of forest as part of the process of identifying wilderness quality.[43]

There seems to be great scope for including the impacts of the eucalyptus oil industry in future ecological history research in Australia. The information provided in this article may help in the identification of eucalyptus distilleries as an important element of Australia's forest environment.

NOTES

1. Boland *et al* 1991:11.
2. Boland *et al* 1991:11.
3. Small 1981:171.
4. Boland et al 1991:11-15.
5. Small 1981:171; Penfold and Willis 1961:245-8; Silman 1938:39-42.
6. see Penfold 1932 for a detailed description.
7. Penfold 1932:20-21 claimed raising the grate to 12-18 inches reduced distillation time.
8. Journal of Agriculture of South Australia, July 1919:1033-4.
9. for descriptions, see Penfold and Morrison 1952; Penfold and Willis 1954; and Baker and Smith 1902.
10. Penfold and Willis 1954:320-21.
11. *Chemical Trades Journal and Chemical Engineer,* 1927:553-4.
12. Penfold and Morrison 1952:15.
13. Boland *et al* 1991:187; Penfold and Morrison 1952:15; see Shiel 1985 for some good illustrations of the different types of still.
14. Boland *et al* 1991:193; Small 1981:172.
15. Birmingham 1976:3-4.
16. Penfold and Willis 1954:322-4.
17. Penfold and Morrison 1952:14, 18.
18. Penfold and Willis 1961:245; Boland *et al* 1991:3.
19. Shiel 1985:9; Jervis 1949.
20. Boland *et al* 1991:3; Penfold and Willis 1961:245-6 gives the date as 1852.
21. Shiel 1985; Boland *et al* 1991:3.
22. *Chemical Trades Journal and Chemical Engineer,* 1927:553-4.
23. Bosisto 1876.
24. Thompson 1970; Bolton 1981:41.
25. Boland et al 1991: 4; Poynter 1967:16-17.
26. Baker and Smith 1902:257.
27. Poynter 1967: 18,108.
28. Eastburn 1984:2, 6.
29. Baker and Smith 1911:451-4; Woodward 1952:87.
30. Smith 1911.
31. Smith 1911:20-22.
32. Ashton 1973; Baker and Smith 1902:256-7.
33. Shiel 1985:xx.
34. Small 1981:172; Poynter 1967:237; Shiel 1985:169.
35. Small 1981:174; Boland *et al* 1991:4.
36. Small 1981:174.
37. Shiel 1985:25.
38. Crumpton 1951.
39. the oil-purchasing companies were:
    A. J. Bedwell Pty Ltd, agencies at Braidwood and Adaminaby.
    Sheldon Harris Oil Industries, agencies at Braidwood, Jerangle, Cooma and Yass.
    W. K. Burnside Pty Ltd, agencies at Braidwood, Captains Flat and Nerriga.
    Cox Findlayson & Co Ltd, agencies at Braidwood and Cooma.
    Affiliated Eucalyptus Oil industries, agencies at Cooma and Captains flat.
    Nightinggale Supply Co Ltd, agencies at Braidwood and Nerriga.
    Bon Manufacturing Pty Ltd, agencies at Braidwood and Nerriga.
    Blok Van Rooyen Pty Ltd, agencies at Braidwood and Captains Flat.
    M. Nomchong & Co, a Braidwood firm selling to Reckitt & Colman.
    H. Hatrick Pty Ltd, Pioneer Soap Company.
40. Hill 1994.
41. Crumpton 1951.
42. Shiel 1985.
43. see discussion in Robertson *et al* 1992:20-21.

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