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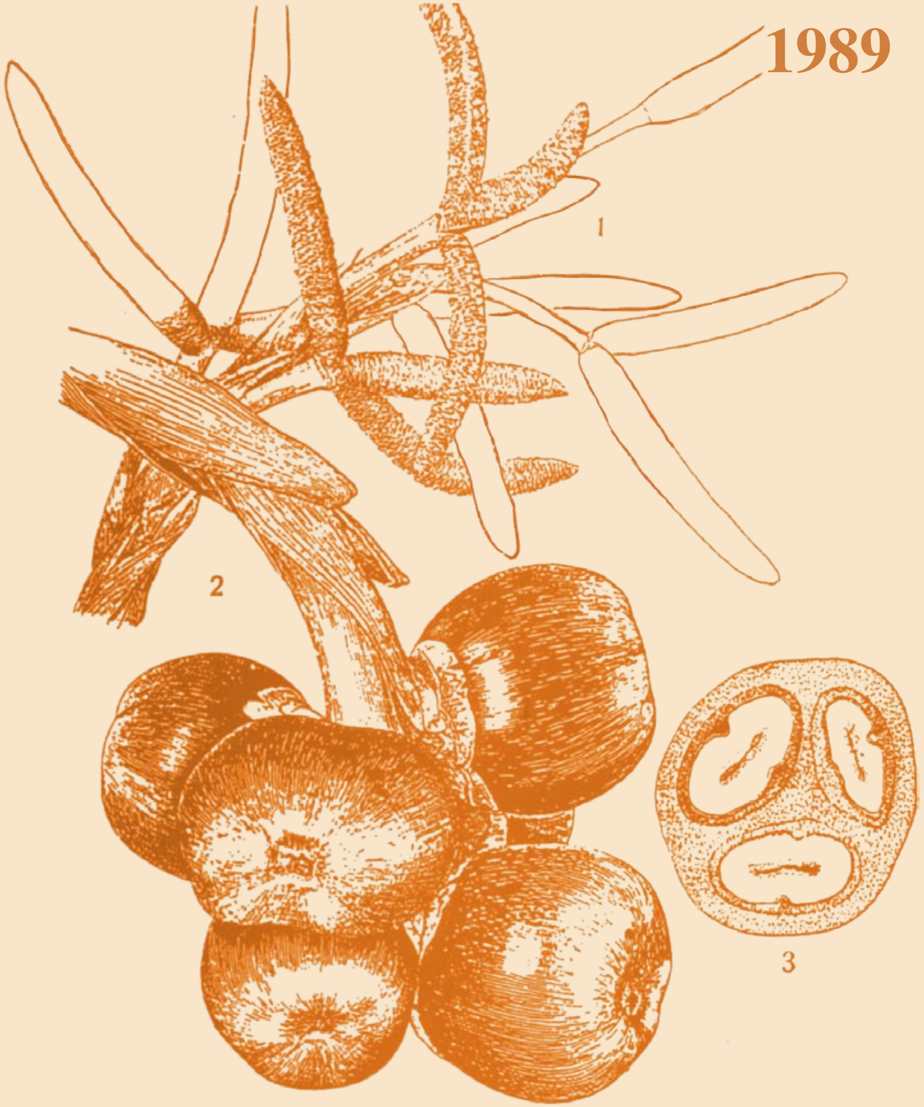

The Palmyra Palm, Borassus flabellifera

West Australian Nut and Tree Crop Association (Inc)

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Publications

The Association publishes a quarterly magazine *Quandong* and the *WANATCA Yearbook*. Beginning in 1990, a third publication, the *WANATCA Sourcebook*, will be produced. Members receive all publications of the Association as part of their subscription.

Membership

For current details of membership contact the Secretary, WANATCA, P0 Box 565, Subiaco, WA 6008, Australia. Members are welcomed from within and beyond Western Australia, indeed about one third of the current membership is from outside Western Australia. Overseas members are encouraged, and pay only standard fees.

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ANNOUNCING

THE WANATCA SOURCEBOOK

Beginning in 1990, West Australian Nut and Tree Crop Association members will receive as part of their subscription, issues of the new WANATCA SOURCEB00K.

The Sourcebook will contain a number of Sections. One Section will replace the **Membership Lists** previously published in the Yearbook. Another Section will contain an improved and updated version of the **Useful Organizations** list.

A third Section will be a greatly enlarged **Commercial Sources** list, expanded and cross-referenced to the status of a complete **Directory of Tree Crop Services**. This Commercial Section will also carry advertising.

In addition, the editions of the Sourcebook will contain a progressively increasing number of other Sections, each presented as a **table of information** on some aspect of nuts, fruits, and other tree crops.

Each of the Sections will be backed by a computer database, which will be updated regularly and used to produce subsequent editions of the Sourcebook.

SYZYGIUM AS A SOURCE OF EDIBLE FRUITS

PETER G. WILSON
Royal Botanic Gardens
Sydney NSW 2000

INTRODUCTION

The genus *Syzygium* is one of the 3 largest genera in the family Myrtaceae, with over 500 species; its distribution ranges from India to Australia with a few species occurring in Africa and the Pacific. According to the most recent treatment (Hyland, 1983) there are 52 species in Australia, 43 endemic and 9 indigenous.

There has long been confusion about the distinction between *Syzygium* and *Eugenia* and nearly all the early literature refers to *Syzygium* species as Eugenias. The two genera have been shown to be quite unrelated, despite the superficial similarities, and can be relatively easily distinguished as follows:

Syzygium: inflorescence much branched, usually terminal (sometimes from the trunk or older stems); seed with free cotyledons.

Eugenia: inflorescence of one or a few flowers in a short raceme, axillary; seed with partly fused cotyledons.

Only one species of *Eugenia, E. reinwardtiana* (previously known as *E. carissoides*), occurs in Australia; it is a wide-spread Pacific species and is said to have a sweet, edible fruit. The genus Eugenia has very many species in South America plus a few in southern Africa; the best-known species in cultivation are *E. uniflora* and *E. brasiliensis*.

In Australia there are three other genera, many of whose species have been included in *Syzygium* or *Eugenia* in the past. These are *Waterhousea, Acmenosperma* and *Acmena,* all of which are closely related to *Syzygium*. There are records of Aborigines eating *Acmena smiihii* ("Lilly Pilly") fruits, but they are not very palatable.

All Australian species of *Syzygium* have fleshy fruits and most of them are edible. However, not all are palatable and none have had much commercial appeal until recently, when there has been an upsurge of interest in bush foods. The lack of palatability can be the result of a number of different causes: an overly strong, aromatic flavour from the oil in the glands in the outer layers of the fruit, a bitter, acidic taste, or a dryish, pithy texture to the flesh. It should be remembered, in this context, that many species grow near streams and have their primary means of dispersal by water rather than through the agency of animals which eat their fruit. Also, the seed-coat of *Syzygium* species is papery (rather than hard and bony as in some other Myrtaceae, like *Psidium*) and not particularly resistant to digestion by animals.

EDIBLE SPECIES

About 25 of the Australian species are recorded as being edible; there are probably more that are edible but many are not very well known. This list is derived from published sources (see references) with some additional notes from personal experience. The palatability of many of these is questionable, but there are certainly some with commercial potential.

NATIVE AUSTRALIAN SPECIES

S. alliiligneum "Onionwood"
Tall tree to 30 m. Flowers white, in dense terminal or axillary clusters. Fruits red, globular to cylindrical, up to 5 cm wide; flesh firm and fleshy. Flowering February-March, fruiting July-October.

This is a rainforest tree of northern Queensland with a range extending north from Innisfail. Nothing is recorded of the flavour of this species but it is known that the fruit are a favoured food of the Cassowary.

S. amplum
Tree to 15 m. Flowers white, in panicles borne on the stems below the leaves. Fruits probably red but not seen ripe. Flowering and fruiting times uncertain.

A poorly known species of low altitude rainforest in New Guinea and Saibai Island in Torres Strait. Reports of edibility presumably come from native informants.

S. aqueum "Water Apple"
Tree 3-10 m. Flowers white, in dense terminal or axillary clusters. Fruits red, rarely white, 2.5-3.5 cm broad, 1.5-2 cm long; flesh crisp, with a spongy texture and a faintly flavoured, watery taste. Flowering and fruiting times uncertain.

This species is well known from South-East Asia and has only recently been found occurring naturally in Cape York where it grows close to sea level. Hyland reports that the fruit from these plants (which he saw in October) are edible but very acidic and oily, unlike the widely cultivated forms in Asia which have the advantage of usually being seedless. These cultivate forms have also been grown in Australia; I have seen a specimen from as far south as Murwillumbah in northern N.S.W. (latitude ± 28° 20' South) where it was fruiting in March. Plants in Indonesia are reported to flower twice a year but I do not know whether this is the case for plants cultivated in Australia.

The fruit of this species is grown for local consumption and for market sale in Asia, where it is eaten plain as a refresher or with chili. The fruit is also being grown commercially in North Queensland and is currently (November-December) being sold in Sydney by more exclusive retailers as 'Water Cherry'.

S. australe "Brush Cherry"
Tree, usually to 10 m tall. Flowers white, in small terminal and axillary clusters. Fruits pink to purplish-red, globular to pear-shaped, 1.5-2.5 cm long; flesh crisp and spongy, slightly acidic with a faint but fragrant flavour. Flowering Spring-Summer, fruiting Summer-Autumn.

This species was wrongly known as *S. paniculatum* for many years. It is wide-spread with a range extending from Mossman in northern Queensland to Milton (latitude c. 35° 15' South) in southern New South Wales. It is found in damp places, particularly in stream-side rain-forest. The species fruits prolifically but has never been exploited commercially.

[From: Jones (1986)]

S. branderhorstii
Tree, usually to 10 m tall. Flowers white (rarely red), in much-branched panicles borne on the trunk and large branches. Fruit varying in colour from white to red to black, ovoid to ellipsoid, 3-5 cm long; flesh succulent. Flowering September-November, fruiting December-March (Australia).

This species grows in rainforests in coastal areas at the top of Cape York Peninsula, in the Torres Strait Islands and much of New Guinea. The fruit is eaten by native Melanesians in these areas and there is evidence that they have cultivated the species for this purpose.

S. bungadinnia
Tree 10-25 m tall with reddish papery bark. Flowers white, in clusters at the ends of the main, or side, shoots. Fruits cream, flattened-globular, to 7 cm broad, with a single, large seed; flesh firm. Flowering July-August, fruiting October-December.

This species is an Australian endemic, occurring in northern Cape York and the Torres Strait Islands. The fruit is reported to have been an important food source for Aborigines.

S. cormiflorum
Tree to 30 m. Flowers white, in clusters on the trunk or larger branches. Fruits white (occasionally pink to reddish), globular to ovoid, 3-6 cm across; flesh pithy with a pear-like odour. Flowering late Winter to Spring, fruiting Spring-Summer.

A rainforest species extending from Townsville into the southern half of Cape York. Cribb & Cribb describe the flavour of the fruit as very mild and Jones reports that the seeds of this species are often eaten by insect larvae.

S. corynanthum "Sour Cherry"
Tree 15-30 m tall. Flowers cream, in short terminal and axillary clusters. Fruits pink or red, pear-shaped, up to 2 cm across; flesh crisp and juicy with a sour taste. Flowering April-July, fruiting Spring (New South Wales).

A rainforest species with its range extending from Comboyne in New South Wales (latitude c. 31°30° South) to northern Queensland. The species produces a high proportion of fruits that have no seeds, but the fruit is acidic and has mainly been used for making jams and jellies, although Cribb & Cribb describe it as pleasant to eat.

S. crebrinerve
Tree 15-25 m. tall. Flowers white, in terminal and axillary panicles. Fruits pink to magenta, flattened-globular, 1.5-2.5 cm across; flesh succulent. Flowering November-December, fruiting January-April.

A rainforest tree occurring from the Comboyne Plateau in New South Wales to Mount Glorious, just north of Brisbane. The fruit is edible and has been used in the past to make thick conserve or pie filling. The species produces good crops of fruit, some of which are naturally seedless, according to Jones, but others have lost their seeds through predation by insect larvae.

S. erythrocalyx
Tree 8-17 m tall. Flowers pink to yellowish, in small clusters that are terminal or axillary or are borne on the trunk or branches. Fruits white or red, globular or flattened-globular, 5-7 cm across; flesh succulent, reasonably palatable. Flowering July-August, fruiting November-December.

A rainforest tree from northern Queensland, between Innisfail and the Bloomfield River.

S. eucalyptoides
Tree 10-18 m tall. Flowers white, in terminal clusters. Fruits white to pink or red, globular, 3-4 cm across; flesh succulent. Flowering August-November, fruiting September-February.

Two subspecies are recognised, both of which have edible fruits. The first, subsp. eucalyptoides, occurs along watercourses across northern Australia; the other, subsp. bleeseri, occurs in open forest in Arnhem Land and the Kimberley.

S. fibrosum
Tree to 15 m. Flowers dull orange or brownish, in terminal and axillary clusters. Fruits pink to red, globular or flattened- globular, c. 2 cm across; flesh succulent but slightly fibrous. Flowering April-October, fruiting July-December.
A rainforest tree occurring in the Cape York Peninsula north of the Daintree River and in southern New Guinea, with outliers on Melville and Elcho Islands off the coast of the Northern Territory. Hyland states that the fruit have been used to make jam or tarts, but not in commercial quantities.

S. forte "White Apple" (syn. *S. rubiginosum*)
Tree 25-30 m tall with papery bark. Flowers in dense panicles, terminal on the branchlets. Fruits white, flattened-globular, 3- 4 cm across; flesh succulent, somewhat granular around the seed. Flowering September-December, fruiting November-February.

Two subspecies are recognised, both of which have edible fruits. The first, subsp. *forte*, usually occurs in rainforest in Cape York and on Melville Island, as well as in Papua; the other, subsp. *potamophilum*, occurs in gallery forests in northern Australia (Cape York to the Kimberley). Hyland records the adaptation of the latter subspecies to water dispersal.

S. kuranda
Tree 15-30 m tall. Flowers white, in panicles borne on the larger branches or, rarely, on the trunk. Fruits cream to brownish, globular, to 4.5 cm across; flesh firm and granular. Flowering and fruiting for much of the year.

A rainforest species occurring between Cardwell and Cooktown. Hyland states that the fruit is not particularly palatable.

S. luehmannii "Riberry"
Tree 15-35 m tall. Flowers small, white, in dense terminal and axillary clusters. Fruit dull pink or red, pear-shaped, c. 1 cm long; flesh firm to succulent, aromatic. Flowering Spring-Summer, fruiting late Spring to early Autumn.

A rainforest species with a wide geographic range, extending from Cooktown to Kempsey on the New South Wales north coast. It grows well, although not as tall, at least as far south as Sydney (latitude ±340 South).

This species is already being grown commercially to supply restaurants, where it is used, for example, in ice cream and chutney, and as a sauce or mousse. Trees that bear seedless fruits are being grown in plantation (mixed with other native species) near Murwillumbah in northern New South Wales for the Bush Tucker Supply Pty Ltd. As well as being seedless, these fruits have a flesh that is able to be frozen without undesirable effects on the texture. There has been wider commercial interest shown in the fruit and the species seems to have very great economic potential.

S. malaccense "Malay Apple"
Tree to 25 m. Flowers white to dark red, in dense clusters on the older stems. Fruits pink to red, becoming dark cherry coloured at full maturity, ellipsoidal to globose, to 3 cm long; flesh succulent and juicy with a pleasant, sweetish taste. Flowering October-November, fruiting

January-February (Queensland).

This species is a well known food plant in Asia. It occurs naturally in Queensland, at low altitudes in Cape York north of Cooktown, but is not common. There are a number of cultivated forms of the species in South-East Asia that vary in flavour and in fruit size (some reported to reach 10 or 12 cm long). Jones describes one cultivar as “delectable”.

S. minutuliflorum
Tree 10-20 m tall. Flowers white, in terminal and axillary panicles. Fruits white, flattened-globular, to 2 cm long; flesh succulent. Flowering October-November, fruiting November-January.

A species of gallery forests in eastern coastal Northern Territory from the Daly River to Gove. Jones describes the fruit of this species as “very good to eat”. Hyland comments on the adaptation of the fruit for water dispersal.

S. moorei “Durobby”
Tree to 15 m (occasionally more). Flowers pink or red, borne on the older branches. Fruits white, flattened-globular, to 6.5 cm across; flesh firm or somewhat succulent. Flowering Summer, fruiting Autumn.

A rare species occurring in rainforest in the border region between Queensland and New South Wales. A tree of this species regularly bears flowers and fruits in the Royal Botanic Gardens, Sydney. I have found the fruit of this plant to be quite astringent and unpalatable, although Cribb & Cribb describe the flavour as very mild.

S. oleosum “Blue Cherry” (syn. *S. coolminianum*)
Trees to l0m. Flowers white, in axillary panicles. Fruits reddish-purple, becoming blue when ripe, globular to ovoid, 1-2 cm across; flesh crisp to succulent. Flowering mostly Summer-Autumn, fruiting mostly Winter-Spring.

A rainforest species with a wide distribution extending from North Queensland to the south coast of New South Wales; it is found at higher altitudes in the north and on the coast in the south. The fruit is considered good to eat and Low says that it is ideal for jam-making.

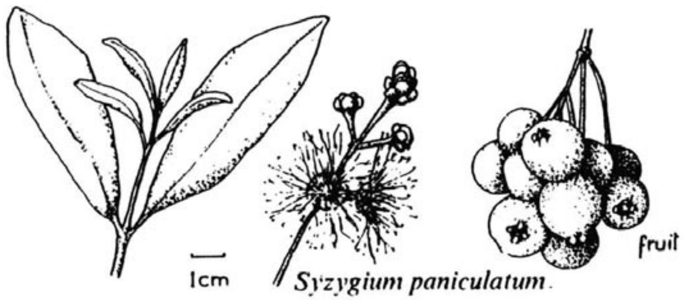
S. paniculatum “Magenta Cherry”
Tree 8-10 m tall. Flowers white, in terminal and axillary clusters. Fruits usually magenta (rarely white, pink or purple), globular to ovoid, 1.5-2.5 cm across; flesh crisp, lightly aromatic. Flowering Summer, fruiting Autumn.

This species is confined to New South Wales where it occurs in littoral (coastal) rainforest. It is rare in the wild with its natural distribution extending from the Myall Lakes to Jervis Bay. Since it is suited to temperate areas and is widely cultivated both here and in California. The flesh has a pleasant, slightly acidic flavour and was the fruit eaten by Cook’s crew at Botany Bay in May 1770.

S. sayeri (syn. *S. dictyophlebium*)
Tree to 35 m. Flowers white, in panicles that are terminal on special lateral branches. Fruits white, globular to flattened-globular, 3-4 cm across; flesh succulent. Flowering Spring, fruiting Summer.

A rainforest tree occurring in Queensland, north of Innisfail, and in Papua New Guinea. Hyland comments that although the fruit is edible it is not particularly palatable.

S. sharonae
Tree to 10 m. Flowers white, in terminal and axillary panicles. Fruits white, flattened-globular, 6-7 cm across; flesh spongy or succulent. Flowering Autumn, fruiting Spring.



[From: Holliday -- Field Guide to Australian Trees]

A rainforest tree of restricted distribution in Queensland, between the Daintree River and Bloomfield. Hyland comments that although the fruit is edible it is not particularly tasty.

S. suborbiculare “Lady Apple”
Usually a shrub or small tree but occasionally to 12 m. Flowers white, in terminal clusters. Fruits red or reddish, more or less globular, 3.5-9 mm wide, with longitudinal ribs in larger-fruited forms; flesh succulent and juicy. Flowering and fruiting for much of the year.
A native of open eucalypt forests, dunes and woodland in the north of W.A., N.T. and Qld (to c. latitude 17° South). The species prefers well-drained sites and is fire tolerant. There are no records of attempted cultivation in more southern areas.

Fruit of this species were an important Aboriginal food source and Low quotes a study that recorded 17mg vitamin C per 100gm for it.

S. tierneyanum “River Cherry”
A tall tree to 25 m. Flowers white, in panicles borne on the stems below the leaves. Fruits red or pink (rarely white), globular, c. 2 cm wide; flesh succulent with an acidic taste. Flowering mostly November-December, fruiting January-February.

This is a species of gallery forests (along streams) and is distributed from Ingham (latitude c. 18° South) north through Cape York and into New Guinea and the Solomon Islands. It is a minor food source for native peoples in New Guinea.

S. wilsonii subsp. *wilsonii*
Shrub, usually 1-2 m tall. Flowers red, in dense terminal clusters. Fruit white, globular to ovoid, to c. 1.5 cm across; flesh succulent to spongy. Flowering Spring, fruiting Summer.

A rainforest plant from northern Queensland between Mossman and Rockingham Bay. A plant of this species is growing reasonably well in the Royal Botanic Gardens, Sydney. The fruit of this species is edible and was used in earlier days to make jam, but the species, with its attractive red flowers, would seem to have more potential in ornamental horticulture than anywhere else.

EXOTIC SPECIES

There are two other species that are commonly grown in Australia:

S. cumini "Jambolan"
Tree 10-20 m tall. Flowers white, in many-flowered panicles borne on shoots below the leaves. Fruits purple, ovoid, 2-3 cm long; flesh succulent, sweet but astringent. Flowering July-August, fruiting September-December.

A native of South-East Asia grown in tropical parts of Australia. The fruits of this species are put to many uses in various Asian countries; drinks, jellies, jams and pickles, to name the most common. The astringency of the raw fruit is usually offset by treatment with salt. There are a number of cultivars that vary in size, shape, colour, juiciness and sweetness of the fruit, as well as early and late ripening varieties.

S. jambos "Rose Apple"
Tree to 8 m. Flowers white, showy, in few-flowered groups at the ends of shoots. Fruits yellow to apricot in colour, globose to ellipsoidal, 3-5 cm long; flesh rather thin and crisp with a distinct rose flavour. Flowering Spring, fruiting Summer.

A native of the tropics but widely grown in Australia; it grows quite well in Sydney but the fruit is prone to fruit-fly attack. The fruit is a popular food in some parts of the world (e.g. India), as a garnish to other dishes, but would probably not be an economic proposition in Australia. The backyard grower will find that the firm flesh is not unpleasant to eat and, as it is high in pectin, it can be used to make jams or jellies.

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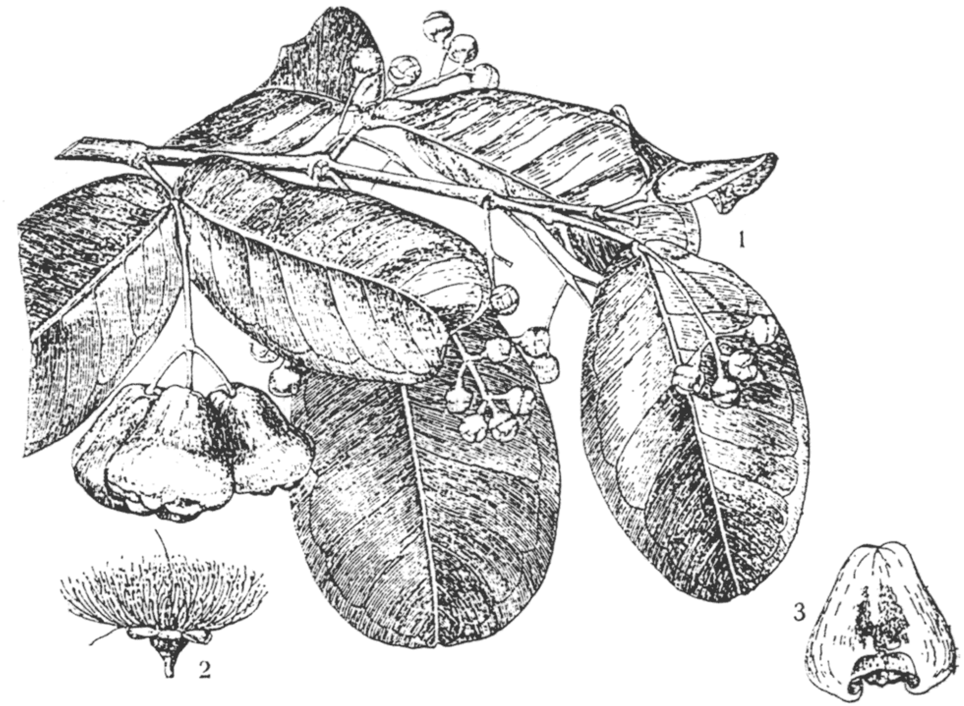

Eugenia javanica, Lam.
Syzygium samarengense -
The Samarang Roseapple or Jambool from Java

INTERCROPPING WITH JUJUBE IN CHINA

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Jujube (*Zizyphus jujuba* Mill.) is an excellent agroforestry intercropping tree species, which has been cultivated in the form of intercropping for more than 2,000 years in China. It is currently widely planted by farmers. With small leaves and sparse canopy, jujube adapts to many kinds of soils: plains, highlands, sandy beaches, saline-alkaline soil, etc. The rainfall in its growing area is from 200 mm to 1000 mm per year.

A suitable planting model for jujube in an agroforestry intercropping system is with 3-4 x 15m in spacing, 5-6m in height, and north-south row orientation, and combining with crops in the form of "high-low-high" or "high-low-middle-low-high".

Jujube agroforestry systems have high ecological and economic benefits. Energy utilization rate is about 77% higher than that in monoculture. The systems can produce 9,000 kg/ha of grain plus 4,500kg/ha dried fruits annually. The output is 3 times higher in intercropping than that in monoculture.

INTRODUCTION

Jujube *(Zizyphus jujuba* Mill.) originated in China. It probably evolved naturally and was artificially selected from *Z. spinosus* Hu. With its main occurrence in the middle-lower reaches of the Yellow river in Henan, Shaanxi, Shanxi, and Shandong provinces, Jujube falls in the temperate zone.

In addition, it is widely grown in Hebei province, extending over east longitude E.76-124°, north latitude N.23-42°. This species was growing in west Asia more than 2,000 years ago, and was introduced to India in 1930 and to Europe in 1837.

Its most notable value is that its fruits are delicious, richly nutritious, and contain good materials for medicines. The well known ancient Chinese text, *Book of Medicinal Materials,* recorded that dried jujube fruits are good for the heart, liver, spleen, lungs and kidney, and for curing coughs, prolonging life, etc. The sugar content of the dried fruit is 50.3-86.9%, the protein content is 1.2-3.3%. It contains 18 amino acids of the 24 essential for human beings.

Jujube is a traditional agroforestry species in China, rarely competing for water, nutrients and applied fertilizers with intercropping crops. Its sparse canopy allows a large amount of light to pass through, making this available for use by the intercrops.

Jujube intercropping is a traditional farming system in China. Intercrops are mainly wheat, corn, soybean, cotton and vegetables, etc. Old records indicate that jujube was widely planted around households and farmlands. It is long-lived, with a record age of 1,800 years. Usually trees bear fruits for 80-100 years.

This agroforestry system has been rapidly developed during recent years. In Hebei and Shandong Provinces alone, the intercropped area is 133,000 ha, and the output of dried fruits is about 65% of the national production.

MODIFICATION OF MICROCLIMATE IN THE JUJUBE INTERCROPPING AGROFORESTRY MODEL

Modification of microclimate in the intercropping system is dependent on many factors.

Row Orientation
The growing season of jujube is from April to October. Its sparse canopy allows most light to go through. However, the rate of light penetration is a function of row orientation.
In mature intercropped orchards, east-west oriented rows with 1.2m between trunks, which allow 30% and 34% light penetration respectively on the north and south sides of the canopy, are considered as better than north-south rows with 1.2m between trunks, which allow 51% and 40% light penetration respectively on the east and west sides of the canopy. There is a difference in radiation between the two row orientations.

At a 3.5m distance from a 5m high east-west oriented row, radiance duration is reduced to 6-8 hours. Differing crop yields are found between the two row orientations, with wheat and corn yields of E-W oriented rows 15.7% and 30% lower than those of N-S oriented rows. The dried fruit yields of E-W oriented rows are about 10-15% lower than those of N- S oriented rows.

Spacing
At different distances from the trees, the rates of light penetration are different. The light index in N-S oriented rows is 0.8-0.87 at 2m from the trunks, 0.96-0.98 at 4m, and 0.99-1.00 at 6-l0m. Minimum normal distance between rows should be 8m.

Light duration is also dependent on row separation. At 2m distance from N-S oriented rows, 18m, 15m, and l0m apart, light duration is 8.5h, 7.75h, and 5.78h respectively, which is 57%, 52%, and 39% of the open-field values. The 15m row distance is accepted as optimum spacing. More crop shading occurs at the l0m spacing, with only a small difference in microclimate changes and crop yields between the 15m and 18m spacings.

Jujube has a smallish canopy, 3.5-4.5m across. At 1.2m from the canopy, a 15,000 Lux light intensity reached the ground for 11 hours, while a light intensity above 45,000 Lux lasted 7 hours. Daily total light intensity is 19,884 x 101 Lux, which is about 66% of that in open field is 3-4m x 15-18m.

Trunk Height

In pure orchards, jujubes with short trunks are easier to manage and their output is nearly equal to other fruit trees. However, high trunks are needed in intercropping systems so as not to affect the intercropped crops.

It is reckoned that a trunk height of 1.4m is suitable for growing crops under the trees With a 1.4m trunk height, light intensity under the canopy during the growing season was 15,000-48,000 Lux, while with 1.2m trunks it was less than 20,000 Lux.

Intercropped Crops

The effect of shading on intercrop growth varies with the distance from the hedgerows. With a spacing of 4 x 15m, crown width of 5m, and trunk height of 1.4m under the canopy, light penetration in summer is only 15,000-48,000 Lux, which represents 27-59% of that in open fields. Thus suitable intercropping crops in summer are short, shallow-rooted, shade tolerant crops like soy bean, mung bean, daylily, etc.

Zizyphus sativa (Lamk)

Within 2m of the trees, where the direct light duration is 1.5 hours shorter than that in open fields, short crops with high compensation like cotton, millet, etc. should be intercropped. Beyond this range, where the microclimatic system is similar to that in open fields, tall crops such as corn and sorghum can be intercropped. In addition to the above, winter wheat is considered as an appropriate intercrop. In winter, when trees become leafless and dormant, the microclimate anywhere near the trees is nearly the same as that in open fields.

During the early growing season of the wheat, when tree leaves have not yet emerged, light intensity under the canopy is about 6,500-9,500 Lux, which is 96% of that in open fields. Jujuba leaves start to emerge when the wheat reaches the jointing stage (at the end of April in western China). However, the newly emerged leaves still allow almost 96% of light to penetrate the canopy. When the wheat proceeds to the flower and fill stages, and the tree is in faster growth, the light intensity is 20,000-70,000 Lux, which is more than what the wheat requires (at this stage the wheat light demand is 20,000-30,000 Lux). The jujube may also protect the wheat from harm by the hot and dry strong winds.

Recommended models of crops arrangement at different distances from hedgerows are described as “high-low-high” or “high-low-middle-low-high” forms. “Low” crops (cotton, bean, wheat) grow between two “high” hedgerows of trees, and “low-middle-low” crops (corn, sorghum, etc) also grow between the ‘high’ rows of trees.

ECOLOGICAL AND ECONOMIC BENEFITS OF JUJUBE INTERCROPPING AGROFORESTRY

The modification of microclimates in jujube agroforestry and its effect on the inter-crop yields have been widely studied. Acting as shelterbelt, the jujube interplanted in the system can reduce wind velocity and minimize its mechanical and physiological damage to the crops. The temperature and the wind velocity are decreased 0.5-1.0°C and 64% respectively, the relative humidity is increased by 6.0%-8.2%. This kind of agroforestry system has many advantages over monoculture systems.

A significant role of the agroforestry system is to protect the jujubes from production losses caused by the hot and dry winds. The multiple layers of trees and crops can also utilize natural resources more efficiently, especially heat integral radiation. The heat utilization efficiency in a jujube-wheat-corn intercropping system is 177% of annual integral temperature, which is 77% higher than that of corn and wheat together in a monoculture system and 159% higher than that of corn in a corn monoculture.

The microclimate modification and the high thermal energy utilization efficiency favour the growth of intercropped crops and consequently increase crop output. Thus, an intercrop system yields on average 2,235-5,925 kg/ha of fresh fruit and about 1,352 kg/ha of grain.

The net incomes from intercropped trees at spacings of 4 x 7, .4 x 15 and 4 x 21m are 7.0, 3.7 and 2.7 times higher than those in monoculture fields. Now benefits have been demonstrated, farmers are more active in pursuing jujube intercrop agroforestry. For instance, the Zhuji commune in Lelin county, Hebei province, has intercropped 1,666 ha, representing 73.5% of the total farmland. The grain output has increased 25%.

Lishangzhuang village in Xian county intercropped 59.3ha, representing 83.4% of its total farmland in 1965. The total grain output in 1982 was 179,000 kg ,which is 50% more than that in 1965. The jujube fruit provided a very significant extra income for the farmers. For example, in the Gaozhuang commune in Zhang county, Hebei province, the area of intercropped crops was only 13.6% of the total area, but 64.8% of its total income was provided by the jujube fruit.

In conclusion, jujube intercrop agroforestry is playing a significant role in modifying microclimate and increasing productivity and income. It looks to have a bright future with increasing interest being shown by both researchers and farmers.

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FUGITIVE EARTH DOMAINS AS SOURCES OF USEFUL FRUIT AND NUT GENES

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SUMMARY
In the book 'Nuteeriat' I have shown how the past movements of Earth Domains (portions of the Earth's crust) can be traced from a study of present plant distributions. In the current paper I show how this knowledge of domain movements can be used to locate genetic material likely to be of value in the breeding and development of fruits and nuts, particularly ones for subtropical areas.

This paper reviews the broad features of domain movements on Earth, whether as isolated island domains, microdomain shuffle belts, or domain and microdomain aggregates. These domain movements have been mainly away from the equator, and have carried relatives of tropical species into subtropical and temperate zones.

Through natural selection, these 'fugitive' species have acquired characteristics suiting them to their new non-tropical surroundings. Nevertheless, they remain closely related to their tropical cousins, and so can act as a gene source for combining cool-climate habitat characteristics with the desirable fruiting characteristics of their tropical relatives. Examples are given of the relevance of climatic characteristics such as cold tolerance, drought tolerance, and seasonality in the development of such fruit and nut genera as *Diospyros, Artocarpus, Litsea, Canarium,* and *Coffea*.

1. DOMAIN MOVEMENTS

Figure 1 is a broad representation of the main features of domain movements on the Earth over the last 100 million years or so. In geological terms, this period covers the later part of the Mesozoic era and all of the Cenozoic era in which we are now living. Only a few of the more ancient plant families, such as the cycads, can be clearly traced back as far as the Mesozoic; almost all of our major tree crops have evolved during the Cenozoic.

In the figure, an attempt has been made to show the direction and extent of domain movements with rectangular 'trend marks'. Where these marks have an arrow at one end only, they generally represent movements away from the equator, either the modem equator or the former equator (the Tethyan Gulf) which apparently once separated the northern and southern supercontinents of Laurasia and Gondwanaland.

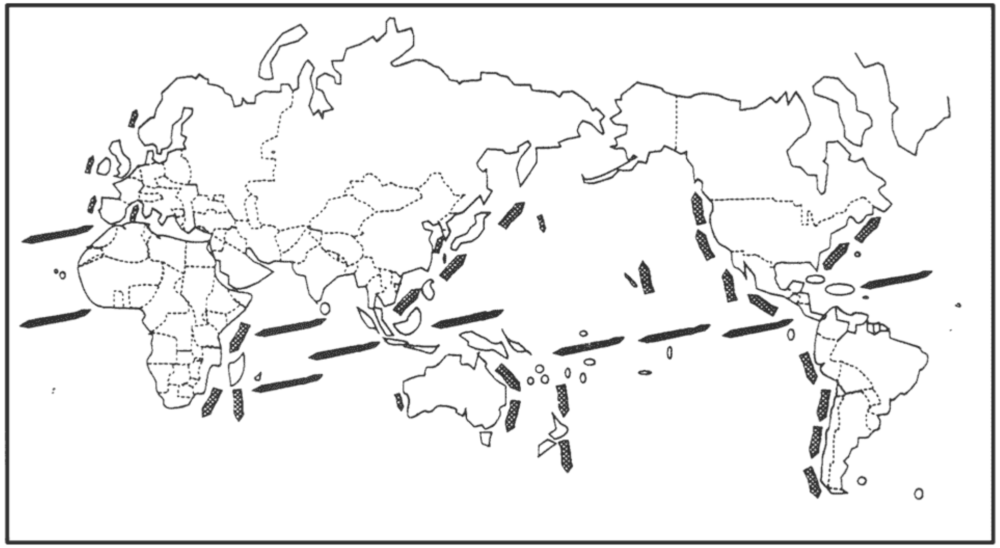

Figure 1. Domain Movement Trends on the Earth

It can be seen that flight of domains away from the equator is a very obvious feature of many areas on Figure 1. It is these 'fugitive' domains which turn out to be so important from the viewpoint of identifying useful fruit and nut genes for subtropical culture.

Where the trend marks have an arrow at both ends, they generally indicate relative separation of domains in an east-west direction. I have suggested that both types of movement are ultimately due to Earth expansion, anti both are relative movements, but in the east-west case there is no notionally fixed measurement line such as an equator to work from. Long trend marks represent especially rapid or continued domain movements, and wide marks represent very active movement zones.

Evidence is given in 'Nuteeriat' to support the view that these domain movements are due to expansion of the Earth, with this expansion splitting up and forcing apart areas of land formerly in close contact. Whether this mechanism comes to be accepted generally or not, is irrelevant from the viewpoint of this paper. The important point is that the reasoning yields a uncomplicated model for current plant distributions which explains many features not understandable at all from earlier models. While the new model has an uncomplicated basis, it is nevertheless capable of embodying considerable detail, well beneath the level of species.

2. SPREADING OF PLANT SPECIES

Another factor which is examined in some detail in 'Nuteeriat' (Noel, 1989) is the way in which plant species spread naturally. It is suggested that a given plant species lives within boundaries which define a given set of ecological conditions. These boundaries, which have been called 'isocons', can be drawn on a map like contour lines, but instead of joining points of equal elevation, they connect points of similar ecological conditions.

The relevant ecological parameters which define the isocons for a given species may vary. An isocon represents a barrier which the species cannot cross, because there an ecological condition which is important for that species reaches a critical value and restricts its spread. The isocon may run along an obvious feature, such as the boundary between land and water. It may have a more subtle basis, such as a change in soil type or ground cover. Often it will have a climatic or temperature basis, such as the line where minimum temperatures reach a certain value, and such lines are themselves dependent on elevation.

Evidence is given in 'Nuteeriat' that a given plant species can only spread naturally at a fairly slow rate along its isocons. To cross an isocon, the species would have to adapt to different ecological conditions. Obviously species are capable of adaption, but adaption implies a change in genetic makeup of the species. If the adaptive changes are great enough, the genetic bank of the species will also change markedly, with the result that anew species will be evolved to live within the limits of its own isocon boundaries.

Latitude is one of the most important isocon parameters, because latitude has a dominant large-scale influence on temperature. This applies both in the present and in the past; whether average global temperatures are high or low, equatorial zones are hotter and polar ones colder.

In practice this means that plants have been able to spread relatively easily along land zones of similar latitude, that is, in bands parallel to the equator. Of course where such a band meets a non-temperature isocon, such as where the land runs into water, this plant spread is halted. It is often the case that different species in the same genus are met with on opposite sides of a great ocean such as the Pacific. Logically, these species must share common ancestors, and these common ancestors must have existed together in the same area in order to breed.
Detailed evidence is given in 'Nuteeriat' to show that the present separation of such species is due to breakup and separation of the domains on which their ancestors once lived, rather than spread of seed of the species by normal seed-distribution processes.

The effect of the two main factors operating, that is, spread within same-latitude land isocons, and domain flight away from the equator, is to create plant distributions which are L-shaped. Spread within isocons, parallel to the equator, gives the foot of the L, and spread away from the equator, with species carried on fugitive domains, gives the stem of the L. This is a simple case, obviously more complex variations on the same basic theme can be found.

3. GENETIC DRIFT ON FUGITIVE DOMAINS

As the domains carrying plant species moved away from the equator, these species had t by their tropical cousins left behind. The fugitive species have thus suffered from a genetic drift which will generally be more marked, the greater the distance that their home domains have moved.

While this drift has been great enough to create new species, it has generally not been great enough to make new genera. The result is that the fugitive species, with adapted genes, are often still hybridizable or graft-compatible with their stay-at-home tropical relatives in the same genus. This gives the possibility of producing crossed or grafted producer plants with the ability to grow and thrive in subtropical or temperate areas, and yet with the desirable fruiting characteristics typical of tropical plants.

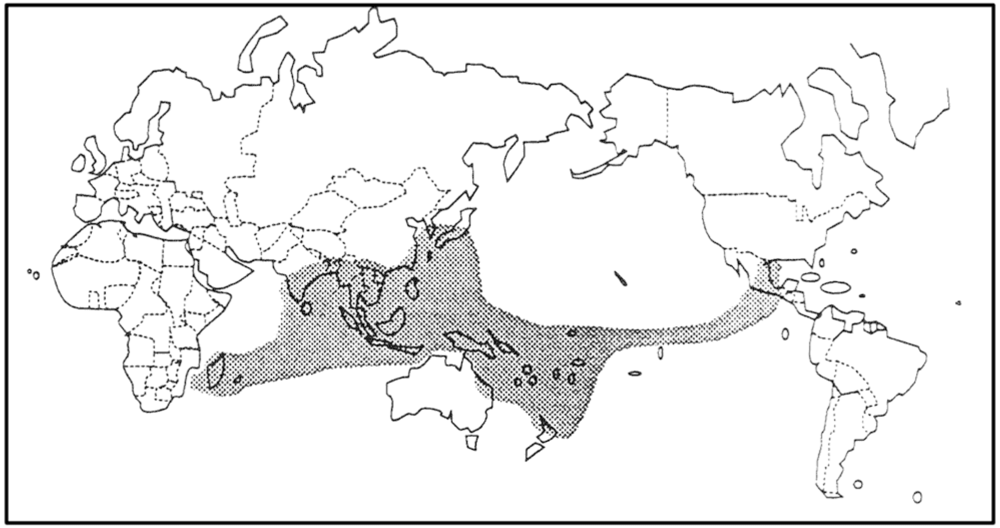

Figure 2. Distribution of *Litsea* species

What are the useful adaptions which have been made by the fugitive species? The most obvious one is adaption to COLD. As an example, the genus *Diospyros*, containing the ebonies and persimmons, is basically a tropical one. Fugitive domains have carried individual species into colder areas, such as north along the east Asian coast, in Japan and China; in eastern North America, from Mexico as far north as Virginia; and south in eastern Africa, in the great shuffle belt which extends right down to the tip of South Africa.

Suppose it was desired to fruit a tropical species such as the Mabolo (*D. blancoi*), an interesting fruit from the Philippines, in Southern Africa. There are 22 native species of persimmon in Southern Africa (Palgrave, 1988), almost every area having at least one native species. It is quite possible that the Mabolo is graft-compatible with some of these. Grafting Mabolo scions on a native rootstock would give a quick, if somewhat chancy, way of fruiting this species locally. A more reliable route would be to cross Mabolo with local species, say by importing Mabolo pollen and applying to female flowers of local *Diospyros*, and screening the resulting offspring with the aim of finding seedlings with local hardiness plus Mabolo-style fruits.

As another example, consider the genus *Litsea*, the distribution of which is shown in Figure 2. This genus contains some very interesting tropical fruits, such as the Alat-Alang or Engkala, *L. garciae*, of Borneo. If you were to buy this unfamiliar fruit in a rural market and bite into it, as I did once, you would be very surprised; it is an unsweet, oily fruit with a buttery texture. Subsequently I was able to identify its genus, which is in the Lauraceae and hence related to the avocado, and so the oily character becomes understandable.

The point is that *Litsea* has the potential for development not just as a fruit, but as a whole class of what might be called savoury fruits. It has a number of fugitive-domain species which have entered temperate areas, in Australia, Mexico, Japan, Korea, China, and New Zealand, and in high-altitude subtropical areas around the Himalayas. The avocado itself has found success in the subtropics because cold-tolerance genes, found in specimens from the Mexican Highlands, were incorporated in hybrids with good-fruiting low-altitude varieties. Clearly the potential, at least, is present for a similar breeding success with *Litsea*.

Another tropical genus with temperate extensions is *Canarium*. This genus has a distribution somewhat similar to that of *Litsea*, but displaced more to the west and not extending quite so far north and south of the tropics. The genus contains several tropical, semi-commercial nuts such as the Pili Nut of the Philippines and the Kenari Nut of Indonesia. In some species, both the fruit flesh around the 'stone' and the nut kernel is edible.

Canarium has a northern extension into southern China, including some areas where appreciable cold is encountered. There, the fruit is preserved and sold as 'Chinese Olive', and the small kernels sold as 'Olive Kernels'. The genus also has a southern 'tongue', hanging down the east coast of Australia as far as northern New South Wales. While Pili and Kenari are rather cold-sensitive, there is a possibility of producing good-sized nuts by combining the genes of these tropical species with those of their temperate relatives.

Of course cold-resistance is also developed in species which have adapted to high altitudes in the tropics. I have suggested that most mountain chains are the product of domain rubbing, so many high-altitude species may have originated through domain movement, even if not of the dramatic type shown in some fugitive domains. A possible application here concerns the Breadfruit genus, *Artocarpus*.

Although some typically tropical species appear reasonably adaptable to the subtropics, this is not the case with the Breadfruit, *A. altilis*, itself. A native of the low Pacific equatorial islands, this plant is very sensitive to cold, and I have never found any record of a plant surviving, let alone fruiting, in unmodified warm-temperate conditions.

However the Breadfruit does have a relative, *A. lakootcha*, which is native to Nepal and other parts of the Himalayas, and this species has considerable cold-resistance. With a graft or genetic composite of the two species, it might be possible to produce Breadfruit in cooler areas.

The examples so far have been concerned with achieving cold-tolerance in typically tropical genera. There is a converse application, concerned with CHILLING requirements of typically temperate species. Many cool-temperate fruits such as the Apple, and some warm-temperate nuts such as the Pistachio, do not fruit successfully if planted in an area with insufficient winter chilling. In the case of Pistachio, a species exists in Burma, and this could be a source of low-chill genes. In the case of the Apple, tropical rootstocks from the related genus *Docynia* have been used with success to grow apples in Burma (Watts, 1908).

A second adaption which may be found in fugitive species is DROUGHT resistance. Most of the great deserts of the world are in the subtropics, not the tropics. Within some of these arid lands may be found the hardy rootstocks needed to grow good fruits under adverse conditions. Returning to *Diospyros* and Southern Africa for an example, it might be noted that at least two species, *D. acocksii* and *D. lycioides,* appear to extend into the arid areas of Namibia (Palgrave, 1977).

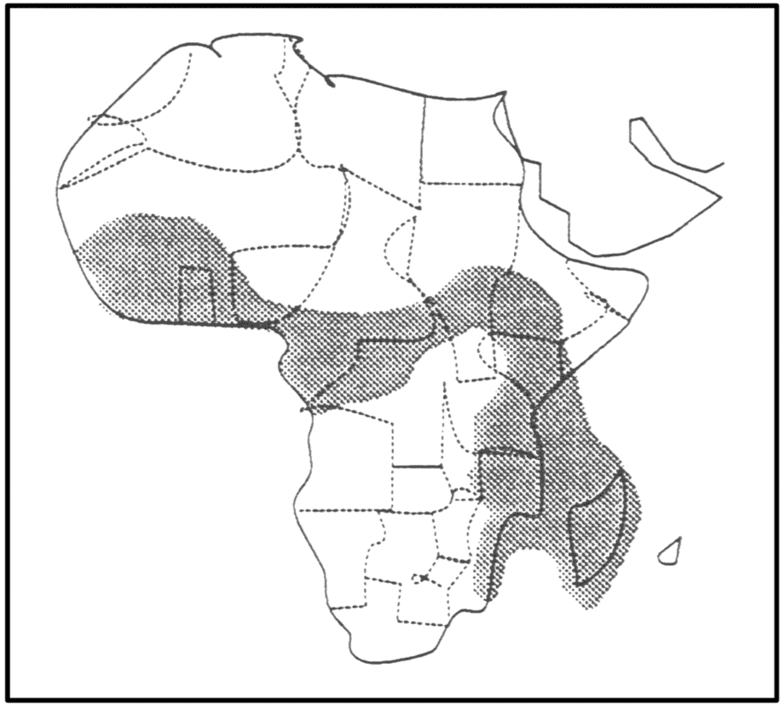

Figure 3. Distribution of *Coffea*

My final example of an adaption which could have great practical application concerns Coffee. Figure 3 shows the distribution of the main species of *Coffea* (based on Berthaud (1988)). The distribution is a typical one, with a wide equatorial band plus extensions away from the equator where species have been carried off on fugitive domains. These extensions have brought *Coffea* down as far as the South African lowveldt on the African mainland, and also well south on Madagascar.

Coffee is the most important tree crop in the world, in terms of world trade. It is far and away the biggest agricultural import item for the United States, the only one measured in billions of dollars annually. The main commercial species is *Coffea arabica*, which originated in Ethiopia, although more lowland tropical species such *C. canephora* or *C. liberica* are also grown, particularly in humid climates, where Arabica Coffee is unworkable because of its poor resistance to diseases such as Coffee Blight.

Because Arabica Coffee evolved to grow in a high-altitude tropical area, it has some natural cold resistance, and in fact will grow and fruit quite well in a mediterranean climate. Because of its huge market importance, attempts have been made to grow coffee in more developed countries such as Australia, using mechanization, but these have not been notably successful. The reason is that Arabica Coffee fruits ripen gradually along the stems over extended periods, and so cannot all be harvested in one or two runs like apples.

It has been said that subtropical coffee growing will not be commercially successful until the harvesting season can be shrunk right down; ripening treatments with chemicals such as ethrel have been tried, but results have been indifferent and the treatments costly. In spite of the obvious potential for 'western' methods, coffee today remains largely a third-world crop raised by peasant labour.

It seems that the weak link here is the dependence on Arabica. As a highland tropical species, it has cold resistance, but not seasonality. It does not have a tightly-defined harvest time, even for a particular clone. This seasonality could be introduced from its fugitive-domain relatives which have moved down into Madagascar and southern Africa. These do have defined ripening seasons, because their internal biological mechanisms have evolved to expect hot and cold seasons.

An excellent local example is *Coffea racemosa,* some provenances of which extend right down into Natal (Palgrave, 1988). Palgrave notes that this plant is "very hardy and resistant to disease; the seeds produce a good and distinctively-flavoured coffee. Fruits mature between October and January". Particular clones of this species may be expected to have quite short harvest times.

While there are complications with combining genes from Arabica and Racemosa coffees (one is a tetraploid and the other a diploid), these are problems which have been successfully solved (Berthaud, 1988). It appears that the introduction of genes for SEASONALITY from fugitive-domain coffee species could transform this major tree crop into a mechanized subtropical product which could be successfully raised well outside its traditional tropical areas.

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IMPORTATION OF RARE FRUITS AND NUTS - OR GET 'EM WHILE YOU CAN!

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ABSTRACT

This article emphasises the need for a concerted effort at accessing rare fruit and nut species and cultivars not currently in Australia. There is a pervasive attitude that all worthwhile material of this type has been imported. Nothing could be further from the truth. The IUCN estimates 60,000 species of plants might be extinct by 2050. Due to deforestation and hanging dietary habits in developing nations, many of these rare fruits will be lost or even harder to obtain than today. The paper mentions outstanding examples of species and cultivars awaiting introduction. It includes, for the first time in print, my collated lists of yet to be obtained material from Africa, India, Philippines, South America, etc, well over 1000 species, and will use a family such as the Sapotaceae to further illustrate the need to actively promote accession of new material.

INTRODUCTION

What constitutes rare is in the eyes of the beholder. Rare from the perspective of conservation relates to those species considered endangered in their native habitat. A staggering 40 000-60 000 plants could be extinct by the year 2050, according to a panel of leading botanists convened by the International Union for the Conservation of Natural Resources (IUCNR), and the World Wildlife Foundation (WWF).

In addition to the threat to so many species is the dwindling germ plasm within species. "The genetic composition of cultivars has become more vulnerable to destructive economic forces. Valuable plant genetic resources are rapidly decreasing as a result of the destruction of natural habitats with economic development, and the decrease in forests due to the reckless felling of native varieties for wood pulp, lumber and fuel." (lazuka, 1987).

Further, modem agricultural technology has been a formidable factor in gene base erosion by substituting plant protection techniques for genes. "For example, we can now give crops resistance to diseases and insects by using chemical sprays ..." (Iazuka). In addition, the dietary changes away from traditional fruits and nuts to foods of the modem world culture further diminishes the gene pool. For example, the sweet form of nam-nam, *Cynometra cauliflora,* has virtually disappeared from Java. "What is important in this situation is to take immediate action to collect, evaluate, document and conserve these quickly disappearing plant genetic resources so that they may be utilized .... in the future."(Iazuka).

"Agricultural and horticultural crops are well established in the world economy but the number of species involved is small -only about a hundred play a significant part in the world trade and of these fewer than twenty make up the staple crops that feed most of mankind. On the one hand, there is concern that the genetic base of these staple crops in cultivation is very narrow, often alarmingly so, and that the wild populations of their ancestral species or relatives are rapidly disappearing due to the loss of their habitats. On the other hand, there is an increasing interest in introducing into cultivation some of the thousands of species that are so far only used on a local scale and which might provide us with novel crops for fruits, nuts, oils, medicines, herbs, fibres, fodder, firewood, ornamentals and so on. "(Botanical, 1987).

To stem this tide of genetic erosion of staple crops, international organizations within the IN system, such as the FAO and the International Board for Plant Genetic Resources (IBPGR), try to look alter the conservation of these resources. One avenue taken has been the establishment of germplasm repositories. Throughout the world, germplasm collection sites have been established, set up to cater for various crops including fruits. For example, at Corvallis, Oregon, USA: *Vaccinium*, *Rubus*, and *Amelanchier*; at Lagunas, Philippines: *Musa*; at Rimba Ilmu, Malaysia: *Aurantioidae* tribe of Rutaceae, which includes Citrus. I wish to emphasize that a *Rubus* collection in Oregon or a banana collection in the Philippines is not the same as a *Rubus* or banana collection in Australia.

In 1985 at their Canary Is. convention the International Union of Botanical Gardens (IUBG) realized the desperate situation facing thousands of species, and undertook to actively attempt to save as many species as possible. Towards this end the Botanic Garden Conservation Secretariat was formed. The conservation movement has come to realize that protecting individual species, whether animal, plant or fungi, is not the answer. The in situ protection of the entire native ecosystem is the only way to ensure the long-term survival of any particular species. Therefore coordination and support for in situ sites is of paramount importance.

"Today many natural habitats are being destroyed. Forest cover is diminishing, especially in the tropics, wetlands are receding, islands and coastal ecosystems are being infested with weeds. During the next few decades many thousand plant species will become extinct or their wild populations severely eroded genetically unless preventative measures are taken. In some cases it is already too late to ensure the future viable field population; ex situ conservation is now the only option open to us. Many of the habitats of these potentially important species are at risk and steps need to be taken urgently to preserve both the communities in which they occur and their germplasm ex situ as an insurance or a last resort rescue measure." (Botanical).

Mangifera: the genus of the mango is a prime example. Though M*angifera indica* and its wide genetic base are in no danger, how many are aware that there are some 38 other species in this genus, including some with delicious fruits? Nine of these species are rare and endangered, and for another thirteen species there is simply not enough information. Dr Reid, IBPGR, reports that Mangifera collection work in 1986 located species previously thought extinct in the wild as well as a new species located as an isolated individual in a backyard. Further, varieties of *M. foetida* and *M. pajang* with fruits of firm texture and strong aroma that are particularly useful for flavouring drinks and yoghurt were discovered, while a variety of *M. caesia* with a distinct pear-like taste was found.

Considering that many of these *Mangifera* species occur in the wet tropics they are of immense value in their own right, as well as for breeding programs with *M. indica*. Considering the advances in genetic engineering techniques as well as traditional inter-specific plant breeding programs, it is indeed realistic to envision incorporating, say, anthracnose resistance into the mango. But genetic engineering does not create genes, they must be available in the germ plasm. I have used *Mangifera* as an example so I need to point out that "with regard to fruit trees... the genetic collection of resources is limited to commercially valuable crops, and many regional crop resources remain untouched." (Pandey, 1987).

So what can you do to help all these rare and endangered species in their native habitats? You take active steps of support by financial membership and/or donations to such groups as the Rainforest Information Centre, Botanical Garden Conservation Secretariat, Australian Conservation Foundation, and so on. You communicate with others, and you write letters - e.g. objecting to the importation of rainforest timbers like meranti (*Shorea* spp.). If cashed up, be sure your money is in ethical investments.

Rare in the context of the Australian perspective means rare or non-existent on this tectonic plate, even if common in its overseas habitat. There is the notion that almost all species and cultivars of fruits and nuts worth introducing has already been achieved. Nothing could be further from the truth. Plant importation of worthwhile fruit and nut species and varieties has hardly begun. The aforementioned case of *Mangifera* is one case in point. But the list runs into thousands. The following species are selected from my various hit lists around the world of material not known to exist by me in Australia.

INDIA

Actinidia callosa; Aglaia edulis (Sapindaceae) - large succulent aril; *Alphonsea lutea* (Annonaceae) - edible aromatic creamish pulp; *Bauhinia vahlii* (Leguminaceae) - liane with huge leaves, beaut flowers and consumed roasted seeds; *Baccaurea sapida* (Euphorbiaceae) - "Lotkua" tall tree found in E. India, sub-Himalayan tract, Andaman Is. The pulp of the ripe fruit is delicious; *Buchanaia lanzan* (Anacardiaceae) "Chironji" a delicious nut formerly imported in quantity into Europe; *Castanopsis hystrix* (Fagaceae) - good flavour resembling chestnuts; *Euryale ferox* - 'Gorgan Nut', aquatic herb, tasty seeds eaten raw or cooked; *Garcinia paniculata* (Guttiferae) - E. Himalayas & N. Hills, pulpy aril in fruit is like that in mangosteen, highly flavoured and very yummy; *Madhuca latifolia* (Sapotaceae) - the world's most delicious flower being 65% sugar, consumed in thousands of tons annually; *Mammea longifolia* (Guttiferae).

Table 1. Priority considerations for the conservation of Mangifera species

NOTATION SPECIES	A	B	C	D	E	F	G
M. cochinchinensis	x	x				x	
M. flava	x	x					
M. lagenifera		x				x	x
M. pentandra	x	x				x	
M. reba	x	x					
M. superba	x	x					x
M. duperreana		x					
M. inocarpoides	x		x				
M. monandra	x		x				
M. timorensis	x		x				
M. zeylanica	x		x			x	x
M. andamanica	x		x				x
M. camptosperma				x			x
M. gedebe				x			
M. caloneura					x		x
M. dongnaiensis	x				x		
M. gracilipes	x				x		
M. griffithii					x	x	
M. havilandii					x		
M. khasiana	x				x		
M. minutifolia	x				x		
M. pajang					x	x	x
M. parvifolia					x		
M. siamensis	x				x		x
M. similis					x		
M. altissima						x	
M. caesia						x	x
M. foetida						x	x
M. longipes						x	x
M. macrocarpa						x	x
M. odorata						x	x
M. sylvatica						x	x
M. minor							x

Notation Key

A. Very localized or endemic
B. Endangered
C. Vulnerable
D. Rare
E. Insufficiently known
F. Edible fruit
G. Closely related to *M. indica*
[From Mukherjee (1985)]

SOUTH AFRICA

Englerophytum magalismontanum (formerly *Bequaertiodendon magalismontanum*) (Sapotaceae) the famed Stamvrug with its gorgeous bright red plum shaped fruits, purplish flesh and sticky milky juice is tart and delicious even to the palates of white S. Africans; *Bialium schlechterii* (Leguminaceae) - among the most popular in Zululand; *Diospyros mespilformis* (Ebenaceae) - another palatable persimmon; *Hexalobus monopetalus* (Annonaceae) - an annonaceous type fruit with vivid scarlet fruits known as baboon's breakfast, is also relished by humans; *Inhambanella henriquesii* and *Manilkara* spp. (Sapotaceae) -these are further widely consumed palatable sapotes of South Africa; *Morus mesozygia* (Moraceae); *Pappea capensis* (Sapindaceae) - red aril held in such esteem reserved for exclusive consumption by Zulu chiefs; *Parinari curatellifolia* (Rosaceae) the yellowish pleasant flavoured 'Mobola Plum' was described by Livingston as tasting of strawberry; *Strychnos madagascarensis* - though well known as the genus of strychnine, many species are palatable, including this one, whose dried pulp is as good as dried apricots.

PHILIPPINES

Aglaia spp. (Sapindaceae); *Alphonsea arborea* (Annonaceae); *Anacolosa luzonensis* (Olacaceae) - filbert sized nuts with peculiar flavour resembling sweet corn and chestnuts; *Calamus litoko* (Palmae); *Diospyros pyrrhocarpa* (Ebenaceae) - yet another persimmon type fruit; *Dysoxylum arborescens* (Meliaceae); *Elaeocarpus calomala* (Elaeocarpaceae); *Ficus pseudopalma* (Moraceae); *Lithocarpus philippinensis* (Fagaceae); *Rubus elmeri* (Rosaceae); *Syzygium calubcub* (Myrtaceae) - delicious.

POUTERIA SPECIES

Pouteria domingensis; P. hypoglauca; P. izabalenisi; P. macrocarpa; P. multiflora; P. pariry; P. serpentina; P. speciosa; P. tovarensis; P. uruqui.

Consider the genus Annona. Most of us are only familiar with the big five -*A. squamosa, A. atemoya, A. muricata, A. reticulata*, and *A. cherimola*. Yet there are approximately 48 other species native to a range of habitats. Is the ideal rootstock one of them? We cannot begin to find out until they are located and introduced.

Contrary to popular notion, importation of seed into Australia is a simple matter. More than 99% of all species require no permit, but must be botanically labelled and as cleaned of pulp as is practical. The vast majority of species end up coming right to your mailbox after visual inspection by quarantine officials at the point of entry. After ten years of seed handling experience, I find the salient points are:

1. Pulp cleaning, achieved by rotting (fermentation), by hand, or by mouth. Flotation and assorted sieves are indispensable aids to pulp removal.
2. Cleaned seed soaked 10-20 minutes in a 0.5-1% solution of sodium hypochlorite.
3. Rinse thoroughly.
4. Surface dry 12-24 hours in shade. Never in direct sun.
5. Use plastic envelopes for packing.

6. The difficult part for the inexperienced is determining if seed should be packed by itself, or with dry peat moss or moist peat moss. Dry peat is used as an absorbent in case seed is not considered sufficiently surface dried. Slightly moist peat is used to aid survival prospects for seed likely to germinate en route. If in doubt, divide seed in halves, sending part in dry peat and the other half in well-wrung moist peat moss (not wet peat or else you will invite the rots).

There are also innumerable outstanding cultivars awaiting importation. We still await the complete set of Indian lychee cultivars, as well as the eight recognized wampee (*Clausena lansium*) cultivars from China, the many varieties of *Zizyphus jujuba, Phyllanthus emblica, Asimina triloba, Diospyros virginiana*, and ad infinitum.

Again there are many ways for the individual to be effective. Take advantage of your and your friend's overseas holidays and business trips to collect seed and plant material. How many of you know people in the diplomatic arena who could be used as couriers of live plant material, e.g. lychee cultivars from India?

I support, for socio-economic reasons, the user-pay principle. The exception for me is the application of user-pay to Plant Quarantine. The current pricing structure for quarantining of vegetative material and restricted seed, prohibits any non-profit-orientated importing. For example, due to guava rust all tropical American Myrtaceae must be grown in quarantine for at least twelve months. So all those fantastic jaboticaba relatives, and incredible species like *Pimenta acris,* the Bay Rum, cost $160 per seed line, exclusive of other incidental costs such as initial inspection fees, freight and collection costs, etc. So 10 species costs well over $2000 - absurd considering the urgency. Fruit plants cost $60 for the first one, and $40 for each subsequent plant. Such an expensive system exacerbates the smuggling problem.

I would like to see people contacting the Ministers responsible, and other parties, arguing for a change in user-pays Quarantine Service. Towards the goal of introducing as many rare fruits and nuts into Australia as soon as possible, I am announcing the formation of P.I.C. - an acronym for Plant Importers Club. People interested in this club please write to me for details, enclosing a stamped addressed envelope.

Finally, my perspective on what are rare fruits and nuts, is that in consideration of the rapid decline of the current planetary ecosystem, that all present species, including *Homo sapiens*, are endangered. Even common species can and will be eliminated in less than a generation. Strong words. To state my case, I ask all you to turn the clock back to that safe, sane and secure year 1958 - a mere thirty years ago.

Suppose you are told that the following horror fantasy will come true unless you take individual and collective action. The Earth is invaded by monsters. **Gross Pollution** - in 1988, within 3 months, 38% of the entire seal population of the North and Baltic seas are dead from canine distemper. Bordering nations pump 60 billion litres of toxin-laden discharge daily into these waters. Hundreds of tons of fish die in the North Atlantic, costing Norwegian fisheries at least 300 million dollars. The Norwegian Minister of Fisheries is quoted as saying "I don't know if you could call it a catastrophe."

Suddenly crustacea off the coast of New York and New Jersey develop a strange disease linked to the tens of thousands of tons of sewerage and garbage dumped onto the continental shelf. Guards patrol the beaches of the Great Lakes to prevent people from swimming in the contaminated waters. **Acid Rain** marches across the Northern Hemisphere, sterilizing lakes from the Adirondacks to Scandinavia. The famed Black Forest of Germany is dying. Toxic **Intrusion** - the bountiful delicious artesian aquifer underlying Long Island is declared poisonous.

Dioxin, one of the most lethally known toxins, is found to contaminate streets in a Missouri town. All the people are relocated. Subsequently other towns are also found to be contaminated. They remain where they are. In Bhopal, India, a Union Carbide plant explodes, releasing a cloud of toxic death and injury to thousands. The Rhine river is sterilized by a chemical spill.

Throughout the USA, extremely dangerous hot spots of dumped toxic wastes are being searched for and found. **Mass Starvation** creates famines throughout Africa. Hundreds of millions of people are in a state of malnutrition during the most affluent known epoch of human history. Creeping desertification expands the Sahara relentlessly.

Inland Australia blows away due to mismanagement, resulting in the extinction of many plant and animal species. To wit: all ground dwelling mammals with a body weight between 40 gm and 4 kg are either extinct (17 species), or endangered with their original widespread (save one) range severely reduced, to fragments of their pristine distribution.

Nuclear Holocaust - after a narrow escape at Three Mile Island nuclear power facility, Chernobyl in the Ukraine melts down releasing enormous amounts of radiation. Reindeer-based ethnic communities in Sweden are devastated. Radioactive contaminated produce appears throughout Europe. In 1988, Mexico sends back 3000 tons of radioactive milk powder to Northern Ireland.

Ozone Dissipation - increasing sized hole in ozone layer over Antarctic generates grave concern, due to the effects of increasing ultra-violet radiation and altering precipitation patterns, thereby affecting the strategic balance of planetary life forces. **Blood Plague**, a heretofore unknown disease called AIDS, with 100% mortality, sweeps through humanity. By 1988, some centres in Africa report 35% infection rate with HIV virus. One out of 60 babies n New York City is born HIV positive - over 500,000 estimated carriers in NYC alone. No known vaccine. No vaccine likely, due to incredible mutation ability of virus with as many as 17 mutations found in an infected individual.

Greenhouse Effect is already accepted as 30-50 years away, with no real understanding of the implications by the man on the street. The 1988 June-July issue of *Science* journal contains a paper that re-evaluates the data, postulating that a 5° C temperature increase is only 10-15 years away. The impact on the planet is drastic climatic change, accompanied by massive dislocation, disintegration of social systems, and mega-death.

Surely if you all knew in 1958 this was going to happen, you would have individually taken personal action. You would have made efforts to stop this environmental onslaught. So I ask you what are you going to do now? The handwriting is on the wall. No longer is the motto "If I don't do it someone else will" valid. It is time for an era of conscience. To thine own self be true. We must all take action beyond our work-a-day lives.

Plant importation is a part of what is required. This rapid increase in the destruction of our natural environment threatens the survival of many known and as yet to be discovered useful plants. In no other age has the collection and conservation of plant genetic resources been so important. Under these circumstances, one cannot overemphasize the fundamental importance of collecting these resources and conserving them for our descendants.

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[Based on a talk given at ACOTANC-88, Lismore, New South Wales, October 1988]

SEX DETERMINATION IN SEEDLINGS OF CAROB (*CERATONIA SILIQUA*)

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SUMMARY

Reaction of plant tissue treated with Mandel' s paint was assessed in plants undergoing spring flush of growth. This reaction was similar to that obtained some years ago on tissue from mature trees at Hamel Nursery during spring.

Seedling stock were used in the current tests. Following assessment of sex of the seedlings, proof of sexing accuracy will be sought by outplanting the seedlings and/or grafting to mature stocks to monitor later sexual development. No conclusions could be drawn about reactions from hermaphrodite individuals.

AIM

To validate a reasonably simple field test to determine sex of Carob Bean seedlings in infancy, i.e. up to possibly 8-9 months old.

MATERIALS

Twelve seedlings of Carob of unknown gender, supplied by Mr L. Marshall of Armadale. Earlier tests on material in autumn of 1989 gave no reaction to Mandel's paint, although this material had been taken from trees on the same property.

The tests also used Mandel's paint, razor blades, tags for seedling numbering, and plastic bags for transport of material collected.

METHOD

(a) *Plant Material Used*
Small twiglets (up to approx. 3-4 mm diameter), with leaflets attached, were cut from seedlings after these were labelled with numbers, 1 - 12. Twiglets and leaf material collected were given numbers corresponding to those of the parent plant. All material collected was put in a plastic bag to keep moisture in the material collected.

(b) *Staining*
Oblique sections were cut of twiglets and the central mid rib of compound leaves. Each exposed surface was immediately dipped in Mandel's paint solution and left to stand for approx. 2-3 minutes. At the end of this time positive staining had occurred to a greater or lesser extent, as indicated in the Table.

(c) *Assessment of Staining*

Sexing of each numbered piece of material was attempted, based on the strength and location of the staining, i.e. criteria used for sexing was as follows:

1) Deep blackish purple stain in a concentric ring around the central tissue was regarded as indicating a female specimen.

2) Dark staining of scattered flecks over most of the cut section, with some bunching or blobs of darkened tissue around the central tissue, was regarded as indicating a male specimen.

(d) *Rationale of Staining Reaction Assessment*

It is reasoned that female trees need to develop, or have established, suitable translocatory tissue to carry starches and sugars rapidly to developing fruiting processes. This orientation of conducting tissue therefore results in concentration of starch and sugar solutions during spring growth flush, and is required at an early age so that it is in place as the tree develops. Mandel's paint contains the elements iodine and potassium in solution, and is known to react strongly with starches, and possibly sugars, at this time of the year.

The correctness of this reasoning will be checked by outplanting seedlings for later verification of these assessments. Hermaphrodite individuals will tend to complicate the test, but indecisive reactions may be indicative of this type of plant.

CONCLUSION

1. It is concluded that Mandel's paint does react with a broad spectrum of starches and sugars present in Carob twiglets and leaves during spring periods of growth flush,

2. By study of the arrangement of the staining positions of tissue, the sex of individual plants may be identified.

3. Hermaphrodite plants are regarded as those plants which give an indecisive reaction. More investigation is required in this area of the technique.

4. Proof of the ultimate validity of the technique can only be had through observation of outplanting of the test plants, or grafting to mature trees to hasten the results.

5. The staining reaction is perishable. Approximately 24 hr after treatment, the staining is no longer evident. Fixing of the reaction will be necessary for storage of reacted specimens. Fixing could not be done in these tests because of lack of reagents.

Table 1. Reactions to Mandel's Paint, tests on carob (Ceratonia siliqua)

Sample No.	*Twiglet*	*Leaflet*	*Assessed sex*
1	Pale to mid purple in circular ring	Pale to nil	Male
2	None	Pale, scattered	Male
3	Dark purple	Dark staining	Female
4	Dark purple	Pale	Female
5	Mid to dark colour (scattered)	Dark purple/black	Female
6	None	Dark	Female (poor sample)
7	Light purple/black in circ. bundles	Nil or pale	Male
8	None	Dark to mid colour and pale (2 samples)	Female (poor sample)
9	Dark purple/black	Dark colour, dried out quickly	Female
10	Dark .. scattered	Medium colour	Female
11	Mid to dark, scattered greenish periphery	Nil or pale	Male
12	Dark, circular	Dark, circular	Female

ACKNOWLEDGEMENTS

My thanks and gratitude are expressed to Mr Marshall for his patience and cooperation in these tests.

1. Reaction Considered to Indicate Male Plants

Twiglet Oblique Section

Green/yellow tissue with scattered black flecks and generally discontinuous in central tissue

Leaf Petiole

Green/yellow tissue with scattered black flecks and marked black blobs around central tissue

2. Reaction Considered to Indicate Female Plants

Twiglet Oblique Section

Marked blackish concentric coloration of tissue

Leaf Petiole

Also marked black concentric tisue coloration with reddish-purple outer layers

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USEFUL PALMS OF THE BORASSOIDEAE FAMILY:
BORASSUS AND HYPHAENE

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These palms belong to the family Borassoideae - the Palmyra Palms - and a brief description of the family features (Whitmore, 1977) is given below.

> *Massive solitary fan palms. Leaves are very large and with ridges on both surfaces; the blade divided at the margin into induplicate pointed leaflets with a terminal leaflet; stalk without marginal spines, the base massive and splitting. Palms are dioecious. Inflorescences are stout, not much branched and hanging down through the split leaf bases. Flowers are spirally arranged on thick spines. Petals overlapping; male flowers are solitary or sometimes grouped and generally covered by large, overlapping bracts. Female flowers are solitary, larger than the male (except in Hyphaene). The ovary is syncarpous generally with three chambers. Fruits are large with a fibrous-fleshy wall; seeds, one to three in each fruit each with a hard stony coat; the endosperm is massive and the ovule produces a long cotyledon stalk on germination.*

Palms of this family are found in Africa and Asia and comprise 6 genera and 20-40 species.

BORASSUS

Commonly known as the Palmyra Palm in India and Ceylon, or Lontar in Indonesia, the genus comprises four accepted species (Uhl & Dransfield, 1987), two of which, *B. flabellifer* L. and *B. aethiopum* Mart., are widely-distributed and important economic plants. A third species, *B. sundaicus* Becc, has a limited use in eastern Indonesia where it is grown as a commercial crop in dry, poor, agricultural soil, where it is used to reclaim otherwise non-arable land (Baskoro, 1984). According to some authorities the taxonomic distinction between *B. flabellifer* L. and *B. aethiopicium* Mart is tenuous in the extreme and, based on their relative economic uses and capabilities, Burkill (1966) considers them identical.

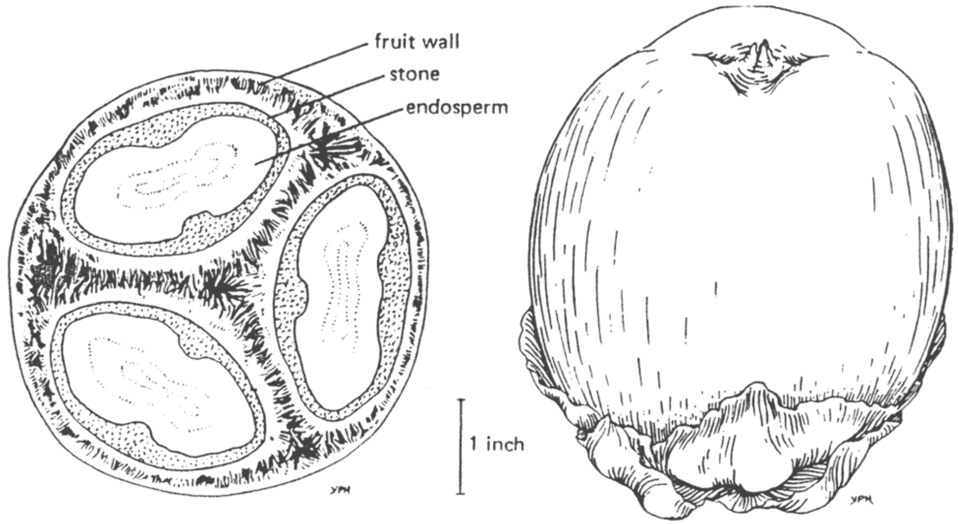
In the same way this author suggests that *B. sundaica* Becc., from Malaysia, should not be distinguished as taxonomically distinct from *B. flabellifer*. Whitmore (1977) also describes from Malaya a closely related genus *Borassodendron* which grows to 25 feet and has a large, untidy crown of dark, shiny leaves. The genus is characterised by the presence of flanges which penetrate towards the centre of the fruit from the stoney wall, reminiscent of the deeply lobed coconut *Lodoicea*.

B. flabellfer L. is distributed in many tropical countries but reaches its zenith, both as a conspicuous feature of the landscape and as a commercially important crop, in India, where it is found in great groves on the coastline from Bombay to Madras. To the east it is found in the dry areas of Burma and extends down the Thai peninsular until it reaches Kedah in Malaya. Further south in Malaya the climate is too wet and these palms can only be maintained by cultivation (Burkill, 1966).

In India, *Borassus* is a very important palm, and it has been estimated that as many as 40 million palms may be growing in Tamil Nadu State alone (Davis and Johnson, 1987), making it one of the most common trees in India, ranking second only to the coconut palm. Blatter (1926) offers an extensive account of its uses in India and quotes an ancient Indian poem, which lists no fewer than 801 different uses for the palm, and indicates that this palm has been deeply involved in the prehistory, literature, and folklore of India since the earliest period of civilisation on that subcontinent.

For instance, it has been suggested that the earliest form of Sanskrit writing was made on palm leaves some 6000 years ago (Ferguson, 1888). Further, the origin of the English terms "leaf' and folio" in relation to book printing are probably derived from palm leaves writing (Davis and Johnson, 1987).

Apart from the usefulness of the palm leaves as thatching material and for wrapping, the main economic attributes of Borassus palm are its food products such as fruits, nuts and palm hearts; in the extraction of sap for conversion into Toddy and/or Palm Sugar; its timber and its fibres. Each of these features will be discussed below.



Fruit and fruit cross section in Borassus flabellifera

Mature palms produce 200-300 spherical fruits each year, each measuring 15-20 cm in diameter and each weighing, on average, 1.5 kg. Immature fruits are green but later become ark-purple to almost black (Davis & Johnson, 1987). Immature fruit are removed when the endosperm is still soft, sweet and gelatinous and sold in the marketplace. The fruit are sliced and the jelly-like endosperm is eaten, either raw or it maybe sliced and served in syrup. Mature fruits develop a fibrous, yellow mesocarp which can be eaten raw or baked, often being mixed with sugar. Each fruit bears three nuts, in which the mature endosperm is hard and bony and has no direct human use. However, germinating seeds develop a starchy, edible tuber. Davis & Johnson (1987) describe the process thus:

> *"Seeds of mature palmyra fruits harvested for the mesocarp pulp are germinated in mounds of loose soil about 1-15 m high. The seeds are sown in the top of the mound and watered regularly; within 45-60 days they germinate. The embryonal axis grows downward within a long apical tube into the soil and strikes roots. Growing upward from the roots is a bladeless first leaf within which there accumulates food material translocated from the endosperm, thereby forming the starchy tuber. These tubers measure about 15 cm in length and 2.5 cm in width.*
>
> *Harvested before the plant begins its above-ground growth, the tubers weigh an average of 60 g; about half the weight is made up of usable starch. Assuming that a single tree bears 200 -300 fruits each year, and that each fruit contains three seeds, the germinated seedlings could potentially yield 18-27kg of starch. If they are dried after harvest, the tubers may be stored for several months."*

These authors make the pertinent point that starch obtained from these tubers may offer a commercial source for the production of industrial alcohol, though they caution against the widespread consumption of the starch, as preliminary toxological studies have shown it to possess both a hepatoxic and neurotoxic effect upon experimental animals.

'Palm hearts', i.e. the succulent growing points of the palm, are edible but it is suggested (Davis & Johnson, 1987) that they are unlikely to be an important commercially untenable except in areas where palms are being removed for land clearing or some other purpose.

Perhaps the most valuable commercial product of the Palmyra palm is its sap, which can be drunk fresh or allowed to ferment into 'palm toddy' or 'palm wine'. The sweet sap is also the source of 'palm sugar' which itself is a valuable source of carbohydrate for further fermentation into alcohol and/or vinegar.

Although methods of obtaining palm sap vary from country to country, the overall practice is basically similar. The tapper climbs the trunk of the palm and removes the terminal leaves to expose the young inflorescence. Regardless of whether the tree is male or female, the inflorescence axis is beaten with a wooden stave. It is said that in Tamil Nadu State in India, female inflorescences yield a large quantity of sap.

The bruised inflorescence is then cut and the exuding sap allowed top into a container, and in some areas a fresh cut in the inflorescence is made later in the day to yield more sap. The collected sap is taken directly to toddy shops, where it is sold and drunk immediately. However, naturally occurring yeasts in the sap bring about rapid fermentation, and by the time it reaches the consumer it has an alcohol content of about 5-6%; this is referred to as palm 'toddy'.

Fermentation can be prevented by the addition of lime (calcium hydroxide) to the collection vessel. It is said that in Tamil Nadu a single palm can yield up to 150 litres of sap annually, and the cut inflorescences produce sap for 3-5 months (Davis & Johnson, 1987). In Burma palm sap is collected in a similar manner, but here the actual method of collection, by means of ancient-style equipment, testifies to the antiquity of the practice, particularly in remote villages (Friedberg, 1977). Analysis of palm sap varies little from country to country; it contains approximately 15% sucrose with a pH of 6.4-6.9 (Franke, 1977; Friedberg, 1977). The most complete analysis of sap has been provided by Davis and Johnson (1987), based on the work of Paulas and Muthukrishnan (1983) and this is reproduced below.

Composition of Palmyra Sap

Specific gravity	1.07
pH	6.7-6.9
Nitrogen	0.056 g/100cc
Protein	0.35 g/100cc
Total sugar	10.93 g/100cc
Reduced sugar	0.96 g/100cc
Minerals as ash	0.54 g/100cc
Calcium	Trace
Phosphorus	0.14 g/100cc
Iron	0.4 g/100cc
Vitamin C	13.25 g/100cc
Vitamin B1	3.9 IU
Vitamin B complex	Negligible

Palm sugar, known also as jaggery in many parts of the East, is produced locally by allowing the filtered sap to boil in square containers until it thickens, and it is then poured into half shells of coconut to set. The resultant 'cake' is deliquescent because of the presence of salts in the sap, and in order to keep the 'cakes' dry they are either rolled in flour or else rice-flour is added to the boiling, thickening sap (Burkill, 1966). Palm sugar is also made on a commercial scale, but the sap is first slaked with lime and supplemented with either phosphoric acid or superphosphate (Davis & Johnson, 1987).

Two commercially viable "spin-offs" from the production of palm sap are vinegar and alcohol. Vinegar production occurs naturally when palm sap is allowed to ferment anaerobically, and is the basis of many local industries. The potential value of commercially produced alcohol, however, is only now being realised, and an exploratory investigation by Jeyaseelan & Seevaratnam (1986) has recently explored the commercial viability of utilising palm sap to produce both alcohol and a secondary protein source.

Results indicated that by careful selection, strains of *Saccharomyces cerevisiae* (the wine yeast) could carry out the fermentation process on crude sap to yield high levels of alcohol and a yeast biomass that was higher in levels of essential amino acids and protein than conventionally grown yeasts (*Candida utilis*) grown on molasses. Studies on animal nutrition confirmed his. Such work offers a new biotechnology to many regions of Asia where toddy drinking is discouraged, and where natural yeasts could bring innovative methods of commerce to even the most primitive areas where palms are grown and tapped.

Two other commercially useful byproducts of Palmyra palm are fibres and timber, and Burkill (1966) lists five separate kinds of fibres produced by a single palm: a loose fibre from the base of the leaf stalk; a long fibre from the leaf stalk; a fibre from the interior of the stem; a fibre or coir derived from the pericarp; and the fibrous material of the leaves.

Local usages of the various fibres produce beautiful local basketware, cord, rope, and matting. The leaf-base fibre is the raw material for the production of brushes, and this type of fibre is an important export commodity from various regions of India. Exact chemical and physical analyses of Palmyra fibres have been provided by Venngopal, Satyanarayana & Lalithambika (1984), who showed that these fibres have 41-49% cellulose and 28-43% lignin as their major constituents; while the mechanical strength of such fibres has been investigated by Satyanarayana et al. (1986).

Palmyra palm yields the only available timber in parts of India, and although the outer part of the trunk yields very hardwood, this portion is only a few inches thick (Burkill, 1966). This author also states that the male palm wood is harder and stronger than the female. An 85 year old palm can provide a stem some 20 m tall, and the strongest wood is said to occur in the lowermost 3 m from the base, while the uppermost section of some 8 m cannot be used as timber and is sold as firewood (Davis & Johnson 1987).

HYPHAENE

Commonly referred to as the Doum Palm or Dum Nut Palm, the genus comprises some 30 species distributed in Africa, Madagascar, and Arabia (Willis, 1966). Important economic species also occur in India and other parts of Asia, though considerable controversy ensues among taxonomists regarding the exact speciation within the genus. It was generally thought that the genus was endemic to Africa and that species occurring in Asia were acclimatised imports. However, a recent study by Furtado (1970) suggests that the common epithet *Hyphaene thebaica* described from Israel and Ceylon should be renamed *H. sinartica* and *H. taprobanica* respectively. A third well known species, *H. indica*, from the North West coast of India, should be renamed *H. dichotoma*, while a fourth species, *H. reptans*, has been recorded from the mountains of Arabia. Notwithstanding these new taxonomic developments the major species described in this paper is *Hyphaene thebaica* L. Mart. - the common Doum Palm of Egypt. Another species *H. natalensis* the Lala (or Ilala) Palm from Tongaland in Natal province is also mentioned as a source of wine.

Hyphaene is botanically interesting as it is the only genus of Palms in which the trunk branches above ground. The most well known species, *H. thebaica*, has a long history of cultivation in Egypt as far back as 1800 B.C. and is now an economically useful plant in many arid regions of the world. The following account of *H. thebaica* is a composite based on the descriptions by Purseglove (1975) and Whitmore (1977).

> *Dioecious branched palms with spreading branches, growing to 15 m in height and found growing in Savannas and semi-arid regions of tropical Africa and W. India. Usually 4 crowns are produced following the dichotomous branching of the stem, but occasionally 8, and rarely 16, are produced, each bearing a crown of 8-20 flabellate leaves measuring 130-180 cm broad, made of 20-40 segments. The inflorescences are axillary in the lower leaves and consist of 4-10 spadices each 2 m long. Male and female flowers are of equal size and pollination is by means of wind currents. The fruits are oblong, brown, smooth, indehiscent drupes 7.5 x 5 cm in size and ripening in 8-12 months. The mesocarp smells and tastes of gingerbread and the endocarp is dark brown and hard. The single seed is ovoid with a very hard, white endosperm..*
>
> *The mesocarp is edible, and may be eaten raw or ground into a flour. The hard endosperm has been used in India as vegetable ivory and hand-crafted into buttons and beads. The endosperm is not as hard as real vegetable ivory produced from Phytelephas seemannii from South America. The young kernels of the seeds are edible.*

Analyses of the chemical composition of kernels has been made by Amin and Paleologou (1973) who showed it consisted of. 11.3% oils; 7.0% protein; 1.72% ash; 11.76% moisture; 37.2% cellulose; and 30% mannans. The most important commercially exploitable component of the kernel is the sugar D-mannose, and extraction of this component was achieved following acid hydrolysis (Sallem, 1977), resulting in a 20% overall yield. Analysis of the woody endocarp was also investigated and this was found to consist of 23% xylan and 52.3% cellulose. Following methylation of the B-linked xylan, the degradation products confirmed the presence of 1-4 linkages in the chain, and that C-3 was the point of branching in the molecule.

Pesce (1985) has further suggested that the manocellulose found in the seeds can be transformed into glucose mannose, which in turn can be fermented by means of yeasts into alcohol. Transformation into cellulose can be achieved either by 5% hydrochloric acid or by the involvement of diastase extracted from germinating palm seeds.

As with many tropical fruits which constitute at least a portion of man's diet, investigations into their pharmacological properties appears to be a never-ending source of study for physiologists. When investigated chemically by Sharaf et al (1972) the fruits of Hyphaene proved to:

"contain alkaloid, reducing sugars and glucosides. The aqueous extract stimulated the contractions of frog's heart and rat intestine but inhibited uterine contractions in rats. On the arterial blood pressure, the extract proved to be capable of lowering the blood pressure both in normotensive and hypertensive anaesthetised dogs. The mechanism of its hypotensive action proved to be through ganglionic blockage. The extract had no diuretic effect in rabbits and was devoid of oestrogenic and androgenic properties when tested on uterine and seminal vesicle weights of ovariectomized and castrated rats."

In another investigation, Amin & Paleologou (1973) demonstrated that both the nut kernels and pollen grains of *H. thebaica* contained the animal hormone estrone, through the significance of the discovery was not discussed.

The other well established species of *Hyphaene* is the Lala (or Ilala) Palm of South Africa. This species is now recognised as *H. natalensis* Kunze, though it was formally known as *H. crinita* (Furtado, 1970). At present the Lala Palm occupied an area of approximately 156,000 ha in Tongaland and Northern Zululand, and the total number of individual palms is estimated at about 10.5 million.

Moll (1972), in an outline scheme to utilise the leaves for commercial fibre, estimates that with adequate management it is possible to collect some 33 million leaves annually. This writer also explores the commercial exploitation of the sap of these palms, which when allowed to ferment yields a potent drink known locally as ubusulu, which, because of the involvement of yeasts in the fermentation process, provides essential vitamin B, riboflavine and nicotinic acid in the diet of the local Bantu tribes.

Amino Acids in Hyphaene Sap (µmol/100ml)

	Yeast-free sample	Whole sample
Lysine	600	253
Histidine	180	195
Arginine	215	215
Threonine	475	310
Serine	1070	1085
Glutamine	305	280
Proline	235	110
Glycine	504	515
Alanine	1975	1985
Valine	75	35
Isoleucine	50	40
Leucine	55	50
Tyrosine	30	30
Phenylalanine	45	60
TOTAL	5814	5163

Not detectable: cystine, methionine, aspartic acid.

In a detailed investigation into the chemical composition of the fermented sap, Nash & Bornman (1973) offer the following information. The viscous sap had a pH of 6.3 to 6.8, and the only reducing sugar detected was glucose. Following filtration of the fermenting yeast cells, thiamine & nicotinic acid were detected, along with 2% ethyl alcohol and the amino acids indicated in the table.

The authors concluded that palm wine was a useful dietary supplement, supplying essential iron, nitrogen and sugars. They further suggested that the wine may acquire a higher nutritive value after a period of ageing, when yeast cells have autolysed and released their contents.

In discussing the growth characteristics of the various species of *Hyphaene* one immediately runs into difficulties. For example, *H. ventricosa* is referred to as a species with "bulging trunks" (Bailey, 1976) while Menninger (1977) refers to *H. ventricosa* as the Gingerbread Palm or Doum Palm and appends the following description from the Victoria Falls area of southern Africa:

"HYPHAENE VENTRICOSA PALM

Native Name. Mulala; Popular Name: Vegetable Ivory Palm

This beautiful Palm Tree grows principally on the islands and banks of the Zambesi River, in the vicinity of the Victoria Falls. The Palm attains a height of 60 feet or more.

The fruit is the shape and size of a small orange. It is covered on the outside by a thin shiny brown skin. Beneath this is a thicker layer of a fibrous nature which forms a popular diet for elephants, monkeys and baboons. This portion of the fruit is also edible to humans. A third very hard fibrous layer encases the kernel, which is inedible, extremely hard, and is extensively used in the manufacture of curios. Until the advent of plastics, Vegetable Ivory was used for the manufacture of studs, buttons, etc."

Another important species appears to be the Indian Doum Palm, H. indica Beccari, which is characterised by frequent dichotomous branching of the stem (Oza, 1974). Remarking on the distribution of this species, Meher-Homje (1970) notes: "The endemic occurrence of the species in the erstwhile Portuguese territories is a noteworthy feature .... *H. indica* seems to a case of early introduction on the west coast of India".

Doum Palms are said to be easy to cultivate, and the plants thrive in protected places in, for example, Southern Florida (McCurrach, 1960). The photograph on page 105 of McCurrach's book 'Palms of the World' shows a heavy crop of fruit in southern Florida - this hopefully might serve as a stimulus for wider planting of this palm.

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HIGH DENSITY PLANTINGS OF MACADAMIA

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ABSTRACT

Macadamia cultivar 246 planted in hedgerows (5 x 3 m) produced comparable yields at five years of age to low density trees (10 x 5 m) at 10 years of age. Close spaced H2 trees at 10 years produced 6 t/ha compared to 3 to 4 t/ha for wide spaced 246 and 508 trees.

However, close spaced 246 and 508 trees produced only about 3 t/ha. H2 produced 90% higher yield compared to 246 and 508 over a 4 year period. Lower kernel quality of 112 reduced the advantage of grade 1 kernel to 60% compared to 246 or 508. Annual mechanical hedging of high density orchards is essential to allow maximum light penetration of the canopy. Shading inside hedgerows does not appear to greatly affect kernel quality.

PRODUCTION

Tree training and orchard management of macadamias is new compared to apples, where dwarfing rootstocks are used to increase precocity. Growth retardants (Paclobutrazol, IAA) are used to reduce vegetative growth in peaches. More recently Mitchell (1982) withheld water and nutrients to increase precocity in peach orchards.

Macadamia production in Australia is based on Hawaiian selections which have a narrow genetic range and hence do not reach the yields of 7-8 t/ha recorded in Hawaii from 10 year old trees planted at a density of 200-250/ha. Tree training in Australia starts in the nursery to develop a central leader. After planting out it aims at removing V-shaped crotches and poorly spaced main branches. Further training occurs later to accommodate mechanical harvesting. However, the general experience has been that yields do not reach the levels achieved in Hawaii (Ainsbury, 1983).

Information collated from conventional spacings and data from a closely spaced early pruning trial (Trochoulias, 1983) together with subsequent observations of yields from high density plantings will be used to extrapolate information which will help interpret the merits or otherwise of high density plantings vs. conventional spacings.

A HISTORY OF MACADAMIA SPACING IN AUSTRALIA

CSR's early plantings in Queensland were at a spacing of 11 x 4.8 m. This was also the pattern in NSW (10 x 5 m) in the early 1970's. In the late 1970's closer spacings (7 x 4 m) were introduced in NSW (Wilkie, personal comm.). The closest spacing attempted was an innovative 5 x 3 m by H. Baisi at Whian Whian in 1976. Trees were supported on a five stranded wire trellis to a height of 2 m and pruned to a modified palmette system. This was very labour intensive. When trees started to crowd after year 6, the then plantation manager, R. Bowen, introduced a hydraulically driven circular saw pruner on articulated arms, which reduced the labour component for pruning from 10 men all year to 0.4 man years for a 40 ha plantation.

Growers currently considering high density plantings are favouring a spacing of 6 x 3,6 x 4. or 7 x 4 m, which allows easier access for equipment. There has been a trend towards upright trees such as 344 and 660 which are self supporting and need little pruning. Minimum pruning in the early years is desirable (Trochoulias, 1983) especially as a strong framework recommended for single trees is not as critical for trees growing in a high density system.

In broadacre spacings yields have varied from 3.3 to 6.0 kg/ha, depending on cultivar and season, for 10-12 year old trees in selected experimental plots (Stephenson, 1986). Data from the high density planting at Whian Whian are presented in Table 1.

The 1982-83 pruning trial ('A', Table 1) showed that unpruned 5 year-old trees produced 3.3 t/ha, which compares very favourably with a range of 3.7 to 6.0 t/ha from selected 246 trees (" D", Table 1) ranging from 10-12 years of age. Spooner (1983) considers 4.0 t/ha to be the average yield of most mature trees in Australia.

A comparison of close spaced H2, 246 and 508 over a period of four years showed that H2 produced about 90% higher yield than 246 or 508 (Fig 1). The data were collected from 2-3 rows of 40 trees for each variety. Outside rows were not included because of light interception advantage compared to inner rows. With the examination of kernel recovery from 1985 to 1987 across the three varieties (Table 2), the advantage of H2 is reduced to about 60% over 246 and 508 when expressed as t/ha of grade 1 kernel (Table 3) in 1986-87.

It does, however, support the contention by Chapman (1984) that open type canopies have the potential for higher yields. It will be interesting to observe the level of productivity that can be achieved

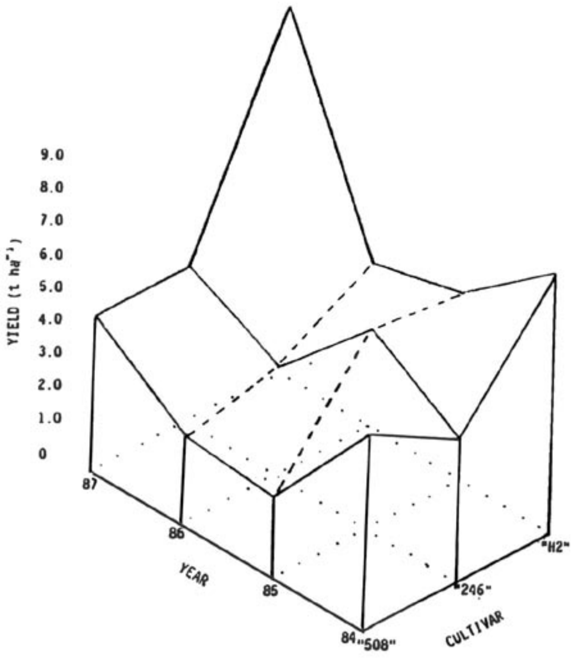

Fig. 1. Yield (t/ha) of cultivars 508, 246, and H2 at Whian Whian from 1984 to 1987

with cultivars which have a high fruiting efficiency (yield per unit volume) and kernel recovery such as A4 and A16 (Bell, 1988). Meanwhile it appears that 7-10 year old H2 trees in a high density orchard will produce about 6 t/ha (Table 1).

Table 1. (Nut-in-shell) Yield (t/ha) of 246, 508 and H2 cultivars closely spaced from 1982 to 1987 at two sites (A and B) compared to conventional spacing (C) from 1980 to 1981

Year	Site	Age	246	508	H2
			unpruned (5 x 3 m spacing) Whian Whian		
1982	A	4	0.9	- -	--
1983	A	5	3.3	- -	--
			mechanically pruned (5 x 3 m spacing) Whian Whian		
1984	B	7	3.5	4.7	7.4
1985	B	8	4.9	2.0	4.6
1986	B	9	2.7	2.1	4.0
1987	B	10	3.8	3.8	9.0
			conventional planting (after Stephenson et al 1986) Qld.		Dunoon 11 x 5.5 spacing
1980	C	10	4.7-6.3	4.4-5.3	0.9
1981	C	11	3.7-5.5	4.0-4.6	1.9
1982	C	12	5.7-6.0	3.0-4.2	2.1
Mixed 246, 508 and H2 mechanically pruned (5 x 3 m spacing) Alstonville					
1984	D	3	2.4		
1985	D	4	2.7		
1986	D	5	2.3*		
1987	D	6	4.5		

* Pruned in October instead of May
+ Harvest not completed 230

246 and 508 had lower production under high density compared to conventional spacing (Table 1). This is probably due to the closed crown of 246 and 508 which reduces light penetration.

Nut quality combined with yield determines the total quantity of grade 1 kernel produced per hectare. There was some concern that the quality of nuts in a high density macadamia orchard would be poor because of exposure to low light intensity.

A small number of samples examined for kernel recovery in 1985 and for kernel recovery and quality in 1986 and 1987 showed that there was no apparent quality difference between nuts sampled from high or low in the canopy from ground level (Table 2). 508 cultivar showed a greater percentage of A grade quality nuts in 1985 compared to 246. The same trend to a lesser degree occurred in 1986. The percentage recovery of grade 1 kernel from H2 was in the high 90's although the kernel recovery was low.

Table 2.- Qualitative determinations of two samples from two heights 1.5 (L) and 3.5 (H) m in cultivars 246 and 508 at Whian Whian in 1985 to 1987.

					Taste panel results		
Cultivar	sample height	Mean kernel weight	% kernel recovery at 1 .5% moisture	%A grade kernel recovery after floatation	Colour	Texture	Flavour
1985							
246	L	2.85	36.8	79.9			
	L	2.79	36.9	88.3			
246	H	2.80	36.9	86.4			
	H	2.91	37.4	77.3			
508	L	2.24	38.8	97.9			
	L	2.31	40.0	96.5			
508	H	2.35	39.4	94.7			
1986							
246	L	3.02	38.2	83.2	6.5 + 0.8	6.8 + 0.8	6.5 + 1.3
	H	3.06	40.0	94.2	6.9 + 1.2	6.9 + 1.1	6.6 + 1.3
508	L	2.77	40.8	99.3			
	H	2.72	40.2	96.8			
H2	L	2.43	31.8	97.3	5.9 + 1.0	7.0 + 0.9	6.4 + 0.9
	H	2.45	34.1	97.1	6.9 + 1.1	6.8 + 0.9	6.6 + 0.9
1987							
246	L	3.26	39.9	92.2			
	H	3.36	38.7	95.8			
508	L	2.73	40.3	95.0			
	H	3.14	40.1	95.6			
H2	L	2.45	33.7	84.9			
	H	2.63	35.4	90.5			

Table 3. Tonnes of A grade kernel per hectare for various varieties from 1985 to 1987

	246	508	H2
1985	1.5	0.76	
1986	0.92	1.02	1.13
1987	1.02	1.12	2.22

When yield and quality data were collated (Table 3), 12 had a greater yield of grade 1 kernel per hectare than 246 or 508 in 1986. Yield of 246 did not vary greatly from 1985 to 1987 while that of 508 showed greater variation. More data is required to establish the relationship between light interception and nut quality in a high density planting.

FACTORS WHICH NEED TO BE CONSIDERED IN PLANNING HIGH DENSITY PLANTINGS

Site and spacing to minimise erosion

In high density orchards (6 x 3 m) erosion can be minimised on gentle slopes by planting on low mounds and creating a slightly dished drain (Firth, 1988) to divert water downhill. In steeper slopes the interrow space should be opened to 7 or 8 m with trees kept at 3-4 m in the row. Mulching from prunings as the trees grow and the close matting of roots from a large number of trees helps reduce erosion as the interrow space is shaded out. Shade tolerant grasses or legumes that do not interfere with pruning operations would further assist in erosion control. Burnside (Pers. comm.) has stated that he has noticed less erosion in high density plantings compared to some conventional orchards.

Orientation of rows

Machinery access, slope of land and length of row are all more important than north-south orientation, which may have minor benefits to light interception in these latitudes (Cull et al, 1983). North-south orientation might have a slight light advantage compared to east-west, but if maintaining cool temperatures for roots during hot dry conditions is important the east-west orientation may be preferable.

Light interception

Canopy structure that allows efficient light interception is well documented in deciduous fruit (Jackson, 1980, 1982; Baldini, 1974). The influence of light intensity on yield and nut quality has not been thoroughly researched. The data presented in Tables 1 and 2 suggest that a cultivar such as H2, which probably allows deep penetration of sunlight because of an open crown, is likely to produce higher yields than 246 or 508, which have higher external foliage density. New cultivars which have low density foliage but high kernel recovery and percentage grade 1 such as A4 and A16 (Chapman, 1984) have the potential to greatly improve productivity of high density macadamia orchards.

Pruning

Pruning is required in high density orchards to allow access for machinery and pest control. A field pruning trial was attempted in 1984 at Whian Whian. Upright, diamond, open pyramid and closed pyramid shapes were to be compared in a replicated trial using 10 tree plots. Torrential rain in 1985 moved nuts to the ends of tree rows which made comparisons impossible. The trial was subsequently abandoned. However, the mechanical pruning operation has found a 105° hedge, allowing 1.2-1.5 m between rows at ground level and wider at the top to allow sunlight penetration, the easiest to manage.

The best time for pruning is after harvest and before peak flowering. Post flower pruning (October) was shown to be detrimental to yield (Table 1). Pruning induces vegetative growth, and growth is minimal in winter months, and it is postulated that most storage carbohydrate would be diverted to reproductive growth with the onset of spring, providing enough fruiting sites have been left.

The mechanical pruner in use has a vertical cut of 7.5 m and a maximum horizontal cut of 5.5 m. When trees grow beyond this height some form of topping will have to be used. Trees higher than 8 m make pest management very difficult. An attempt to remove 2.5 m of top growth from every second row was undertaken at Whian Whian in 1987. A growth regulator (Paclobutrazol) was used to reduce vegetative growth. Internodal growth was shortened for a period of 3 weeks but required repeated spray applications to suppress growth. After one year regrowth at the level of topping was very crowded, causing shading of the canopy underneath. Light trimming at an earlier stage when trees are 3-4 m high may delay the time when major pruning such as topping will be required.

Vegetative/fruiting balance

Pruning manipulates the tree from a vegetative to a floral mode if this is done in winter when vegetative growth is minimal. More light is allowed into the canopy which probably enhances fruiting. There is a need to study in detail the effects of light on productivity. A model could be developed and then measurements made on several cultivars of the spatial relationship of leaves, flowers and nut development within a canopy.

Respiratory losses

As trees age the proportion of energy lost to respiration increases (Landsberg, 1986). There is little or no data on respiration losses in tropical or sub-tropical forests to gain some guidelines. Benecke and Nordmeyer (1982) estimate that respiration losses of conifers from branches, stems and roots range from 25 to 50% of assimilated carbon. About half is attributed to fine root turnover. Parasitism of the root system by nematodes could therefore cause a major drain of assimilates and severely reduce productivity.

Windbreaks

High density orchards need only have windbreaks from prevailing winds on the perimeter. This is a substantial saving in orchard area where conventional orchards require up to 15% of ground area to be devoted to windbreaks. High density plantings can reduce the impact of cyclonic winds. Damage might occur to isolated limbs whereas trees in conventional orchards can suffer major structural breakage and blowdowns.

Advective (wind) effects under normal conditions are reduced in a high density orchard. Tensiometer measurements have shown lower readings in high density plantings compared to data from low density sites.

Table 4. Comparison of screen temperatures at Whian Whian and Dunoon in January, 1987

Date	T max		T min	
	Dunoon	Whian Whian	Dunoon	Whian Whian
9/1	29.8	31.7	11.2	17.5
10/1	30.4	29.9	17.4	20.9
11/1	28.8	32.8	15.4	18.5
12/1	30.4	32.0	16.4	19.8
13/1	30.4	32.6	15.2	18.9
14/1	30.2	32.0	17.2	20.9
15/1	30.0	31.3	16.6	20.3
16/1	33.0	34.4	17.2	20.5
17/1	31.4	33.8	16.6	21.2
18/1	33.8	36.0	18.6	19.8
19/1	34.2	35.6	19.4	22.5
20/1	36.0	36.9	15.4	22.3
21/1	31.4	32.0	20.4	19.4
22/1	36.2	35.3	19.4	23.9
23/1	28.4	30.2	16.6	22.5
24/1	25.2	26.8	17.0	20.3
25/1	26.6	26.6	16.8	20.9

Table 5. Gross returns ($) for macadamia in a low and high density orchard
Low DENSITY (250 trees/ha)

	YEAR									
	1-3	4	5	6	7	8	9	10	11	12
Yield/tree kg	0	0.5	1	4	6	10	12	15	16	18
Yield/ha	0	125	250	1000	1500	2500	3000	3750	4000	4500
Gross returns @$3.00/kg	0	375	750	3000	4500	7500	9000	11250	12000	13500

HIGH DENSITY (660 trees/ha)

	YEAR									
	3	4	5	6	7	8	9	10	11	12
Yield/tree kg	0.3	1	3	5	6	8	10	10	10	10
Yield/ha	198	660	2178	3300	3960	5280	6600	6600	6600	6600
Gross returns @$3.00/kg	594	1980	6534	9900	11880	15840	19800	19800	19800	19800

Orchard thinning

If pruning does not arrest yield decline, the next step would be to remove every second row resulting in a spacing of 225 trees/ha. Whole trees can be removed with root ball and replanted at a new site with potential of producing a commercial crop in two years. The alternative is to remove trees by chainsaw at ground level.

Tree replacement

In the long term, if tree thinning results in very tall trees with declining yield, and presents difficulties to manage from a pest point of view, consideration should be given to replacing the thinned out orchard with a high density orchard again. This would probably take place after a season of resting the soil, cover cropping, and adjustment of nutrients before planting. 20-30 years of cropping may be possible before the need for tree replacement is required. One of the problems that may have to be faced with high density is earlier tree replacement. However even if trees have to be removed in 15 years because of declining yields the opportunity could be taken to plant newer cultivars with a greater productivity index (production per unit volume of canopy). The gains from early cash flow in a high density planting are more than likely to compensate for the later returns and reduced productivity of low density orchards.

Rootstocks

Rootstocks can be a very important component of high density orchards. However, in Hawaii (Hamilton, 1974) and Australia, no single rootstock cultivar is preferred commercially. Preliminary experimental data (Trochoulias, 1987) suggest that eight commercial scions are performing better on tetraphylla rootstock compared to integrifolia. The same scions are growing faster on seedling rootstocks compared to clonal rootstocks.

Clonal 'Beaumont' has been used as a rootstock commercially in South Africa for some years (Allan, pers. comm.). This cultivar has been reintroduced into Australia and is showing promise for its ability to form a vigorous root system (Trochoulias, 1987a).

Herbicides

High density plantings require less herbicide applications compared to low density plantings in the first year due to greater area covered by trees. With the commencement of vertical pruning in 4 to 5 years the grass strip will be completely shaded out, requiring little or no herbicide.

Pesticide application

There is no evidence that high density plantings increase pest and disease problems. Conversely, in a mature high density planting, close interrows ensure minimum wastage of pesticides used.

Mulching

Leaf drop provides mulch early in the life of a high density orchard with the protected environment assisting the accumulation of leaf litter. With annual hedging, the prunings can be pulverised to form mulch 2-5 cm deep which, when added to the leaf litter, helps prevent erosion.

Decline - Environmental stress

In low density plantings macadamia decline has been noticed mostly from the onset of cropping (Burnside, 1983). The oldest high density planting is now 14 years old. Decline is almost absent in 20 ha of trees 11-14 years old. Individual trees in a high density orchard are less likely to be subject to environmental stress from advection. Data from an environmental recorder (Table 4) indicate temperatures during heatwave conditions in January 1987 were higher at Whian Whian, compared to Dunoon which has a lower elevation (cooler site). Tree density is therefore unlikely to influence orchard temperature, which is dependent on locality. This is particularly evident from a small high density group of trees at Rockhampton where widely spaced trees are suffering from high temperature chlorosis (Trochoulias & Lahav, 1983).

Economics

Undoubtedly, the factor which makes high density plantings attractive to investors is the prospect of earlier returns and a shorter pay back period. The major outlay for a high density orchard is the capital outlay for twice the number of trees required compared to a conventional planting (Cull, 1983). Ainsbury (pers. comm.) suggests that the pay back period could be reduced from 15 years to 11 years, making it very attractive to investors.

Future developments

As macadamia becomes domesticated with inputs from plant breeders and horticulturists, the productivity index will increase and smaller trees will be developed, which will become better suited to high density plantings. Growers will also contribute by finding a practical method of pruning hedgerows to maintain a high level of production for as long as possible.

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[Based on a paper presented at ACOTANC-88, Lismore, NSW, October 1988]

HORTICULTURE IN THE USSR:
ITS CHARACTERISTICS, MAIN CROPS, AND THEIR DISTRIBUTION

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Horticulture in tsarist Russia developed slowly and was a backward branch of agriculture. During the period from 1887 to 1914 the area of orchards increased only from 444,000 to 655,000 hectares. After the Revolution, fruit growing began to develop quickly in collective and state farms. By the year 1940, orchards covered an area of 1,790,000 ha.

In 1929-1933 large specialized fruit-growing state farms were established all over the country. The A.M. Gorky Giant Orchard and "The Agronomist" in Krasnodar Territory, "The Agronomist" in Lipetsk region, and others became examples of intensive large-scale commercial fruit production.

Horticulture in the USSR suffered greatly during the war of 1941-1945. At the end of this war the area of orchards was only 1,360,000 ha. In the 1960's horticulture underwent intense development, and by the 1970's orchards and small-fruit gardens covered an area of 3,83 1,000 ha. The area of orchards has decreased lately because horticulture has been concentrated in specialized farms, with elimination of non-productive and frost-prone orchards. Thus the total area under orchards in 1987 was 2,937,000 ha. Their productivity increased from 2.62 t/ha in 1956-1960 to 4.42 t/ha in 1981-1985, and the gross yield increased from 3.036 to 10.262 million tonnes.

Further increase in production of fruit and berries in the USSR will be achieved through intensification of fruit growing through improvement of geographical distribution, further specialization, concentration and agro-commercial integration, increase in existing orchards' yielding capacity, uprooting of non-productive orchards, and establishing new intensive ones. In zones with favourable natural and economic conditions, orchards will be made on mountain slopes and in valleys; fertilization, irrigation and other elements of commercial horticulture will be widely used.

The main ways to intensify horticulture have been previously worked out and tested in practice. They depend on: a) selection of a limited number of valuable, productive, early-maturing, and regular fruit-bearing varieties that are in popular demand. These varieties should be characterized by hardiness, small stature, compact crown structure, and suitability for intensive culture; b) use of spur-type varieties; c) use of vegetatively-reproduced rootstocks producing controlled growth - very dwarf ones (20% of standard vigour), dwarf rootstocks (25%-30%), semi-dwarf (50%) and medium growth (75%); d) choice of tree separation in the row to suit scion-rootstock combination and type of crown formation (flat, compact and spherical crowns); e) avoidance of excessive pruning of young trees, through use of special training techniques to promote early fruit bearing and rapid achievement of commercial yields; f) devising and introducing commercial technologies based on all-round mechanization of agro-technical processes.

The number of botanical species, genera, and families of fruit crops increases from north to south, reaching its maximum in the Caucasus, Central Asia and the Far East. This is the basis of the zoning applied to orcharding of the USSR. Fruit-growing regions are traditionally divided into three zones: southern, central and north-eastern.

The southern horticultural zone includes some regions of Kazakhstan, the northern Caucasus, Transcaucasia, the Crimea, the southern part of the Ukraine, Moldavia, and Central Asia. Climate and soil conditions are favourable for growing such valuable stone-fruit crops as peach, apricot, sweet cherry, plum, as well as pome crops -dessert apple varieties and winter-ripening pears. Persian walnut, filbert, pistachio and almond are widespread here. Subtropical crops (fig, pomegranate, persimmon, olive) and citrus crops (lemon, mandarin) are cultivated on large areas. Berry crops, with the exception of strawberry, are poorly developed. The majority of orchards are either irrigable ones or require irrigation.

The central horticultural zone includes the northern part of the Ukraine, Byelorussia, Central Blackearth and Non-Blackearth parts of Russia, the Volga basin, the Baltic republics, and some regions of Kazakhstan. Apple, sour cherry, and, to a lesser extent, pear and plum are cultivated in this zone. Berry crops - blackcurrant, gooseberry, raspberry and strawberry - are widespread here. Production is concentrated round important population centres - Moscow, Leningrad, Gorky, Kazan and others.

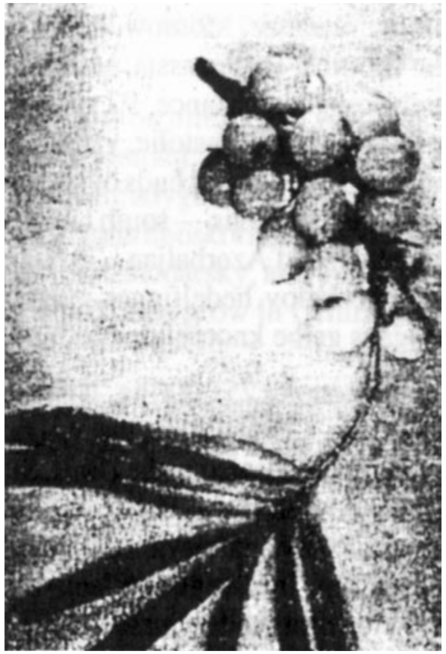
The north-eastern zone comprises northern regions of the European part of the USSR, the Urals, Siberia, and the Far East. Local winter-hardy apple varieties predominate here. Berry crops - blackcurrant, gooseberry, strawberry, sea buckthorn, actinidia and magnolia vine - are highly developed. Some of them (blackcurrant, strawberry, sea buckthorn) have a considerable share in commercial fruit growing, others (actinidia, magnolia vine etc.) - in smallholder fruit growing. In the Far East, plum, pear, and Manchurian apricot are cultivated.

The range of breeds and varieties of fruit and berry crops in the USSR is rich and varied, especially in the southern regions. All in all, 50 species of fruit and berry crops are cultivated in the country. Economically the most important of them are pome fruits - apple, pear, quince; stone-fruit crops - sour cherry, plum, apricot, sweet cherry and peach; nuts-Persian walnut, filbert; berries - blackcurrant, strawberry, gooseberry, raspberry.

Apple is the most common among fruit crops. It occupies more than 60% of the total area of fruit and small-fruit gardens. Next to it comes sour cherry - almost 8%, then comes plum (7%), pear (5.8%) and in southern regions - apricot (3.3%). Much smaller areas are occupied by sweet cherry (1.6%), peach (1.0%), quince (0.8%), walnut and filbert [Kurennoy, 1985].

Overall, pome fruits (apple, pear, quince) occupy 70.3% of the total orchard area of the USSR. Stone-fruit crops (sour cherry, plum, sweet cherry, apricot, peach) occupy 20.9%, nuts - 3.1%, subtropical and citrus crops - 1.6%, berries - 4.1%

In the majority of regions of commercial fruit growing, apple and pear rank first in yield and profitability. High economic efficiency of production is achieved with stone-fruit crops, especially with peach and apricot, in Central Asia, Transcaucasia and Daghestan. Plum production is very efficient in Moldavia, in the north-west Ukraine and in the northern Caucasus. Average yield of pome crops in the country is 4.26 t/ha, which is 33% higher than that of stone-fruit crops (3.21 t/ha). But in a number of zones of Tadjikistan and Uzbekistan, and also in Armenia, where apricot and peach are cultivated on a large scale, the yield of stone-fruit crops Is 30-50% higher and exceeds that of pome fruits.



The Sea Buckthorn, Hippophae ramnoides From: Nesterovich -- - Plody i semena]

About 10,000 varieties of fruit crops have been bred in the USSR, but only 1,540 of them are approved for production. Recommended varieties of fruit crops are determined for every zone and region, with correlation of crops and varieties being taken into account. Plant nurseries in each region breed and propagate only the varieties approved for that region.

It has already been mentioned that apple ranks first among fruit crops in the USSR and occupies an area of 2.3 million hectares. Total production is 6-8 million tonnes per year. Commercial cropping is centred mainly in the Ukraine, Moldavia, the Caucasus, Central Asia, Byelorussia, the Baltic republics, central Russia, and the northern Caucasus. At present 325 varieties are approved. Common commercial varieties are: a) summer ripening - borovinka, papirovka, melba; b) autumn ripening -anis polosaty; c) winter ripening -antonovka, pepin shafranny, severny sinap, calvil snezhny, renet semirenko, jonathan, golden delicious, red delicious; d) spur fruiting - starcrimson.

Pear occupies an area of 207,000 ha. It is less winter hardy than apple, and so is grown commercially mainly in the southern temperate regions: in the northern Caucasus and Transcaucasia, in the Ukraine, Moldavia and Central Asia. Small areas are occupied by pear in the Baltic republics, Byelorussia and in the Far East. 122 varieties have been approved. Of these, williams, clapp's favourite, cure, beurre bosc, beurre hardenpont, bergamot osenny, bessemyanka, and tonkovetka are widespread.

Quince occupies a comparatively small area of 27,000 ha. Its winter hardiness being rather low, it is grown commercially only in the south of the country, in the northern Caucasus, Transcaucasia, the southern Ukraine, the Crimea, and Central Asia. Though this culture is an old one, only 39 varieties are approved.

Sour cherry and **sweet cherry** occupy 336,000 ha. Sour cherry is the most winter hardy of stone- fruit crops, and so is cultivated throughout the country, in central Russia and in the Volga basin (Vladimir, Moscow, Kursk, Saratov, Kuibyshev regions), in the northern Caucasus, in the Ukraine, Byelorussia, Moldavia and in the Baltic republics. This crop is also marked by high drought resistance. 92 varieties are approved, among them the most widespread ones are griotte tardive d'anatolie, vladimirskaya, lotowka, sklianka, liubka, minister von podbielski, poliovka etc. Flower buds of sweet cherry are sensitive to low temperatures, so it is grown only in southern regions - south Ukraine, the Crimea, Moldavia, Krasnodar Territory, Daghestan, Armenia, and Azerbaijan. 73 varieties are approved. The most common ones are: aprelka, valery chkalov, hedelfinger, guigne romon oliva, diabera chyornaya, bigarreau napoleon rose, drogans gelbe knorpelkirsche, and kaiser franz knorpelkirsche.

Plum occupies 251,000 ha. It is commercially grown in the northern Caucasus, in the Ukraine, Moldavia, Central Asia, the Volga basin, and Byelorussia. The largest areas of commercial orchards are located in the Urals, Siberia, and the Far East. The most popular varieties are anna spat, common plum, Italian prune, pamyat timiryazeva, peach plum, reine claude d'althan, kabardlinskaya rannaya, and renklod kolkhozny. Myrobalan plum is also commercially significant. In state and collective farm orchards the varieties desertnaya, obilnaya, krasavitsa and pionerka predominate.

Apricot is cultivated on an area of 117,000 ha. It is one of the leading crops in Central Asia and Daghestan. It is also commercially significant in the northern Caucasus, in the south Ukraine and in Moldavia. 59 varieties are approved, among them the most widespread ones are komsomolets, arzami, akhrori, krasnoshcheky, khanobakh et al.

Peach occupies about 36,000 ha. It is the leading fruit crop in Uzbekistan, in other republics of Middle Asia, in Transcaucasia, the northern Caucasus, and Moldavia. In the Ukraine it is also commercially important. 27 varieties are approved: sochny, greensborough, golden jubilee, pushisty ranni, konservny ranni, lebedev, elberta and some other varieties are common.

Berry crops occupy an area of about 143,000 ha. 27,000 ha are occupied by strawberry. 96 strawberry varieties are approved, popular ones are festivalnaya, yasha, chernobrivka, ivovskaya rannaya, senga sengana, zarya, and krasavitsa zagorya. Currant is cultivated on 69,000 ha, and plantations are to be extended. Blackcurrant (*Ribes nigrum* L.), redcurrant (*R. rubrum* L.) and common currant (*R. vulgare* Lam.) are commercially significant. The main varieties of blackcurrant are altayskaya desertnaya, golubka, byelorusskaya sladkaya, pamyat michurina, minay shmyrev, seyanets golubki; of redcurrant - erstling aus virlanden, shchedraya, red Dutch et al.

The area under gooseberry is 20,000 ha. The main approved varieties are russki, smen, finik, and hauton. Raspberry is commercially cultivated on an area of 21,000 ha. The best approved varieties are novost kuzmina, barnaulskaya, and novokitaevskaya. Wild sea buckthorn is widespread in the Caucasus, in Transcaucasia, in the European part of the USSR from the Baltic Sea to the Black Sea, and in Western Siberia. In Altay Territory it is commercially grown and occupies an area of 3,000 ha. 5 varieties bred by the M.A. Lisavenko Siberian Institute of Horticulture are approved - vitaminnaya, dar katuni, zolotoy pochatok, mashchnaya, and novost altaya.

Nut crops occupy a small area of 107,400 ha. But wild nuts grow on millions of hectares in Central Asia, the Caucasus, and in the south Ukraine. Filbert, almond, Persian walnut and pistachio are cultivated in the USSR. The main varieties of filbert are adygeiski-1, panakhesski, saivanobo, cherkesski-2, and kudryavchik; of almond - bumazhnoskorlupy, desertny, nikitski-62, and yaltinski; of Persian walnut- ideal, desertny, krasnodarsky, and yubileyny. Pistachio is not yet cultivated in commercial orchards. Its wild forms grow in Central Asia on an area of 300,000 ha.

The area under **subtropical crops** is limited to some regions of east Transcaucasia, the Black Sea Coast of the Caucasus, the Southern Coast of the Crimea, and Central Asia. The most important crops are olive and persimmon and two citrus crops - orange and mandarin. The area under the latter grew from 9,500 ha in 1960 to 29,300 ha in 1987.

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[Based on an article in *Pomona* [North American Fruit Explorers], Fall 1989]

NUT TREES OF ANHUI PROVINCE, CHINA

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ENVIRONMENT

The habitat in the south of Anhui is characterized by a subtropical warm climate, with an annual average temperature of 15.5° C, annual average rainfall of 1400-1500 mm , and an absolute minimum temperature of -13.3° C. The average annual relative humidity is 79%, average temperature in January, the coldest month, is 2.9°C, and average temperature in June, the warmest month, is 27.6° C.

NUT TREES

The Ginkgo *(Ginkgo biloba)*

The ginkgo tree is a very ancient tree native to China. It has a wide range covering most of our country. Anhui province is included in this range. It is usually found in temple yards and parks. The seed of ginkgo is full of nourishment and has been used as a medicine by Chinese people for over one thousand years. It is available in the market most of the time during the year. It is also used as an ingredient of moon cakes and pastries.

Old ginkgo trees are frequently seen attaining heights of 25-30m, with a diameter at breast height of over 1 metre. Ginkgos are found at elevations up to 1100m above sea level in this province.

It should be noted that some botanists believe that ginkgos exist in a wild state in the mountains of south Anhwei and Chekiang provinces, but other botanists argue that there is no natural regeneration of ginkgo in any part of China, including Anhui, as they have never seen wild ginkgo stands or ginkgo mixed in hardwood forests. I think that this controversial question can only be solved by further investigation and study.

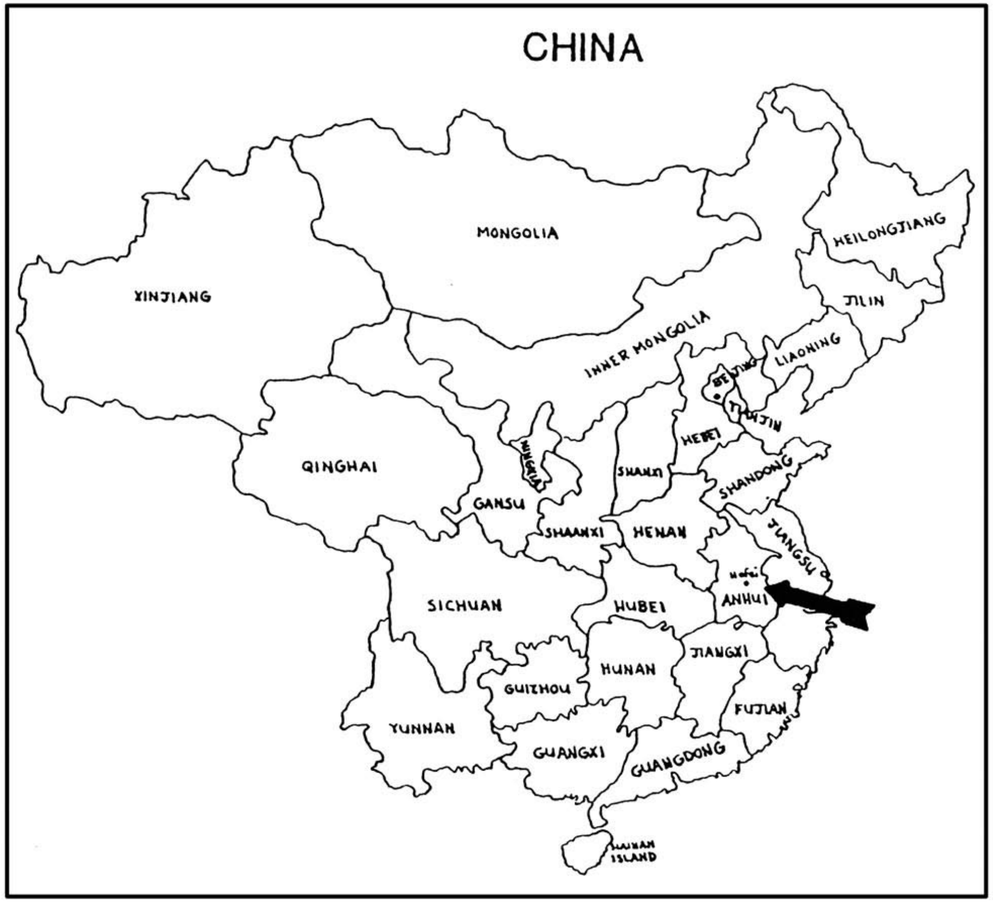
The Walnut Family (Juglandaceae)

The walnut family consists of 8 genera and 24 species in China. Two species are the most important nut trees in our Anhui province.

The first is the English walnut (*Juglans regia* L.). It has been widely cultivated in this province from the north to the south. The habitat is characterized by high light intensity and fertile soils, and is not subject to very cold temperatures, so the walnut is especially suitable for growing in the northern part of Anhui.

A large walnut orchard was established in the northern plains of this province in the 1960's. It covers 1,530 ha, with about 200,000 trees planted. There are a number of varieties, cultivars, and hybrids derived and selected. The annual yields have been around 500,000 kg in the last

few years, with half of the product, amounting to 200-400 t, exported to West Germany and England. These walnuts enjoy a high reputation for their excellent quality.



The second species is the Chinese Hickory (*Carya cathayensis*). It belongs to the same genus as the American pecan and hickories, but is in a different classification section, *Sinocarya*. This tree occurs in Anhui, Chekiang, Hupeh, Hunan, north Fukien, Kiangsi, and Kweichow provinces. The main centre, however, is in the south of Anhui and the north of Chekiang. The species covers an area of some 2,000 ha, and the annual yield is around 550,000 kg (550 t).

The harvest once reached 1,130,000 kgs in a year. The seed of the Chinese Hickory has a high oil content (69-74%).

In recent years, a natural stand of Chinese Hickory, with an area of 30-50 ha, has been discovered in the western part of the Dabei Mountains. I have been there once and collected specimens for identification. The area attracts many botanists and foresters, who go there for investigation and research work. Hickory trees in the section *Sinocarya* are found native only tin China, and are characterized by a naked bud without bud scales. Botanically, Sinocarya includes four species:

1) *Carya guizhou* - Guizhou Hickory. This tree has a limited range, and is found at elevations of 1200-1300 m above sea level. Guizhou Hickory is found in mixed evergreen and deciduous hardwood forests. The nut is not edible, but the wood is hard and durable.

2) *Carya hunanensis* - The range of this tree lies in Hunan, Guizhou, and the west and northern sides of Guangxi provinces, at elevations of up to 800 m. The seed is edible and is good tasting.

3) *Carya tonkinensis* - Limited in range to Guangxi and Yunnan provinces, at elevations of 1300-2200 m. This tree is often mixed in evergreen and deciduous hardwood forests with *Quercus glauca* (Ring-cupped oak) and *Quercus acutissima* (Sawtooth Oak). The shell of this species is very hard, and it is the least valuable for food. The wood is particularly hard and durable, and is used for special purposes.

4) *Carya cathayensis* - occurs in southern Anhui and northern Zhejiang provinces, with a limited range in the Dabai mountain region, at elevations of 200-1200 m. This is the most important hickory in China.

America's famous pecan hickory (*Carya illinoensis*) was introduced and planted in this country at the beginning of the present century by missionaries. It is chiefly planted in churchyards, home gardens, compounds, public gardens, parks, etc. The pecan grows quite normally at a young stage, but later becomes very slow-growing, likely being affected by a high water table, poor drainage, and insect attack.

The Hazelnut (*Corylus heterophylla* var. *sutchuenensis*)
This small Chinese hazelnut tree is not considered as an important nut tree in Anhui. It has a wide range in the south and west mountains of Anhui. Its elevation is from 600-1600 m above sea level, often found in the deciduous hardwood forests. Nuts are eaten by monkeys and other animals during the winter season.

The Beech family (Fagaceae)
There are 6 genera and 32 species in this province. Many species of this family occupy the dominant positions in the deciduous and evergreen hardwood forests. Here we will mention only the chestnut species. The genus *Castanea* includes three species in China; our province has all three. These three species are the Chinese Hairy Chestnut (*Castanea mollissima*), the Small Chestnut (*Castanea sequinii*), and the Henry Chestnut (*Castanea henryi*).

The Chinese Hairy Chestnut is the most important of the three species. Its range covers the whole province, and it has been cultivated by our people for over one thousand years, so they have accumulated a great deal of experience in the culture of this chestnut tree. As for the other two species, they are still found in the wild state, often mixed in mesic hardwood forests, or in pure stands, especially the Small Chestnut, found at high elevations in the mountains. Chinese Chestnut trees are planted in the lower lands. The range can reach as high as 900 m above sea level. There are several big chestnut tree orchards in this province. One is in the middle of the province, not very far away from Hefei town, and the other one is in the southeast of the province. The centre of production is in the mountains bordering the Jiangsu and Chekiang provinces at low elevations.

At a rough estimate, there are about 540 ha planted, with 5,550,000 individual trees planted in all. The annual yield is 2,500,000kg. The peak production reached was 3,180,000 kilograms in 1973. In the harvest season for the Chinese chestnut (September), large amounts of chestnuts are available in the market, at cost of about one U.S. dollar per kilogram.

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[Based on a talk given by Professor Li Shuchun to a group of American scientists visiting Anhui Province, China, in September 1988. Professor Li has a special interest in woody plants and dendrology, and consented to talk to the visiting American scientists about the nut trees growing in this area of China. The talk was originally reported in the Nebraska Nut Growers Association newsletter for April 1989]

PISTACHIO MARKETING: AN AUSTRALIAN PERSPECTIVE

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United Tree Farmers
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Pistachios in Australia are a relatively unknown commodity. Local production is as yet vanishingly small as the industry is in its infancy. Imports are valued at about 2 million dollars per annum.

Being young, the industry has a chance to organize its structure efficiently and take advantage of the marketing lessons learnt by other primary producers. The major lesson, put simply, is "United we stand, divided we fall".

This article will only provide the background information necessary to make marketing structure decisions. It is not definitive and does not attempt to provide a blueprint for a Pistachio Marketing Board. As the Californian Industry has many similarities to the Australian, but is about 20 years further on down the track, much of their experience will be referred to.

AUSTRALIAN INDUSTRY STRUCTURE

First commercial plantings in Australia were made in the Riverland of South Australia in the mid-seventies. These were small, and until the early eighties, typical for the industry. The mid-eighties saw the beginning of extensive new plantations, with the emergence of four major plantations, plus many smaller plantings. Table 1 summarizes the best estimates of present and projected plantings, gleaned from Pistachio Growers Association questionnaires.

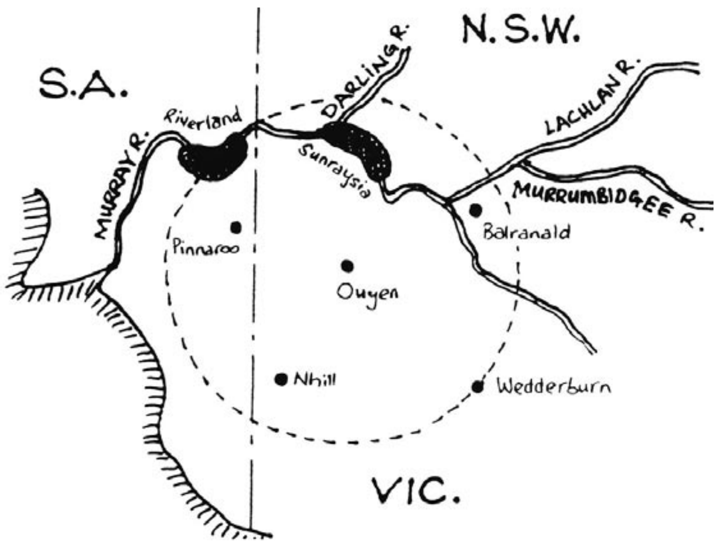

Fig 1. Geographic Distribution

Apart from the Western Australian plantings, the industry is geographically quite tightly clustered, with well over 90% of plantings being within a 200 km radius of Ouyen in Victoria (Fig. 1).

The four major plantations are situated at Kyalite and Robinvale (Balranald district), Kirungin (Pinnaroo district) and Telopea Downs (Nhill district). The two further substantial acreages (Wedderburn and Western Australia) are as yet still in the R & D phase, so their production details are largely discounted in this article.

Table 1 Pistachio tree numbers (existing and projected)

(Source - P.G.A. 1989 Questionnaire)

	Existing Orchards					Proposed	Total
DISTRICT	8yo+	3-8yo	l-3yo	Not Budded	Total	1989-9	Planting
W. Australia	100	700	700	8 500	10 000	16 000	26 000
Riverland	1 400	7 000	3 500	1 600	13 500	6 500	20 000
Pinnaroo	-	1 000	2 000	35 000	38 000	60 000	98 000
Sunraysia	100	1 400	1 000	500	3 000	7 000	10 000
Nhill	-	-	15 000	21 000	36 000	41 000	77 000
Wedderburn	-	1 000	3 500	7 500	12 000	44 000	56 000
Balranald	-	11 500	26 500	16 000	54 000	51 000	105 000
Ungrouped	350	1 650	3 500	3 500	9 000	13 000	22 000
TOTALS	1 950	24 250	55 700	93 600	175 000	238 000	413 500

All four sites are intensively managed as irrigated horticulture and are set up to be machine harvested. Whilst details differ as to rootstock, density and management technology, they are all capable of high-quality production of a single variety, the Australian-bred "Sirora".

As between 70 and 80% of the Australian industry is concentrated in four hands, their impact will be dominant for the forseeable future. This has two major implications.

Firstly, any marketing structure will likely be set up by some form of alliance of these companies, and their requirements be paramount in it. Secondly, the quality standards for nuts will be dictated by this alliance.

Thus it seems likely that smaller growers would have their needs best served by the formation of a cooperative to add a fifth major voice to marketing proposals.

PRODUCTION

Total pistachio production in Australia in the 1987/88 season was around five tonnes. The 1988/89 season saw a lack of winter chilling, producing a very poor crop of around 1 tonne.

This season (1989/90) should see the first reasonably sized crops - perhaps up to 30 tonnes.

Generally, crops from this season on should increase dramatically (Fig. 2) as more acreage comes into production. Note that pistachio tend to biennial bearing, so production will follow a good-year/poor-year cycle.

As production increases, two needs will have to be met: processing facilities, and storage, for the 'on year' crop. Processing facilities could well be made large and central to service the needs for the bulk of the industry. Experience on the small blocks already producing is that small-scale processing is barely economic. Storage and processing would thus seem to be best served by a large central plant, co-operatively owned by the producers. These facilities would need to be near a good source of water, labour, and on the major transport routes.

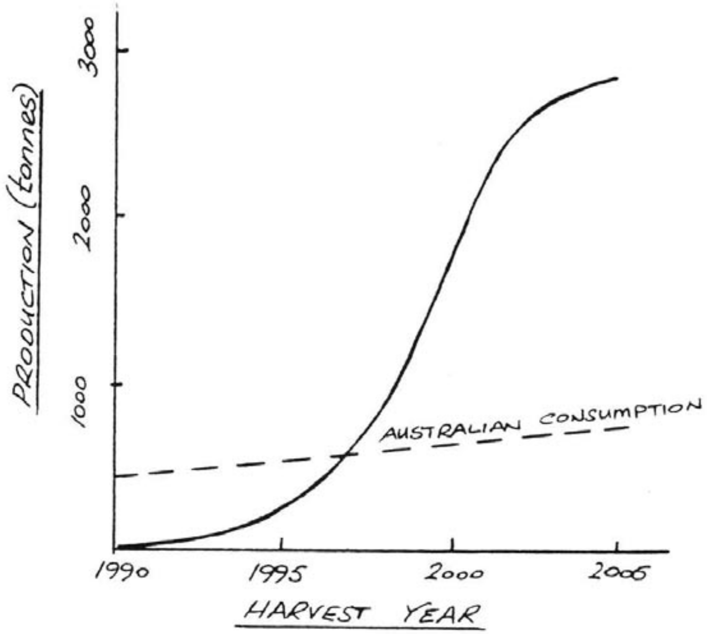

Fig .2. Production consumption (estimated)

Examining Fig. 2, which graphs the projected yield and consumption in Australia, it seems that production will quickly outstrip consumption. Two cautionary notes about this figure should be considered, Estimated production has been calculated using P.G.A. tree numbers (Table I) and estimated average yield/tree (Fig. 3), with a 15% allowance in tree number made for males. There has been no allowance made for orchard thinning. Probably a more accurate method of estimating production is to look at acreage. Unfortunately no statistics have been collected on acreage. However, if it is assumed that the average density is 370 trees/ha (a high figure), the projections indicate an excess of 1,000 ha planted by the end of 1993.

Californian statistics and extension advice map an average annual production of 2.5 tonne/ha (1 ton/acre). Local research indicates firstly that Sirora may have a higher yield than the American variety (Kerman), and secondly that it should not suffer from biennial bearing to the same extent.

Taking all these factors into consideration, the absolute production figures should be taken with a grain of salt. However, in the absence of any substantial change in consumption trends, it is apparent that domestic production in the order of 2,000 to 3,000 tonnes per annum, in 15

years time, will be greater than domestic consumption.

Australian consumption is no more than 400 tonnes/annum with an average annual growth rate of about 20 tonne/annum, or five per cent (Fig. 4).

This market, in world terms, is in the order of 0.3%. America's production alone has averaged 30,000 tonnes over the past six years and is growing at 11% per annum.

Clearly the Australian market is minuscule and could easily be satisfied by imports, without affecting world trade in any way. No import barriers exist to pistachios, in fact a tariff that was in place was removed after lobbying by the American industry only two years ago. Whilst the Australian market will always be small, it does have at least two characteristics that are in the local industry's favour.

Firstly, no coordinated marketing of pistachios has been carried out. In America the Californian Pistachio Commission has been remarkably successful in improving their domestic consumption of the product through intensive research, analysis and target marketing. They have also been aggressive in opening export markets. Domestic consumption increases have been in the order of 6%/yr (and increasing).

Given strict adherence to quality control, a coordinated approach to marketing, and effective marketing ploys, there is no reason why the Australian consumption shouldn't follow a similar pattern. Unfortunately, however, general research indicates that Americans generally consume more fresh fruit and nuts than Australians.

The second characteristic is the lack of over-seas interest in gaining a solid market share in Australia through brand marketing. This factor may provide an opening

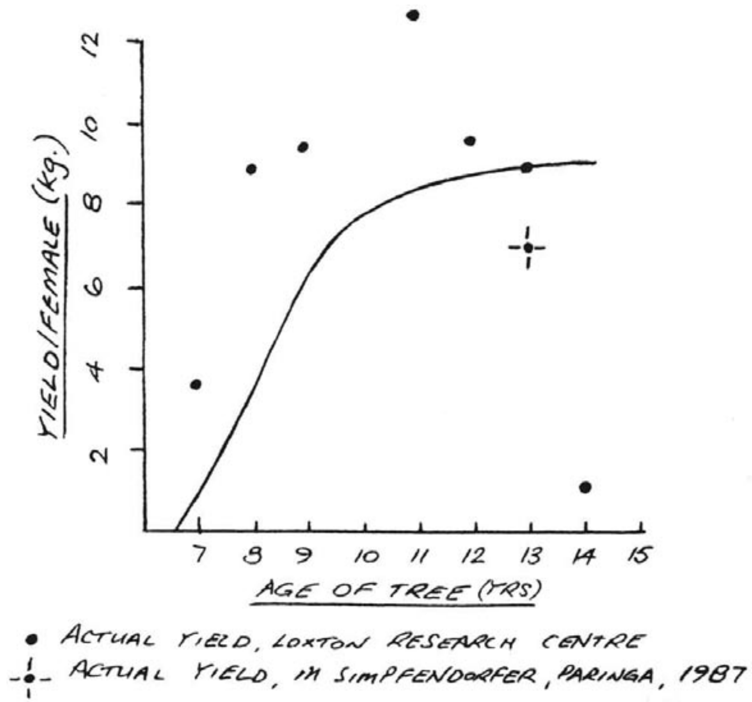

Fig. 3. Average Yield/tree

for a Pistachio Marketing Board to gain a foothold in the marketplace by judicious imports and appropriate packaging and marketing, until the local product becomes available. It is worth noting that the Americans targeted a major Japanese supermarket chain earlier this year and set up an exclusive agreement for selling and promoting a single brand of American pistachios.

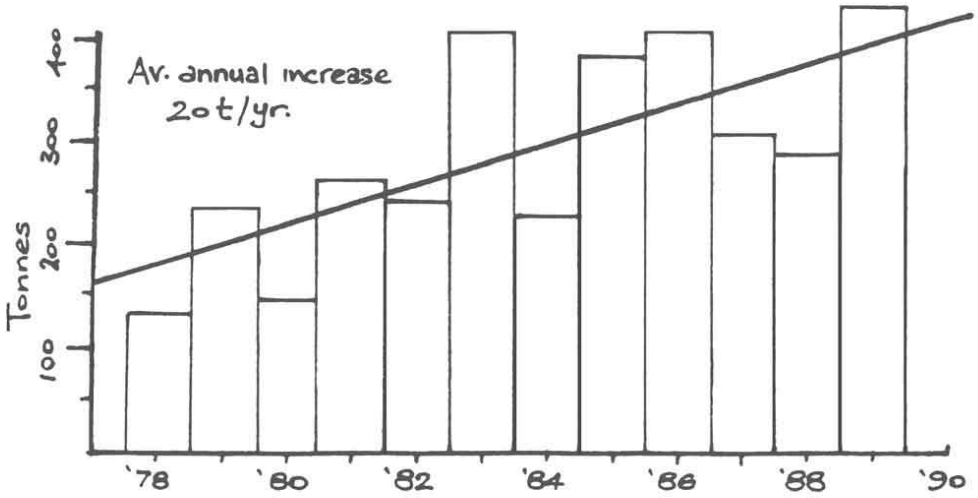

Fig. 4. Pistachio Imports 1978-89

Exploratory market research by a Roseworthy undergraduate student for a project entitled *Developing a marketing plan for Australian Pistachios* indicated three major points.

1. Only a fraction of the population had tasted a pistachio.
2. Only a very small percentage (2%) regularly bought pistachios.
3. High price was the biggest barrier to purchase.

Summing up marketing, the Australian market on present trends will only reach 700 tonnes/annum by year 2005 - well below projected production. Californian experience, however, shows the phenomenal gains that can be made through an industry-wide approach to marketing. Given that Australia can achieve the same level of cooperation between producers and processing and marketing, to place pistachios as cheaply as possible in the appropriate retail hands with maximum benefits to growers, there is little reason why pistachios should not greatly increase their market share, and place, either domestically or on the export market, the whole Australian production.

MARKETING STRUCTURE

The basis for any marketing structure must have at least five elements:

1. Total, or at least overwhelming, support from the industry.
2. Unified and high quality control.

3. Brand Marketing for consumer identification.
4. Thorough market research and effective target marketing promotions.
5. Marketing effectiveness - resulting in high volume trade with maximum returns participant growers.

To achieve those goals it is probable that the following structures will need to be in place.

1. Centralized processing facilities.
2. Grower accreditation.
3. Effective implementation of agreed quality standards.
4. A produce levy to support a marketing body.
5. Integration of wholesale and retail marketing,

To be realistic, the Australian crop is unlikely to be able to support any full-time marketing personnel for at least five years.

Moves are already underway with at least some of the big four producers to address the processing question. Furthermore, one of the big producers is involved in the nut marketing industry.

What seems to be needed, then, is talks to produce:

1. A draft marketing strategy.
2. Quality standards.
3. Grower accreditation.
4. Draft proposals for processing facilities.

The participants in these talks would likely be the four major producers and at least on representative from a cooperative of the small producers.

Table 2. Import Statistics *(Australian Bureau of Statistics)*

Year ending June	1984	1985	1986	1987	1988
Total Imports (t)	223	376	393	304	282
Imports from Iran%	6.2	6.6	64.6	57.0	67.5
unit price ($/kg)	4.95	4.28	4.48	4.41	6.19
Imports from U.S.A. %	91.8	92.2	27.2	15.3	14.0
unit price ($/kg)	6.32	5.92	6.62	7.16	5.75
Imports from others %	2.0	1.2	1.7	29.7	18.5
Total Worth ($m)	1.4	2.2	2.0	1.5	1.7
unit price ($/kg)	6.25	5.80	5.01	4.91	5.96

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[Based on a report produced for the Pistachio Growers Association Inc. and printed in Australian Pistachio News for December 1989]

RESPONSES OF POTTED HASS AVOCADO PLANTS TO PACLOBUTRAZOL DRENCHES

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INTRODUCTION

Shoot extension growth is strongly influenced by gibberellins. Since paclobutrazol is a potent inhibitor of gibberellin biosynthesis (Dalziel & Lawrence, 1984; Rademacher, Jung, Graebe & Schwenen, 1984; Hedden & Graebe, 1985) it follows that paclobutrazol should exert its greatest effect on tissues which are rapidly growing and developing at the time of treatment or shortly thereafter (Steffens & Wang, 1986).

Accordingly, effective growth control has been obtained in a wide range of plants (Lever, Shearing & Batch, 1982), whether applied to the soil, to a whole plant or to the stem (Quinlan & Webster, 1982; Williams & Edgerton, 1983).

There has been extensive research on pome and stone fruit crops, with relatively less done on evergreen fruit trees (Wolstenholme, Whiley & Saranah, 1989). Pleasing results from field trials conducted on avocados have resulted in paclobutrazol recently being registered as a soil drench for tree growth control.

This trial evaluates the responses of potted avocado plants to paclobutrazol drenches, with special reference to morphology, dry matter partitioning and leaf mineral element concentration.

MATERIALS AND METHODS

A randomised block design was used with 112 Hass on Duke 7 avocado plants. Four-tree plots received one of four concentrations of paclobutrazol, and were replicated seven times. Each plant was randomly assigned to a plot, and treatments similarly assigned to the plots.

Plants in polythene sleeves received from Westfalia nursery, Duivelskloof, were re-potted into 10 litre volume plastic bags containing a 1:3 sand to FR1T-enriched, pasteurised pine bark medium and allowed to grow for about four months. Each plant received dilute nutrient feed (N,P,K) administered daily through a microjet irrigation system of spray stakes. During this Period of establishment under glasshouse conditions and natural daylight, no branching was permitted to encourage maximum growth from one growing point. The trees were kept erect with wire stakes.

At the end of the spring vegetative growth flush, each plant was treated with its assigned concentration of paclobutrazol mixed into 250 ml water, poured evenly over the surface of the medium, which had previously been saturated with water to ensure uniform penetration of the chemical. Treatment A (control) plants received only 250 ml water each. Treatment B, C and D plants received, in addition, 1.25, 2.5 and 5.0 ml Cultar® per m^2 canopy area, respectively. Canopy area was calculated as average stem height multiplied by average estimated canopy width. Date of application was August 23, 1988.

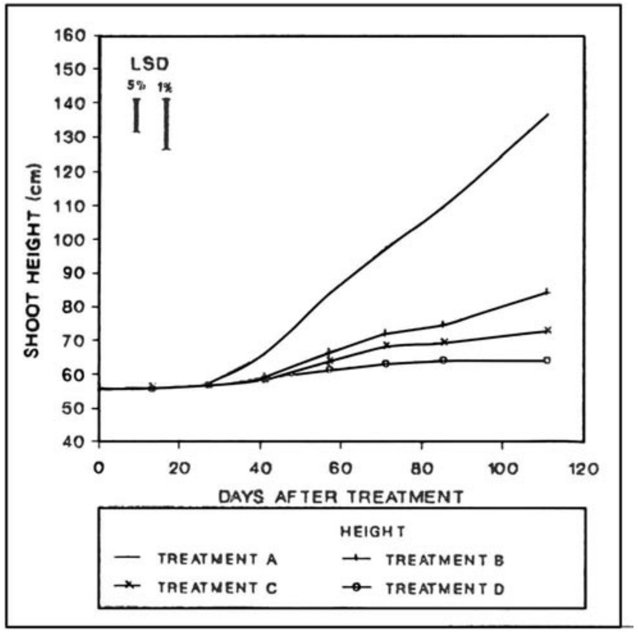

Fig. 1. Hass avocado shoot growth inhibition response, after treatment with different concentrations of paclobutrazol applied as a drench.

Initial measurements of stem height, diameter and leaf number were taken after treatment, followed by subsequent measurements of stem height and diameter, taken at approximately two-week intervals until harvest at 111 days after treatment (DAT). Subjective visual observations were also made during these times. Harvest coincided with the hardening off of the second vegetative growth flush.

At the conclusion of the experiment (December 12, 1988), measurements were taken of stem height, measured from medium surface to apical bud; diameter, measured approximately 3 cm above the graft union; leaf area, using a Ll-COR 3100 leaf area meter, and leaf number. The soil medium was washed from the roots and the plants were separated into leaf, stem and root components. The fresh mass of each component was recorded, followed by oven-drying at 60°C to constant mass for dry mass determination. Dried leaf material was analysed for N, P, K, Ca, Mg and B, by Outspan Laboratories, Verwoerdburg.

Leaf chlorophyll a and b contents were determined by placing 0.50 cm leaf discs into 80 per cent acetone and reading the absorbance at 645 and 663 nm (Arnon, 1949) respectively, once all the chlorophyll appeared to have dissolved (48 hours).
Results were analysed by means of analysis of variance, and significance calculated using LD at 5 per cent and 1 per cent.

RESULTS

Shoot growth reduction due to paclobutrazol remained non-significant for up to 57 days, after which the control (treatment A) was always significantly different from the paclobutrazol treatments (Figure 1). At harvest, trees in treatment A were significantly taller than in treatment B which was, in turn, significantly taller than both C and D, whose heights were relatively similar.

Internode length decreased as shoot growth inhibition increased. However, stem diameter data suggest that an increase in girth relative to height was occurring (Table 1).
Leaf area (LA), leaf number, leaf- and stem dry mass (DM), all decreased with increasing paclobutrazol concentrations, the control being significantly different from the paclobutrazol treatments. The trend in root DM was similar, but the decrease between A and B roots was not significant. Dry mass data were used since fresh masses showed a similar trend.

TABLE 1. Responses of Hass avocado plants growth, for 11 days in 10 litres of 1:3 sand: bark (v/v), to different concentrations of paclobutrazol applied as a soil medium drench

	Paclobutrazol (ml Cultar®/m2 canopy area)				
	A	B	C	D	
Parameter	0	1.25	2.50	5.00	SIG
Plant height (cm)	136.4a	84.5b	73.Obc	64.3c	**
Internode length (cm)	10.la	7.3b	5.lb	3.5b	*
Stem diameter (mm)	11.9a	8.68b	8.2b	8.12b	**
Total LA (cm^2)	5691a	878b	847b	796b	**
Leaf no	114.4a	42.4b	39.Ob	29.lb	**
Branches/plant	12.4a	7.2b	6.2bc	4.4c	*
Leaf DM/plant (g)	53.9a	27.8b	26.9b	22.9b	*
Stem DM/plant (g)	41.2a	16.9b	15.1b	13.9b	**
Root DM/plant (g)	46.2a	38.la	25.7b	23.36b	*
Root:Shoot ratio	0.49a	0.85c	0.62b	0.63b	*
Leaf chlorophyll a (Absorbance 645 nm)	0.612b	0.702a	0.649b	0.673b	*
Leaf chlorophyll b (Absorbance 663 nm)	1.436	1.558	1.607	1.439	NS

Means within rows followed by the same letter not significantly different by LSD at 5 per cent (*) and 1 per cent (**). NS = non-significant.

TABLE 2. Hass avocado leaf nutrient content as affected by soil-application of paclobutrazol to plants growing in 1:3 sand:bark (v/v) in a glasshouse

	Paclobutrazol (ml Cultar®/m2 canopy area)				
Element	A	B	C	D	SIG
	0	1.25	2.50	5.00	
N(%)	3.334a	2.740b	2.824b	3.031b	**
P (%)	0.334	0.314	0.314	0.310	NS
K(%)	1.783a	1.516b	1.473b	1.450b	**
Ca (%)	1.506	1.663	1.453	1.591	NS
Mg (%)	0.447a	0.499a	0.476a	0.573b	**
B(mg/kg)	59. lab	63.4a		51.3b	*

Means within rows followed by the same letter not significantly different by LSD at 5 percent (*) and 1 per cent (**). NS = non-significant.

Branching, which was first detected 41 DAT, and was predominantly on control plants, progressively decreased with increasing paclobutrazol concentration. Flowering began 16 days later on B treatment plants. At 71 DAT, there were 0, 6,11 and 10 plants with flowers in treatment A, B, C, and D respectively. Panicle expansion was progressively inhibited with increasing paclobutrazol concentrations, and at the highest concentration, the flowers were closely associated with the stem, often located under the extremely curled leaves (Figure 2). Some fruit were set, growing to pea size before termination of the experiment.

Aphids were observed on control plants only at 85 DAT, and were sprayed with Mercaptothion (125 ml/100 litre).

The root:shoot ratio of treated plants was significantly larger than the control (Table 1). Treatment B had the highest root:shoot ratio, with C and D being significantly lower, but similar to each other.

Leaf chlorophyll a content (represented by absorbance values) was significantly higher in treatment B leaves than A, C and D, being lowest in the control. Chlorophyll b showed no significant trends, although the highest concentration was in treatment C.

Mineral element trends (Table 2) reveal that leaf N levels were significantly higher in control plants than treated plants. Amongst the paclobutrazol treatments, treatment D was highest on average. The overall level was high. P had a non-significant, tenuous trend to decrease with increasing paclobutrazol concentration. Leaf K decreased as concentration increased, with the control concentration being significantly higher than B, C or D, which were not significantly different.

No trends were detected in leaf Ca levels, but treatment B had the highest level, and treatment

C the lowest. The leaf Mg level was significantly higher in D plants than the others, with the being lowest on average. The only significant response to boron was a reduction in leaf concentration at the highest paclobutrazol treatment.

DISCUSSION AND CONCLUSIONS

Reduced shoot growth, typically expressed by the shortening of internodes, is one of the most widely reported morphological responses to paclobutrazol for both deciduous and evergreen plants (Wample & Culver, 1983; Stang & Weis, 1984; Bausher & Yelenosky, 1986; Early & Martin, 1988, Kohne, 1988). In this trial, the same response was observed.

Eight weeks elapsed before significant differences in shoot growth became apparent. This lag period was possibly the result of chemical application coinciding with a root flush that followed the first shoot flush. Chemical intercepted by the roots may have been drawn preferentially to active sites of growth in the roots and only later transported upwards in any significant quantity, into the shoot. Alternately, the chemical could have moved into the shoot immediately, with inhibition only becoming apparent once active shoot growth resumed.

About this time, leaves appearing on new stem growth of treated plants had reduced LA, abaxially curled midribs, a darker green colour and 'bubbled' lamellae, consistent with previous reports (Wample & Culver, 1983; Kohne & Kremer-Kohne, 1987; Wolstenholme, Whiley, Saranah, Symons, Hofman & Rostron, 1988). At the high concentrations, while the leaves generally appeared darker green, chlorophyll a and b readings reflected little significant change in chlorophyll content (Table 1). This may suggest that at harvest, some degree of etiolation has occurred, due to differential shoot growth producing shading. Since Mg is the central atom in chlorophyll (Devlin, 1975), the high Mg content found in treatment D leaves (Table 2) could mean that some shade-induced alteration to chloroplasts had occurred.

Soon after the onset of new growth, flowering was observed on treated plants. Reproductive buds may have been induced by paclobutrazol, either directly by a lowered gibberellin concentration in cells, or indirectly by modifying the root:shoot ratio through a shift in assimilate partitioning.

Further indication of altered partitioning is possibly given by the slight, general tendency for stem girth to increase relative to height (Table 1), as well as the fact that control plants had many branches and no flowers, while treated plants had fewer branches and produced flowers. This agrees with Anon (1984), who regards the diversion of assimilates to flower bud production as the major effect of paclobutrazol, aside from growth inhibition. Nonetheless, it uncertain why a greater proportion of plants did not flower.

Possibly then, the high root: shoot ratio obtained in B treatment plants (Table 1) is associated with these plants flowering first. This large ratio may result from some measure of root growth stimulation, especially since shoot growth was not excessively inhibited. However, stimulation observed in citrus plants, in response to relatively low concentrations of paclobutrazol, resulted in accelerated shoot growth (Bausher & Yelenosky, 1986). The difference may result from the different application methods, as the citrus trees were sprayed. In

any event, the fact that such young plants were induced to flower is indicative of the powerful growth retardant effects of paclobutrazol.

Leaf N levels increased with increasing paclobutrazol concentration, in agreement with previous reports for deciduous crops (Atkinson & Crisp, 1982; 1983; Raese & Buns, 1983), except that paclobutrazol treatment levels were below control levels (Table 2). The overall high levels detected could be the result of the regular supply of liquid fertilizer to the plants, as well as that in the pre-enriched bark medium, leading to luxury uptake by the plants (Tisdale, Nelson & Beaton, 1985).

Decreasing K trends reflect the typical response found in apple crops subjected to paclobutrazol (Swietlik & Miller, 1985). Since a general tendency in plants is for Ca and Mg ions to compete with K for entry into plants (Tisdale, Nelson & Beaton, 1985) - if leaf concentrations reflect this relationship - the K levels may be associated with the general Mg levels, which tended to rise. Calcium, however, followed no trend, but the high level in treatment B leaves may be the result of the relatively larger root system in these plants. P levels remained particularly uniform indicating a clear lack of response to paclobutrazol.

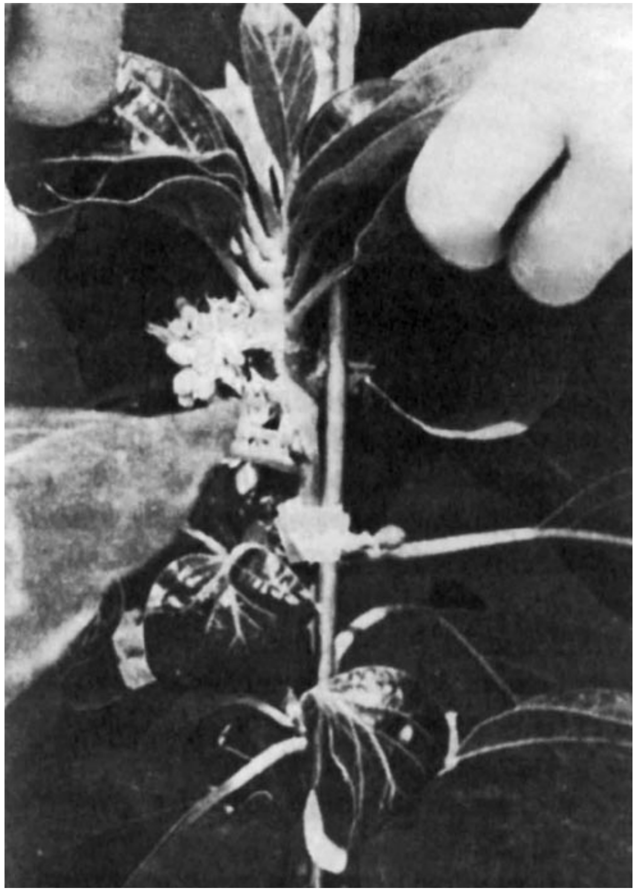

Fig. 2. Treatment D Hass avocado plant, showing small, curled leaves with "bubbled" lamellae, short internodes, flower position and developing fruitlets

Boron showed no clear trend, but was low in treatment D plants. Since flowering was most intense in this treatment, the low B level observed may partially reflect a loss due to flowering.

The varied responses of the leaf elements could be partially accounted for by the different leaf development stages at harvest, since paclobutrazol resulted in delayed budbreak, so that C, and especially D treatment leaves were younger than the A and B treatment leaves. This trial clearly reveals that paclobutrazol effectively controlled vegetative growth, encouraged flowering and induced typical morphological responses in potted Hass avocado plants. Application rates were higher for treatments C and D than recommended for avocado plants, in order to compensate for the high bark content of the medium, which being organic, was expected to bind the compound (Williams & Edgerton, 1983). Lower paclobutrazol concentrations may well have clarified differences between the treatments themselves, which in this instance were often non-significant.

A physiological study of gibberellin and carbohydrate levels would possibly provide more information, to enable more effective utilization of paclobutrazol and other new anti-gibberellin growth inhibitors. This work is in hand.

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