ISSN 0312-8997

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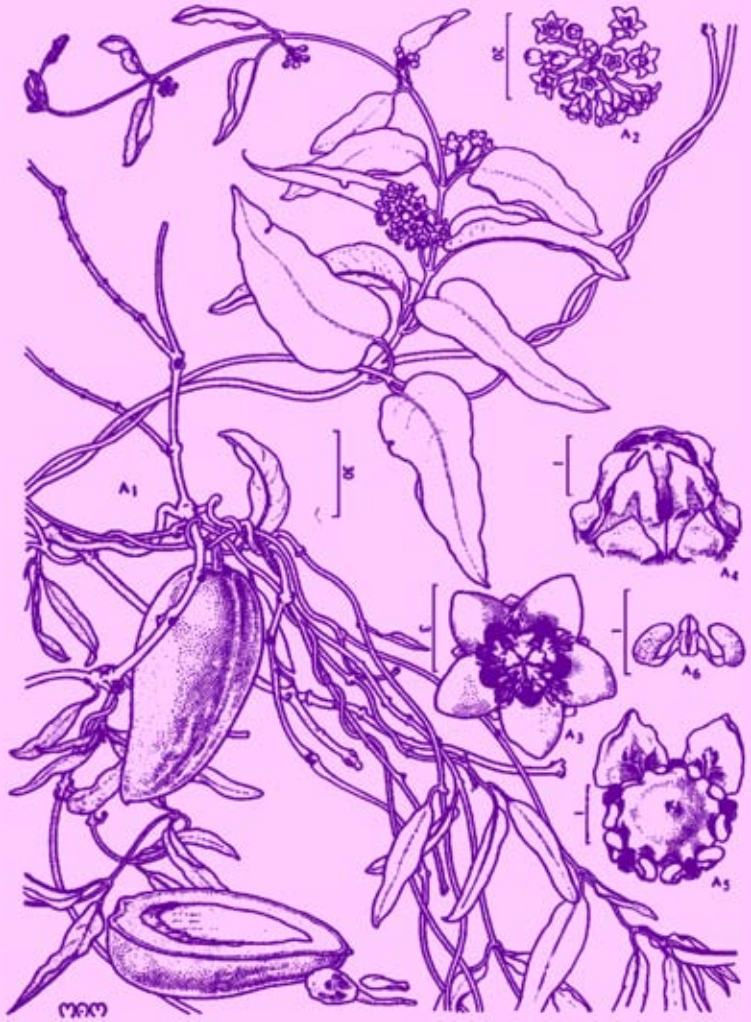
Price $20.00

WANATCA YEARBOOK • Volume 18 • 1994

WANATCA Yearbook 1994



Marsdenia australia, the Bush Banana (see page 27)

West Australian Nut and Tree Crop Association (Inc)

Yearbook 18 • 1994

Registered by Australia Post: Publication WBH 0868 ISSN 0312-8997

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West Australian Nut and Tree Crop Association (Inc)

WANATCA Yearbook

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West Australian Nut and Tree Crops Association (Inc.)

PO Box 565, Subiaco, WA, 6008

Publications

The Association publishes a quarterly magazine *Quandong* and the *WANATCA Yearbook*. Members receive these publications of the Association as part of their current year's subscription. The Association also sponsors the *Australasian Tree Crops Sourcebook* (ATCROS). Mebers also receive a afree copy of this if an edition is published while they are current members.

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.

For further details of the Association, see Inside Back Cover

Bibliography: ISSN 0312-8997
Supplement to Quandong: ISSN 0312-8989

Typesetting and design: Personal Publishing Press Services, PO Box 27, Subiaco WA 6008
Printed in Australia by Optima Press, Perth

UNDEREXPLOITED FRUITS AND NUTS OF RUSSIA

LEONID A. BURMISTROV §
Vavilov Institute of Plant Industry
44 Bolshaya Morskaya St
St Petersburg 190000, Russia

"A pound of prophylaxy is more valuable than 12 kilograms of treatment."

-- Nobel Prize-Winner Prof. L.P. Pavlov

"Shortage of vitamins in foodstuff and insufficient quantity of mineral substances in vegetative food account for premature senescence."

-- Prof. A.M. Kirhenstein

In Russia vast territories are occupied by fruit crops. A great diversity of forms helps to select plants most valuable for Man's health and therefore most deserving for their cultivation in orchards.

Some wild fruit plants have already been released commercially, e.g. Sea Buckthorn, the others have only recently had attention drawn to them, and are about to be introduced (honeysuckle, japan quince, black elder), and the rest are widely used in their wild habitats by the original inhabitants (barberry, viburnum, dogwood, hawthorn, Siberian cedar pine). The main botanical and agronomical features of a number of wild plants which are of first priority for domestication are described here (Brezhnev, 1981; Gammerman, 1976; Petrova, 1987; Shapiro, 1981; Shchepat'ev, 1978; Sklyarevsky, 1975; Trofunov, 1976; Vigorov , 1976).

Sea Buckthorn

Sea Buckthorn (*Hippophae* L., Elaeagnaceae Juss.). All in all, 3 Sea Buckthorn species are found in the territories of Europe and temperate Asia. Of those, only 1 species grows in Russia.

This species, *Hippophae rhamnoides* L., has been familiar since ancient times. Greeks used its leaves and young shoots for feeding sick horses. They recovered very quickly and their skin became glossy and shining, hence the botanical name of the genus.

Wild forms are very diverse. In the Lisavenko Horticultural Research Institute of Siberia, much has been done to select promising breeding strains. Special attention has been paid to such features as productivity, large fruit size, easy separation of berries at harvest, high con-

§ Member, WANATCA

tent of oil and vitamins, adaptation to different conditions of growth, different ripening dates, canopy strength and longevity, and absence of thorns.

Sea Buckthorn grows along the banks of rivers, seas, lakes, streams, on river pebbles and sands, and especially on lower and middle mountain zones. It is common in west European Russia and in Western and Eastern Siberia. Wild populations are found in Scandinavia, Central and Western Europe, the Mediterranean area, Iran, Mongolia, the Himalayas, and Tibet.

It was introduced by the St. Petersburg Botanical Garden as an ornamental plant, with seeds and plants from the mountainous region of Altai, in the 19th century.

In Russia, as a crop it is found from Arkhangelsk, Tomsk, Chita to the southern border. It withstands drought very well. In propagation, adventitious roots are rapidly formed when branches are covered with sand or soil. Its good winter hardiness suits it for the northern regions of the country.

It needs a lot of light, withstands some salt, prefers rich, well-aerated soils. Compacted soils with insufficient aeration in the root zone gives stunted trees. The shallow roots prefer moist, but not excessively wet, soils. Sea Buckthorn is highly responsive to fertilization.

Sea Buckthorn, Hippophae rhamnoides

It may be propagated by seed, which give up to 96% germination and have a viability of about 2 years. The seeds are sown in autumn or spring after 3 month stratification. Plants may also be propagated by root suckers or cuttings. Stumps shoot readily. Varieties of Sea Buckthorn may be propagated by softwood or hardwood cuttings.

Female plants may be differentiated from males only at the flowering stage. When planting, the sex of plants should be taken into account. It is recommended to plant 8-10% male plants in the orchard. Sea Buckthorn grows rather slowly. Fruit bearing occurs in 3-4 years and at 6-7 years the main commercial varieties (Velikan, Dar Katuni, Zolotistaya Sibiri, Obilnaya, Oranzhevaya, Prevoskhodnaya, Chuiskaya, etc.) yield full crops of over 20 kg/tree.

The life-span in its natural habitat is 80 years and more, but as a crop it may be kept for 15- 20 years.

Sea Buckthorn is a branching, thorny shrub or small tree, 1.5-5 m high, with bow-shaped branches with a dense cover of silver-grey leaves. The leaves are strap-like or linear lanceolate, 2-8 cm long, and 0.2-0.8 cm wide, nearly sessile. The thorns are 2-7 cm long. The plant is dioecious and wind pollinated. Staminate flowers are small, greenish-brown, in short small ears 5-6 mm long. Pistillate flowers are greenish, plain, bunched in 2-5 in the axils of leaves or thorns, on a pedicle 0.5 cm long. They appear in early spring (beginning - middle of April) simultaneously with the opening of the leaves. Each year female plants produce bare, juicy, sour-sweet fragrant fruits, of orange or orange-red colour, tasting of pineapple. The fruits are ball-, egg-, or ovoidal drupes 0.8-1.0 cm long and 0.3-0.6 cm in diameter. Fruits weigh about 0.5 g, of which 16% is seed.

Fruits are juicy, with a dry matter content of 7-12%. Sugar content is relatively low, up to 3.7%. In cultivated varieties the fruit is much larger, and the sugar content reaches 6.4-10.5%.

Sea Buckthorn is characterized by a very low pectin content (0.15%) compared to other wild fruits, and even this is only protopectin. Fruit acidity varies from 2.6% to 4%. Sea Buckthorn is a tetravitamin crop, having a considerable quantity of vitamins A, D, E, and C in its fruits, this is unusual for fruit crops. In pharmacology it is noteworthy for its fatty oil -- the fruit flesh contains up to 9% and seeds up to 12% of fatty oil. The content of carotene (provitamin A) in fruits is up to 11 mg/100 g, of tocopherol (vitamin E), 8-10 mg/100 g, of vitamin K_1 (phylloquinone), very rare in fruit crops - 0.8-1.2 mg/100 g. Of the water soluble vitamins, there is a significant content of ascorbic acid, with 16-40 μg/100 g thiamin (vitamin B_1), 0.03-66 μg/100 g riboflavin (vitamin B_2) and up to 0.8 mg/100 g of vitamin B_6.

The content of ascorbic acid, carotene and oil fluctuates according to the geographical zone. Sea Buckthorn of European origin is characterized by high vitamin C content (800-1300 mg/100 g) and comparatively low content of oil (4%) and carotene (3 mg/100 g). The forms from Mongolia have vitamin C contents of 227 mg/100 g, carotene at 8 mg/100 g, oil at 5-7%, while the Caucasus forms have no more than 10 mg/100 g of vitamin C, and carotene, is practically absent.

The content of polyphenols with P-vitamin activity is 700-3700 mg/100 g in fruits

Sea Buckthorn oil has a thick consistency, and is bright orange with a distinctive taste and smell. It contains 110-165 mg/100 g of vitamin E and a rather large amount of vitamin F, which regulates skin metabolism. The content of carotinoids in the Sea Buckthorn oil is up to 350 mg/100 g. It is used to treat radiation sickness and many infectious diseases, burns, dermatoses, stomach and duodenal ulcers, mucous problems of the mouth, trophic wounds, and gynecological diseases. In folk medicine the extract from boiled fruits and leaves is used for treating stomach diseases and rheumatism.

Sea Buckthorn is used not only as a medicinal plant, but is also of great importance as a food source. Fruits are processed for jellies, jams, fruit candies, juice, and for a yellow dye used in food.

In Siberia the wine prepared from Sea Buckthorn fruits is considered to be one of the best. It is of the 'Hungarian' type and smells like pineapple. With a brew mixture of fresh fruits and sugar in proportion 1:2, the vitamin C level retained is 50 mg/100 g. In the West Pamir region, the flowers of Sea Buckthorn are used cosmetically, for softening the skin.

Barberry

Barberry (*Berberis* L, Berberidaceae Torr. et Gray). The genus numbers 175 species, widely spread in central and southern Europe, Central and East Asia, North Africa, western North America, and South America.

Common Barberry, Berberis vulgaris

On the territory of the former USSR 12 species are grown in their natural habitats. The common barberry (*Berberis vulgaris* L.) is the most important of them. It grows along the edges of forests, on lawns, along stony and rubbly slopes in the forest -steppe zone of western and central parts of Russia and in the Caucasus, as well. It is found as high as 2000 m above sea level. It prefers neutral and mildly alkaline, rather rich soils but also may grow on poorly grassed stony slopes and talus.

It is frost, drought and heat resistant, dislikes wet feet, and is a light demanding plant, so it grows wild only on open and well-lit slopes and edges of forests. It is a shade tolerant plant, but it does not set fruit in shade.

It is widely grown as an ornamental plant in the European territory of Russia, and has long been cultivated with this objective in Western Europe and North America.

Amur Barberry, Berberis amurensis

Till recently it has not been advised to cultivate *B. vulgaris* in close vicinity to fields as it was considered to be a carrier of cereal rust, *Puccinia graminis* Pers. But in Russia the most dangerous species in this respect is *P. glumaris* Pers., which is not associated with *B. vulgaris*. Also, populations of common barberry resistant to rust are found in the wild state. Their search and introduction into cultivation is urgently needed, since the natural reserves of *B. vulgaris* are becoming exhausted due to industrial use of its roots in pharmacology.

B. vulgaris is a deciduous, upright, heavily branching thorny bush, 1.5-2.5 m high. Yellow-purplish shoots later become elongated and turn brownish-grey. They are covered with numerous triple thorns 2 cm long. On the shortened shoots in the axils of thorns the leaves are thin, membranous, elliptical, elongate-ovate, 4 cm long and 2 cm wide. Flowers are 6-10 mm in diameter with yellow petals. They are in groups of 8-25 forming pendulant clusters (inflorescences) 3-6 cm long. Flowering is in May-June. Fruits are 9-12 mm long, elongate-elliptical, bright red, palatable, mass is 0.12 g. They ripen in September-October, when overwintering the fruit abscission occurs.

The chemical composition of fruits consists of: dry matter 31.6%, including sugars (4.6-2.1 %); pectins (0.92%, including soluble 0.54%); acids 3.8-6.7%, ascorbic acid, 13-33 mg/100 g. The quantity of tannins and dyeing substances ranges from 1030-2700 mg/100 g, depending upon climatic zone. Flavonols predominate.

The content of alkaloids in fruits is 174 mg/100 g, of that amount 15 mg is from fruit pulp and 159 mg/100 g from seeds. The proportion of berberin reaches 60%. The total number of alkaloids in the plant is 11.

This is one of the most valuable medicinal-fruit plants. Extracts from its roots rich in alkaloids are used for treating cholecystitis, cholethithiasis and chronic hepatitis. Infusions from roots are used as an ingredient in the complex drug cholelitin, used for treating cholethithiasis and cholecystitis. A 20% infusion of leaves is used as a hemostatic agent in metrorrhagia and as a vermifugal drug. A 5% infusion is used for cholecystitis. The berries have a nice refreshing flavour and are used for making jams, jellies and soft drinks. During flowering it is an excellent honey plant.

As an ornamental plant it is used in living hedges and borders. Garden forms, with dark purple leaves trimmed with white or yellow, and yellow fruits enhance lawns.

Elder

Elder (*Sambucus* L., Caprifoliaceae Vent.). The genus embraces about 40 species, distributed in subtropical and tropical countries of both hemispheres. On the territory of the former USSR, 11 species are found in the wild. Of that number, the black elder (*Sambucus nigra* L.) is of importance as a fruit plant

Common Elder, Sambucus racemosa [Nesterovich]

This species grows as understorey in the broad leaved forests, more rarely in mixed forests along the edges, in groves of bushes, especially along the shores of rivers, roads and on weedy plots in the southwestern and southern belt of the European part of Russia, also in the Ukraine, Crimea and in the Transcaucasus. It is found in western Europe, in Asia Minor, and North Africa.

It is a shade-enduring plant, but usually grows in well lighted places. It grows singly or in small groups. It is cultivated as a soil protecting understorey plant. It is sensitive to soils. In forests with rich soils it provides a dense understorey over areas of several hectares.

Black Elder is propagated by seeds, layers, and cuttings, as from the abundantly-produced shoots from stumps. It forms a spreading shrub or a small tree, 3-8

m tall, with a trunk up to 30 cm in diameter. Leaves are 32 cm long, compound, odd-pinnate, and consist of 3-9, often 5, leaflets which are nearly sessile, elliptical or oblong-ovate, unequal. Leaves and young bark smell unpleasantly.

Black Elder, Sambucus nigra [Douglas]

Flowers are light-yellow, small, sweet-scented, grouped in 5-ray terminal inflorescences which are polyanthous, flat, umbraculiform. Flowers in the crotches of axes and lateral flowers are sessile, the rest are on stalks (pedicels). Flowering is in May-June. The fruit is a small globular berry-shaped drupe, 3-6 mm in diameter, weighing about 0.23 g, black-violet, glistening. The pulp is juicy, acid-sweet, dark-red, and mucilaginous, with a characteristic taste and aroma. Fruit ripens in August-September. Fruits remain on bushes after leaf-fall.

Dry matter content of fruits is 18.2%, including sugars 5.2-7.4%, pectins 1%, acids 1.3%. Content of ascorbic acid in ripe fruits is 10-50 mg/100 g, and the total quantity of polyphenols reaches 2960 mg/100 g, the greatest part of which is anthocyans (2400 mg/100 g). The bark contains sambunigrin and coniine, valerian acid, choline, sambutsin, sitosterol, tannins. In the dry flowers there are 0.027% of solid ethereal oil, organic acids, tannins, mucilage, and paraffin-like substances.

Flowers and berries are used in perfumery, and in confectionery for colouring creams and candies. The fruits are used for making jams, jellies, mousses, candied fruit jellies, in pies and for seasoning soups. The fruits of black elder are an excellent raw material for the production of natural food dyes. The fruits can also be dried. The flowers are used in food - the fragrant inflorescences are added to the grape must to give a muscat taste and smell. Flowers are also used for making jams and are added to fancy pastry for almond smell of biscuit.

Elder is a valuable medicinal plant. Flowers, fruits and bark are used for preparing medicinal drugs. Fruits are used as purgative. Fresh berries and flower water are used for treating rheumatism. Tea from flowers is used as a sudorific antipyretic agent, a flower infusion is used as a gargle for ailments of the respiratory tract, throat, and oral cavity. A flower infusion is used for compresses and poultices. In folk medicine flower water or tea is recommended as a sudorific, diuretic, astringent, mildly disinfectant treatment, and sometimes for bile expelling.

The bark is used as a diuretic substance to treat dropsy and kidney diseases, also to induce vomiting. Extracts from berries and bark are used as a purgative, diuretic and sudorific. Ripe berries are used in food, and for medicinal use green flower inflorescences are cut and then dried.

Honeysuckle

Honeysuckle (*Lonicera* L., Caprifoliaceae Vent.). The genus embraces over 200 species spread over temperate zones of the northern hemisphere. In the former USSR over 50 species are found.

Edible honeysuckle (*Lonicera edulis* Turcz. et Freyn.). The natural habitats are mountainous regions on lime soils, in humid dark-coniferous forests, and in the peat bogs and marshes of eastern Siberia and the Russian Far East. The plant grows well in both very wet and in dry conditions, exhibiting not bad drought resistance. But in the latter case its productivity is reduced and fruit quality is poorer, as bitterness appears and fruit size diminished. Best productivity is shown under good light conditions. It is a cold resistant plant It is not very fussy as to soils but yields decrease on non-fertile and insufficiently moist soils.

Honeysuckle is propagated by seeds, which are sown the first year after harvest, and also vegetatively by soft, very rarely by woody, cuttings. Amateur gardeners propagate it by dividing a bush into parts.

Golden honeysuckle, Lonicera chrysantha [Nesterovich]

The bush is up to 1 m in height with a ball-shaped crown. The bark on old branches peels off in long strips. The leaves are simple, longitudinally-lanceolate, narrow, acuminate, 5 cm long, thin. The flowers are numerous, yellowish, aromatic, set in leaf axils. The corolla is 8- 13 mm long. Flowering is in the second half of May - beginning of June, over 20 days.

The fruits are elongated, elliptical, cylindrical or longitudinally-elliptical, 9-12 mm long with a rough surface, covered with a bluish wax coating which is easily wiped off. The flesh is red-violet, juicy, sweet with a sour aftertaste, aromatic, tasting like a blueberry. The fruits ripen in June-July and fall immediately. Yield per one bush is 1.0-2.7 kg, a fruit weighs 0.65-1.45 g.

The content of dry matter in fruits is 19%, sugars - 4.0-13.2%, titrated acids - 2.6-3.1 %, ascorbic acid from 40 to 130 mg/100 g, pectins -1.6%, P-vitamin active substances - 600-1800 mg/100 g.

Berries are valued for their taste. They are eaten fresh, or used for making jams, juices, compots and drinks. A great advantage is their earliness (berries ripen 7 -1 0 days earlier than strawberry). Since ancient times berries have been used in folk medicine as a remedy for strengthening capillaries in case of hypertension, for treating cardiovascular diseases, malaria, and gastric-intestinal disorders.

Kamchatka Honeysuckle (*L. kamtchatica* (Sevast.) Pojark.). In its natural habitat this grows in larch, and particularly in birch forests, in forest glades, and hedgerows. It is found, as single plants or in groups, in the Russian Arctic and Eastern Siberia, and in the Far East in Kamchatka, the Kuril lslands, and Sakhalin. Selected forms are known.

It is highly branched shrub, about 2 m in height, with dense, ball-shaped crown. Young shoots are heavily pubescent with short thin hairs and long bristles. The leaves are large, elliptical or oblong-elliptical, 4-10 cm long. The flowers are yellow or yellow-green in the axils of two lower pairs of leaves, on short pendant hairy peduncles. Flowering is in June-July. The fruits are 10-16 mm long, oblong-oval to globular, dark violet with bluish waxy coating, weighing about 0.8 g. The flesh is juicy, aromatic, and sweet, with a sour after-taste. Fruits ripen in August and persist on the bush. The yield per bush is up to 1 kg.

The dry matter content of fruits is 16.7%, sugars - 6.5%, pectins - 1.4%, titratable acids - 1.7%. The total content of tannins and dyeing agents reaches 1900 mg/100 g, ascorbic acid - up to 50 mg/100 g. The fruits are used as a dessert and also for making jams, jellies, juice, and fruit drinks. The berries are rich in vitamins and are used as a remedy for cardio-vascular diseases and for gastric-intestinal disorders.

Altai Honeysuckle (*L. altaica* Pall.). This grows along the edges of coniferous mountain forests, in glades in dense bush, in moss tundra, on stony slopes and among the rocks of the Altai range, in the north of European Russia, in Western and Eastern Siberia, in the Urals, and on the Kola Peninsula. It is characterized by high cold and frost resistance. With good light incidence and enough soil moisture it is highly productive (up to 2.5 kg per bush). Fruit begins in the second or third year, the optimal yield is in the 5th and 6th year.

It forms a shrub up to 1.5 m high with a compact crown. The bark on old branches peels in long strips. The leaves are oblong-elliptical, lanceolate or longitudinal, thin. Flowers are yellow-white, 13-18 mm long, in pairs in leaf axils. The fruits are 10-16 mm long, oblong-elliptical, cylindrical, or oval, blunt-topped at both ends, bluish-black. Berries are juicy and sweet with sour after-taste, slightly bitter, with a fragrant aroma.

Viburnum, Viburnum sargenti [Nesterovich]

The dry matter content of fruit is 14.2%, sugars 6.2%, pectins 1.5%, titrated acids 2.1 %, ascorbic acid 228 mg/100 g, with nearly 3% anthocyans. Fruits may be used fresh, in jams, jellies, juices and fruit drinks. Due to the high concentration of anthocyans this species is most promising as a source of natural dyes for the food industry.

Viburnum

Viburnum (*Viburnum* L., Caprifoliaceae Vent.). This genus includes about 200 species, including 8 in Russia. It is distributed over the temperate climate zones of Europe, and in Asia, North and Central America, and North Africa.

May Rose or High Cranberry (*V. opulus* L.). This is a European/Siberian species, growing as an understorey in wet mixed and deciduous forests, mainly along the edges, on open spaces in thick bush, in ravines, on clearings on the banks of rivers, lakes and swamps. It does well on fertile and damp soils, dislikes sunny sites, and is frost resistant. It is found in the European part of Russia, especially in the central and forest parts, as well as in the forest steppe zones. It extends to Western and Eastern Siberia. It is propagated by seeds, layers, suckers, and cuttings. It is recommended to sow seeds in autumn. Careful cultivation increases yields 1.5-2 times.

Its form is a high (1.5-4.0 m) dense shrub or small tree. The leaves are opposite, unequally toothed, large, 5-10 em long and wide. Stalks are 4-5 times shorter than blades. Flowers are pentapetalous, white or pink-white, sweet-scented. They are arranged in loose, flat, large umbellate inflorescences 5-15 cm in diameter, with pedicle 2-2.5 cm long, from which 6-8 rays stem. Flowering is in May-June.

Fruits are bright red, oval or ball-shaped, 8-12 mm long with one big, flat, heart-shaped stone. A fruit weighs about 0.76 g. One bush yields 3-4 kg of fruits, ripening in August/September. Ripe fruits are juicy, edible, but when fresh they are astringent and bitter. After a light freeze the bitterness considerably decreases.

The dry matter content of ripe fruits is 16-20%, sugars 6.6-10.5%, titrated acids 1.4-3.3%, pectins - 0.92% (0.50% - soluble), ascorbic acid - 10-40 mg/100 g.

The total content of tannins and dyeing substances in ripe fruits is 440-1660 mg/100 g. Carotene content of ripe fruits is 2.1 mg/100 g. The leaves contain viburnin and vitamin K (Phylloquinone). The seeds have up to 21 % fatty oil. The bark has up to 6.5% of resinous (tar like) esters which, when hydrolized, produce isovaleric, acetic, formic, capric, caprylic, butyric and a number of other acids. The bark contains also about 6% of triterpene saponins, about 2% tannins of pyrocatechol origin, the glucoside viburnin, and other substances.

This Viburnum is a valuable medicinal and food plant. The fruits are used for jams, pies, as sauces, for jellies, and are also eaten after rubbing through a sieve with sugar. Popular uses are as steamed berries and flat cakes. The juice has gelling properties, and can be used with apple puree to make fruit candies and pastilles. Fresh berries are used for treating gastritis, ulcers of the stomach, and also as a mild diuretic, purgative and sudorific agent. The berries tone up heart action, they are also helpful for neurosis and vascular spasms. Berries fermented with sugar are recommended for decreasing blood pressure and hypertension. Juice and boiled berries with honey help in case of colds, cough, diarrhoea, ulcers of stomach and duodenum, colitis, haemorrhoids and nasal bleeding. A 10-20% berry juice solution is used

in cases of skin disorders, acnes, and ulcers. The juice relieves the pains of bronchial asthma and hypertension. Green berries are used to treat pimples on the face.

High Cranberry bark for use in medicine is harvested when the sap is moving (April-May). Liquid extract and boiled bark is used as a haemostatic agent in internal bleeding, as well as a spasmolytic and soothing agent in gynecology and against infantile cramps. Externally it is used for stopping skin bleeding. Preparations from the bark of *V. opulus* raise blood pressure. A bark infusion is recommended for nervous disturbances.

In folk medicine the boiled flowers are used for treating coughing, common cold, asphyxia, for improving digestion, in case of intestinal spasms, diarrhoea, as well as a expectorant, sudorific remedy, and in gynecology. The boiled flowers are added to baths for treating skin diseases of children. The boiled root is a good remedy for scrofula, convulsions, hysteria, sleeplessness, and breathlessness. Recently it has been found that the leaves of *V. opulus* are more rich in viburnin and vitamin K than the bark, hence it is recommended to produce liquid extract out of leaves. The bark together with the flowers and fruits of this plants is used in veterinary medicine to treat foot-and-mouth disease of cattle.

This cranberry is an ornamental plant, it is largely unaffected by industrial gases and is not troubled by smoke. It is used to protect soil from erosion.

Dogwood

Dogwood (*Cornus* L., Corneaceae Link.). The genus embraces four species, of which only one is found in Russia. The first attempts to classify the dogwood were made by Theophrastes, about 2300 years ago. The Latin name was assigned by Linnaeus in 1776.

The Common Dogwood or Cornelian Cherry (*Cornus mas* L.) grows in the mountain forests of the lower and middle belts (up to 1500 m elevation) in the Caucasus, in the understorey of oak and hornbeam forests, as well as in clearings in the forests, on hill slopes, and in thickets. Outside Russia it is found in the Crimea, in the Ukraine, Moldova, over most of Western Europe, and in Iran, Turkey, and Afghanistan. Four species are known from South America.

Numerous forms are known, such as dwarfed, variegated, with pyramidal crown and with crinkly leaves. There are forms with yellowish-white and yellow fruits.

These plants are heat-loving. They grow slowly in open areas and fruit late. They are extremely drought resistant as their dense, leathery leaves and pubescence on shoots protect them from excessive water loss. They are one of the most frost-resistant fruits of the temperate zone, and can withstand -37°C. The wide range of the dogwood shows its good adaptability to soils. It is resistant to pests and diseases.

Since ancient times it has been considered to be a fruit crop in many countries of Europe (the Balkan Peninsula) and Asia Minor.

Dogwood grows to a high shrub or small tree, 2-5 m high (sometimes reaching 8-10 m), with a trunk up to 20 cm in diameter, with very hard wood. The leaves are egg-shaped, elliptical, and lanceolate, 11 cm long and 5 cm wide, opposite. The flowers are small, yellow, densely pubescent, in groups of 5-9, sometimes 15-25, in pendulant inflorescences. Flowering is in March, April, long before leaf appearance. The fruit is a juicy drupe. Ripe fruits

are dark red, sometimes light red or pink, pear-shaped, cylindrical, 10-30 mm long, smooth, glittering. The flesh is tasty, juicy, sweetish-sour, with a characteristic aroma. Fruits ripen in September. Fruits weigh 1.1-4.5 g, 7-20% of which is the stone. Dogwood grows slowly, has a long life span, and may fruit for 150 years.

Japanese Cornel or Dogwood. Cornus officinalis [Duke]

Fruits contain from 63% to 76% water, depending on conditions of growth. Dry matter content in fruits of wild dogwood is higher than that in cultivated forms (15-19%). The fruit sugar content of wild plants is 9.4-17.4%, of cultivars 6.8-10.8%. Cellulose makes up 0.9-2.0%, pectins 0.6-14%, of which 0.35-0.63% is soluble. In spite of a comparatively low content of soluble pectin, dogwood juice sets easily. Total acidity of the fruits of wild dogwood is 1.1-3.2%; cultivars have higher fruit acidity (2.6-7.4 %) .

Both wild dogwood and hybrid semi-cultured forms are valuable sources of vitamins. Wild dogwood may contain only 9 mg/100 g of ascorbic acid, but the amount increases with more northerly populations, and in central Ukraine it reaches 36-122 mg/100 g. Cultivars of the forest-steppe zone of the Ukraine have ascorbic acid contents of 13.2-35.8 mg/100 g.

As to quantity of tanning substances the dogwood surpasses most fruit crops. Wild plants contain 2400 mg/100 g of tanning and dyeing substances.

The dogwood has been known since ancient times as a medicinal and fruit tree with valuable wood. Hippocrates wrote of the astringent property of the leaves of dogwood and that the boiled water of these leaves was used for treating stomach diseases. Dioscorides and Pliny the Elder also mention the dogwood as a medicinal plant. Ovid describes the process of making jam from dogwood in his poem “The Golden Age”.

The fruits of dogwood, with their delicious sweetish-sour taste and distinctive aroma, are used fresh and for making jams, jellies, fruit candies, puree, stewed fruits, and soft drinks. The fruit juice is used in making a firm red jelly. The dried fruits are used in sauces, and are widely used in canning in Armenia, Georgia, Ukraine, and Moldova. In folk medicine the fruits are used to treat scurvy and diarrhoea. The stones and leaves, containing easily extracted tannins, are also used for preparing medicinal drugs. When imports of tanning extracts to Russia were cut in 1916, tanneries making harnesses and shoes for the army started to use dogwood leaves for tanning.

Flowering Dogwood is an excellent honey plant and ornamental plant. It is used for making living fences. It is propagated by root suckers, layers, cuttings, or seeds, which have

a long dormant period (up to 29 months). Dogwood grows extremely slowly, fruit-bearing begins only in the 10-12th years. This feature, and lack of data on orchard management and propagation methods, are responsible for the slow introduction of the Dogwood as a crop.

Hawthorn

Hawthorn (*Crataegus* L., Rosaceae Juss.). The species of hawthorn are characterized by great variability, and they cross easily with each other, which makes their classification difficult. More than 90 European species and about 1200 North American species have been described. They are found in the temperate zones and to some extent in the subtropical zones of the Northern Hemisphere, in mountain regions and in valleys with forest and steppe vegetation. Their northern range extends to 60-65° latitude. The southern border of the range runs through the southern tip of Florida, through Asia Minor, Central Iran, Afghanistan, North India, southwest China, and central Japan. In the territory of the former USSR there are 47 native species and 89 species have been introduced.

In the wild, hawthorns grow singly or in groves. They grow on forest edges, in clearings and forest glades, and on rocky scree slopes. They are not fussy as to soils, and undemanding in cultivation. But they grow best on deep, moderately moist, well-drained fertile heavy soils. They respond well to lime soils. The majority of species are winter-hardy and light demanding. They are valued as ornamental, honey, fruit, and medicinal plants.

Hawthorns grow as deciduous trees or shrubs, 3-5 m high, sometimes 10-12 m, often multi-trunked or multi-stemmed. Most species possess thorns, 9.6-12 mm long. The leaves are ovate or obovate with entire pinnatifid or lobed blades, 1-12 cm long, more or less densely pubescent, on stalks. Inflorescences are compound, peltate, few- or multi-flowered. Flowers have a corolla 1-1.5 cm in diameter, with white or rosy petals. The fruit is a pome, it may be ball-shaped, broadly elliptical, or pear-shaped. The skin is yellowish-orange, red, or black, and the flesh is usually yellow, dry and mealy or juicy and sweet. Fruits ripen in July-October.

Two hawthorn species, Crataegus altaica (left) and C. maximoviczii [Nesterovich]

Hawthorn is an ancient plant of folk medicine, its pharmacological properties were described by Dioscorides as far back as the first century AD. The flowers and fruits are used to treat cardiac functional disorders, angioneurosis, tachycardia, fibrillary arrhythmia, and myosthenia. The drugs involved reduce blood pressure and act as a sedative. Hawthorn leaf extracts stimulate heart activity but increase blood pressure.

Hawthorns have been cultivated as a fruit crop since ancient times in China, Algeria, Spain, and Italy. In the Caucasus and Central Asia the locals eat the fruit fresh or made into jellies, jams, or preserves. Ground fruits, mixed with flour, are baked for sweet bread. The species most useful for food are those of North America which have large fleshy fruits with juicy pulp and a pleasant aroma.

Hawthorns are quite ornamental when flowering or holding fruit. Many species are noteworthy for their brightly-coloured leaves in autumn, which promotes their use in landscape gardening. Species with leathery glistening leaves are especially tolerant of urban conditions.

Plants are propagated from seed, either sown immediately after harvest in autumn, or in the following spring after necessary stratification. Seedlings grow slowly in earlier years, but then put on around 40 cm growth per year. Hawthorns produce abundant stump shoots and root suckers. They do not propagate well from cuttings; root suckers and layers are best for vegetative propagation. Garden forms are grafted, using the species *C. monogyna* Jacq. and *C. oxyacantha* L. as rootstocks. Plants have a life of 100-150 years, though specimens 300 years old are found.

Chemical composition of the fruits is relevant in their use in foods or drugs. Fruits have a dry-matter content of 13.4-21.2%, with sugars 3.7-10.3%, cellulose 1.4-3.1 %, pectins 0.7-1.8%. Titrated acidity has the range 0.6-1.9%, ascorbic acid reaches 10.15 mg/100 g, carotene 0.12-11 mg/100 g, thiamin 8-53 μg/100g, riboflavin 20-66 μg/100 g, and dye substances 230- 1980 mg/100 g.

Many scientists believe that triterpenic acids present in drugs prepared from hawthorn are responsible for its heart-dilating action. The complex of flavonoids called flakrazids isolated from the species *C. curvesepala* Lindm. have been suggested as a drug for stimulating heart activity, reducing blood pressure, and increasing coronary blood circulation. The biological activity of drugs from hawthorn is based on the flavonoids.

Hawthorn fruits contain 17-24 macro- and micro-elements, depending on the species involved and its vegetative conditions and place of growth.

In Russia and the former USSR, the following species are native: *C. altaica* Lge, *C. dahurica* Koehne, *C. chlorosarca* Maxim., *C. sanguina* Pall., *C. pseudoazarolus* M.Pop., *C. maximowiczii* C. K. Schneid., *C. meyeri* A. Pojark., *C. mongyna* Jacq., *C. pontica* C. Koch, *C. pentagyna* Waldst. et Kit., and many others.

Chaenomeles Quince

Japanese Quince (*Chaenomeles* Lindl., Rosaceae Juss.). The genus includes 4 species native to Japan and China, two of which extend into Russia.

The species *Chaenomeles japonica* (Thunb.) Lindl. is native to China and Japan, and is cultivated in Japan, northwest China, and North America. In Russia it is cultivated in the European part, but further north than the Voronezh region it is frozen out. In more southern regions it is winter-hardy and bears fruit.

Japanese quince is propagated by seed, root suckers and softwood cuttings. It grows fast, and is characterized by abundant flowering and setting fruits only in sun-lit places.

Shrubs are up to 3 m in height with spreading branches, covered with thin thorns 1-1.5 cm long. The flowers are on short stalks, with a red or rosy corolla, grouped by 2-6 in short clusters up to 5 cm in diameter. It flowers before the leaves appear in April-May. Fruits vary in shape, from rounded to ovate and pear-shaped, and are up to 6 cm long, glabrous, greenish-yellow, light-yellow or lemon-yellow, sometimes with red blushes. The flesh is hard with a great number of stone cells, sour, astringent, and fragrant. The fruits weigh 20-50 g. They hold 50-80 brown glossy seeds. Fruits ripen in September-October. Fruiting is abundant and annual from the age of 2-3. Five year old bushes yield 4-5 kg of fruits.

Japanese Quince, Chaenomeles japonica [Nesterovich]

Fruits contain 14-17% of dry matter, 1.2-3.1% sugars, 0.7 -1.3 % pectins, of which 80% is protopectin. The content of titrated acid is 3.6-7.2%. The concentration of ascorbic acid in fruits ranged from 18 up to 145 mg/100 g. In addition, the fruits are quite rich in vitamins B1 and B2: the amount of thiamine is 106-122 μg/100 g, of riboflavin 78-330 μg/100 g. The total of tanning and dyeing substances fluctuates within 830-2300 mg/100 g. The characteristic pleasant aroma of yellow ripe fruits is due to enanthic-ethyl and pelargonic-ethyl ethers.

Fruits are not used fresh, but tasty jams, jellies, juice, and other preserves are made from them. They are also used in the confectionery industry and in perfumery. Early flowering shrubs may be used as decorative plants.

C. maulei (Mast.) C.K.Schneid. This occurs in mountainous districts of Japan. In Russia it has been known as an ornamental, winter-hardy plant since the 19th century. From ancient times it has been cultivated in China, Japan, and Korea. It is a crop plant in Norway, Sweden, and USA. In Europe it has been cultivated since the end of the 18th century. Plants are almost indifferent to warmth and soil moisture, they are drought-resistant and do not suffer from frosts. They are light-loving. On sunlit plots they bloom very abundantly, thus one shoot 40 cm long produces up to 60 flowers.

This species does very well on fertile soils. It is propagated by seeds, layers and softwood cuttings and by division. It grows very fast, with flowering from the 3rd or 4th year.

It is a small, up to 1 m, thorny shrub with bowed, pendulant branches covered with thin 1- 2 cm long thorns. Leaves are small, 3.5 cm long, obovate, blunt, crenate-toothed, bare, leathery, and glossy. Flowers are orange-red, large, 2.5-3 cm in diameter, on short flower stalks, grouped by 2-6 in short clusters located along the whole stem. Flowering is abundant in May, lasting 3 weeks. The fruits are juicy, with many stone cells, sour, astringent, and fragrant, with 82-90% flesh. They ripen in September-October. Fruit bearing begins in year 3-4, and yield per bush reaches 1.5-1.7 kg.

The dry matter content of fruit is 16.7%, with sugars 2.5-4.5%, titrated acids - 4.9%, ascorbic acid 22 mg/100 g, tanning and dyeing substances 1160 mg/100 g. There are pectic and aromatic compounds present in the fruit.

The fruits are not used fresh. But they are used for making jams, jellies, syrups, juice, soft drinks, wines, and liqueurs. They are also used in confectionery and perfumery. The plant's low height and abundant and decorative flowering and fruit bearing recommend it as a garden plant and for pot culture.

Siberian Cedar

Siberian Cedar, or more correctly, Cedar Pine (*Pinus sibirica* Mayr.). This is a well-proportioned tree, from 35 to 45 m in height and 2 m in diameter, with a dense cone-shaped crown. Its longevity reaches 900 years. Fruit bearing occurs at intervals. Cones ripen in the second year after ovary formation. Abundant yields of nuts occur every 5-6 years. The tree grows in northeast European Russia (east of the River Vychegda), over almost the whole territory of Siberia, and in the Northern Mongolia. The Cedar Pine forms mixed forests with spruce, fir, and larch, or pure stands, the Cedar Forests.

Seeds (nuts) are dark -brown, 10-14 mm long, 6-10 mm wide. They are extremely valuable as food. Thus, their proteins consist mainly of easily assimilable albumins and globulins, therefore they are digested more easily than proteins of walnut, hazel, peanut and almond. There are 14 amino-acids in their composition. Of those, 70% are essential amino-acids, implying a high physiological value for these proteins. It should be stressed that Cedar Nuts possess higher amounts of amino-acids, namely tryptophan, lysine, methionine. Due to the high content of the above-named amino-acids and histidine, cystine, and argenine, the proteins of the cedar nuts surpass the proteins of casein of milk and those of cattle meat. And as regards the content of valine and tyrosine they are equal in value. The high content of argenine in cedar nuts makes them especially valuable for nutrition of a fast-growing child.

The oil of cedar nuts is characterized by high content of polyunsaturated fatty acids. The oil consists of great quantities of fat-soluble vitamins E and F, which are characterized by high physiological and anti-oxidizing capacity. As regards the content of tocopherols it surpasses the oil of walnut by 1.5 times, and of sunflower oil by 5 times, and as regards the content of essential fatty acids it surpasses peanut oil by 3 times, soybean by 1.5 times, sunflower by 1.5 times. Cedar nut oil surpasses the oil of all other nuts by the quantity of the most important compound for an organism, that is phosphatid phosphorus. Besides that, the nuts are a rich source of the most significant mineral elements: P, K, Mg, Mn, Cu and others.

Cedar Nuts possess up to 64% of fatty oil. By its content they surpass the most important crops that are used for producing oil, such as cotton and soybean by 2-3 times, maize by 6-8 times, and sunflower by 1.5 times. Their fat content is equal to that of the walnut.

From ancient times, in Siberia an infusion of cedar nuts with vodka has been used as a tonic drug and for regulating metabolism. Coming to the point, we may say that it is a most common and a most efficient medicinal drink: - the balsam of health. The bouquet of balsam is of great value, and its fragrance may be compared only with that of the taiga, the great pine forest tracts of Russia.

Conifer needles, nuts, and resin are of importance in pharmacology. Conifer needles contain up to 350 mg/100 g of ascorbic acid and up to 1.5% of volatile oil. Cedar nuts contain proteins, starch, sugars, vitamin B1, and other physiologically active compounds. The tincture of cut conifer needles may be used as a drink, rich in vitamins. Cedar needles may be used as one of the tonic components of hygienic baths. In folk phytotherapy, cedar nuts are used for treating nervous disorders, tuberculosis of the lungs (the 'milk' prepared from kernels), diseases of kidneys and the bladder. By its quality the oil from nuts is very close to the best varieties of vegetable oils of almond and olive.

The Siberian Cedar, Pinus sipirica [Savel'ev]

Cedar resin is used for treating wounds, trophic ulcers, and boils. It may be used for producing turpentine and camphor.

The Cedar bark bast is used for treating ulcers after burns. The powder from the bast helps in treating burns produced by hot water. Gargling with bark broth gets rid of lots of mucus. A broth of bark and vinegar produces a good effect in case of a toothache. A broth of bark and conifer needles helps in cases of liver problems. Nut kernels together with cucumber seeds in raisin juice, boiled up to half its volume, serves as a diuretic drug and helps to treat kidney and bladder ulcers. Cedar tar cures ulcers and is very useful for chronic cough, liver diseases, and enuresis.

Cedar Pine is highly phytoncidal and influences favourably organisms of human persons and animals. Cedar Pine air is saturated with volatile phytoncides which produce a healing action on man and are destructive towards causative agents of diseases. These volatile phytoncides consist of tars, balsams, ethereal oils, organic acids, anthocyans, ferments, and vitamins. As a result, the air is pure and nearly sterile.

The Siberian Cedar Pine is a national pride of Russia. It is a beautiful and valuable tree. It has been proved that the use of products from the Cedar Pine forest, such as nuts, raw materials for pharmacology and industry, furs, honey, etc. exceeds by several times the value of cutting the wood.

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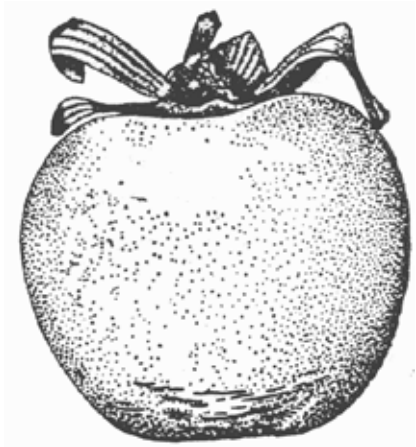
THE WORLD TRADE IN PERSIMMONS

R.J. COLLINS
University of Queensland, Gatton College, Lawes, Qld, Australia
A.P. GEORGE
Maroochy Horticultural Research Station, Nambour, Qld, Australia
A.D. MOWAT
Institute of Horticulture and Food Research, Hamilton, New Zealand

There are two forms of persimmon derived from *Diospyros kaki*, astringent and non-astringent. Astringent cultivars contain high levels of soluble tannins and cannot be eaten until fully ripe and very soft, unless the astringency has been artificially removed. Non-astringent cultivars contain low levels of soluble tannins and can be eaten at various stages of fIrmness, from hard to very soft.



In recent years there has been a trend towards the production and marketing of non-astringent fruit, either from non-astringent cultivars, or from astringent cultivars whose fruit have had astringency artifIcially removed.

Productivity of the persimmon is moderate. The fruit is attractive, sweet, and depending on cultivar and handling can have a long post-harvest storage life. It is well accepted by both traditional Asian and European consumers. However, the fruit is highly susceptible to blemishing and a range of other disorders. High levels of management are required to produce fruit of acceptable export quality.

Some countries, such as Israel and New Zealand, have developed persimmon industries based on export markets, while others, such as Italy and Japan, have industries focused mainly on domestic consumption. Based on current plantings of non-astringent varieties, world production will increase significantly in the next decade. Export industries have developed in response to off-season opportunities in traditional markets and the increasing demand for exotic fruit in non-traditional markets.

Major Producing Countries Northern Hemisphere

Japan

Persimmons are considered a national fruit in Japan, and are the fifth most widely consumed fruit. Average per capita consumption, at 1.2 kilogram, is still rising, compared with falling consumption of fruit such as apples, pears, peaches, watermelons, and bananas. In 1988,287,000 t of persimmons were produced from 26,000 ha. Non-astringent cultivars accounted for more than 40% of total production, with 'Fuyu' being responsible for 75% of non-astringent production. The harvest season spans mid-September to mid-December, and is extended to March by stored product.

Most fruit is sold through local wholesale markets or transported to one of 91 central wholesale markets located across 56 cities. An increase in consumer spending power has created a demand for very high quality fruit.

Prices range from as low as 185 Yen (about US$1.85) per kg during peak supply to as high as 1400 Yen (US$14.00) for out of season fruit imported from New Zealand.

Small quantities (4,424 t in 1986) are exported to South-East Asia. Japan has imposed quarantine barriers against fruit from countries known to host fruit flies.

China

China is the world's largest persimmon producer. Most of its production is consumed domestically. Production in 1988 was 567,750 t from about 150,000 ha. Less than 1 % of this was from non-astringent cultivars. Harvesting extends from October to November.

Most produce is consumed domestically at prices from US$ 0.21 to US$ 0.68 per kilogram. A small quantity (less than 1,000 t) of fresh product is exported annually to destinations such as Hong Kong and Macao. Exports of dried persimmons to Japan and South-East Asia have averaged 2,000 to 3,000 t per annum since 1964.

Korea

Korea is a major producer of persimmon. Annual production in 1990 was about 65,000 t from an area of 10,000 ha. Non-astringent production was 85% of the total production. The harvest season is from November to December.

Most of Korea's production is consumed domestically. Small quantities are exported to Japan.

South·East Asia

South-East Asia covers the countries of Indonesia, Malaysia, Thailand, Hong Kong and Singapore. This area is not an important producer of persimmons. Apart from about 30 ha grown in Thailand, no other significant commercial production has been recorded.

The demand for persimmon in South-East Asia is met by imports, most of which come from Japan, China and New Zealand. Prices in 1988 ranged from US$ 1.90 to US$ 5.60 per kg. There are no significant quarantine barriers to imports into South-East Asia. This market is regarded as a developing one by producers in the southern hemisphere.

Israel

Israel cultivates over 1,200 ha of persimmons, of which only 10% are over six years of age. This accounts for the low annual production. Assuming a yield of 20 t per hectare, potential production could exceed 24,000 t per annum within the next decade. Most plantings are of the astringent cultivar 'Triumph', which is treated to remove astringency before being marketed as Sharon Fruit. It is understood that the Israeli Ministry of Agriculture intends to expand the planting of Sharon Fruit by another 500 ha as soon as possible. Harvesting extends from November to January.

The major export market is Europe, in particular Great Britain, France, Germany, and Scandinavia. Total exports have averaged around 3,000 t annually, at prices from US$ 1.02 to US$ 3.20 per kg.

European Community

Persimmons were introduced into Europe in the mid-19th century and are currently produced in the south of France, Spain and Italy. Italy is the major producer, with 70,000 t being produced from 3,405 ha in 1987. Spain is reported as producing 500 t annually. Although present production is based on astringent cultivars, significant new plantings of non-astringent cultivars are occurring. The harvest season extends from September to November.

Fruit of the non-astringent cultivar 'Fuyu' on the tree

Most production is consumed domestically. The European Community imports most of its requirements from Israel, with lesser quantities from Brazil and Chile. Prices per kg ranging from US$2.05 in the United Kingdom to US$ 8.16 in Germany have been recorded. Trade barriers to protect the domestic market have been imposed in the form of an 8 percent tariff during the domestic supply period and 4 percent at other times.

United States

The production of persimmons has increased from less than 500 t in 1980 to over 4,000 t in 1988. The area planted in 1988 exceeded 600 ha, most of which was in California. The recent expansion of American production has been based on non-astringent cultivars, in particular Fuyu. Harvesting extends from early October to mid December.

Most production is consumed domestically. Los Angeles is the major wholesale market. Small quantities have been exported to destinations such as South-East Asia and Australia. Returns to growers vary between US$ 0.28 to US$ 1.12 per kg. Quarantine barriers against countries which host fruit flies have been imposed.

Major Producing Countries Southern Hemisphere

New Zealand

Current plantings total 260 ha. In 1991 production totalled 1,880 t, of which 196 t were exported to Japan, and 173 t to Singapore. Most of the current production is from the non-astringent cultivar Fuyu.

However, as non-astringent cultivars sometimes do not completely lose their astringency and do not reach acceptable sugar levels under cool moist summer conditions there has been a shift in planting towards high quality astringent cultivars such as 'Tone Wase'. Harvesting occurs between late April and June.

The New Zealand industry is export-oriented, in particular towards the Japanese market. South-East Asia and Australia are becoming more important markets for fruit which does not meet the exacting quality standards of the Japanese market. Early season prices in Japan have exceeded US$ 20.00 per kg. By the end of the season in July, prices can fall to below US$ 6.50 per kg. Exports totalled 235,000 trays (940 t) in 1991, compared with 95,000 trays (380 t) in 1989. New Zealand is fruit fly free; restrictions against fruit from host countries apply to fruit imported into New Zealand.

Brazil

Brazil is the second largest producer of persimmons in the world. Annual production is estimated at 450,000 t from 45,000 ha. Harvest occurs from February to April.

Based on limited data specifying Brazilian product in export markets, it is assumed that a large domestic market must exist. In 1984,60 t were exported to Europe.

Chile

The persimmon industry in Chile is in its early stages. The majority of plantings (92%) are less than five years old. Total production in 1988 was 171 t from 144 ha. Harvesting extends from April to June. The most important cultivar is Hachiya, which is astringent, though it is not the most important cultivar exported.

Trees of most persimmon cultivars are semi-dwarf in growth habit and very high yielding.

The industry is developing an export orientation. Exports to Europe and the USA increased from 39 t in 1986 to 106 t in 1988. Prices vary between US$ 0.77 to US$ 1.28 per kg. Chile has fruit-fly-free status, thus has access to other fruit fly-free markets.

Australia

Although persimmons have been grown in Australia for over a hundred years, significant commercial development has only taken place since the late seventies. A planted area of 400 ha produced 200 t in 1988. There are currently an estimated 200,000 trees planted, most of which are less than 6 years old. A yield of 25 kg per tree would give the industry a potential annual production of 5,000 t when current plantings mature in the late nineties.

Although there are small areas still producing astringent cultivars, virtually all of the recent expansions have been of non-astringent cultivars, particularly Fuyu. Australia's harvesting season extends from early February in North Queensland to as late as June in cooler parts of Southern Australia.

The domestic market is currently consuming most of the country's production, and could be still further developed as more consumers become aware of the non-astringent product. In Queensland and New South Wales, and more recently in South Australia and Western Australia, non-astringent persimmons have been marketed very successfully as 'Fujifruit' a name given to them to remove any association in consumers' minds with astringent cultivars. Australian domestic wholesale prices of non-astringent fruit have averaged US$ 9.12 per single-layer tray of 4.0 to 4.5 kg over the last few seasons.

Asian persimmon flowers: left - male; right - female

Australia exported 22 t in 1987-88. Virtually all of this was non-astringent fruit, of which almost 18 t came from Queensland and New South Wales. 40% was sent to Singapore, and 15% to Kuwait. Other destinations included Hong Kong, Malaysia, New Caledonia, the Philippines, and Saudi Arabia.

In the 1989 season, trial shipments were also sent to Europe and some Pacific islands. As Australia is a host country for fruit fly, exports to destinations such as Japan and North America are currently banned. In the last two years, quantities of persimmons have been imported from California and New Zealand.

Summary

The world trade in persimmons is dominated by the producers and consumers of the northern hemisphere. Astringent cultivars are mostly consumed domestically while non-astringent fruit is more commonly traded on export markets. In most countries where the persimmon industry is expanding, it is doing so as a result of planting non-astringent cultivars.

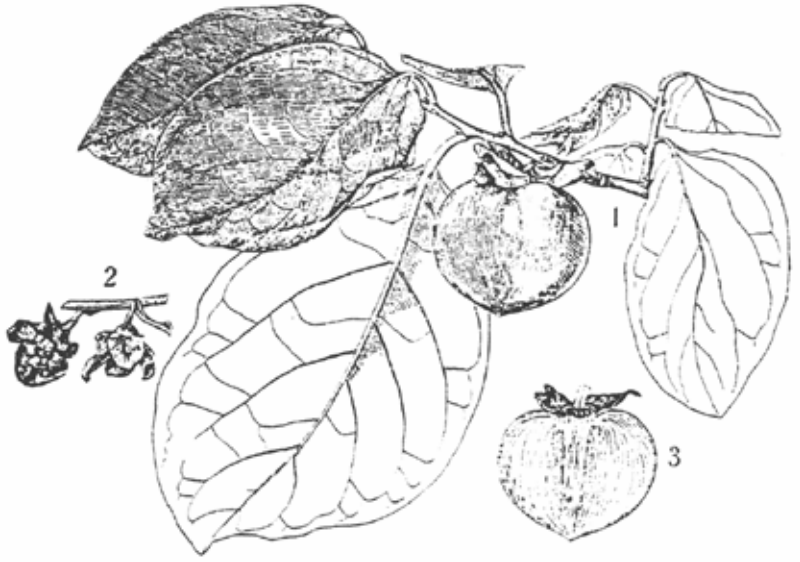
Southern hemisphere countries are expanding their orchards as a response to opportunities to supply out-of-season fruit to northern hemisphere consumers. The major production constraints for export are the need to satisfy requirements of quality, quarantine and long storage life for sea freighting to importing countries.

A summary of world trade is presented in table 1.

Table 1. World supply of persimmons (N.A. = no figures available)

Country	Area (ha)	Production (t)	Exports (t)	Major Destination
China	150 000	567 750	1 000 (1989)	S.E. Asia
Brazil	45 000	450 000	60 (1984)	Europe
Japan	26 000	287 000	4424 (1988)	S.E. Asia
Italy	3 405	70000	N.A. (1987)	
Korea	10 000	65 000	N.A.	Japan
USA	600	4 000	N.A. (1988)	S.E. Asia
Israel	1 200	>3 000	3 000 (1989)	Europe
New Zealand	260	1 880	940 (1991)	Singapore, Japan
Australia	400	200	N.A.	S.E. Asia
Chile	144	171	106(1988)	Europe

[Based on an article in Chronica Horticulturae, Vol 33, Number 2, June 1993]



The Oriental Persimmon, Diospyros kaki L.

NATIVE FRUIT AND NUT BEARING SPECIES OF THE KIMBERLEYS

GIL HARDWICK §
RMS 89, Vasse Highway, Yoongarillup WA 6280

Much has been said about selecting and propagating native fruiting species, apparently for larger and more attractive fruits and nuts finding sufficient market acceptance to support their commercial production. However, most of these native fruits while perhaps small and insignificant looking, are nevertheless prolific and often contain high concentrations of minerals and vitamins.

I would therefore argue that we might rather think of them as hardy yet extremely important diet supplementary crops for people to enjoy freely, not least to provide abundance for growing children, planted throughout our public parks and gardens.

1. ANACARDIACEAE

Buchanania arborescens	Little Gooseberry Tree	Food (Fruit)
Buchanania muelleri	Wild Plum	Food (Fruit)

Listed by Isaacs (1987) p.219; Low (1988) p.150, as NT & Qld relatives of *B. obovata*.

Buchanania obovata	Wild Mango, Green Plum	Food (Fruit), Medicine (Inner bark)

Shrub or tree to 15 m, same family as the cultivated mango. Widespread in northern Kimberleys south to Oobagooma, Dampier Peninsula, King Leopold Ranges and Bungle Bungles. Regarded as an extremely important bush tucker and bush medicine across Northern Australia, it sustained large seasonal Aboriginal gatherings October to December. Ripe green fruit eaten fresh or pounded into cakes and dried for storage, later reconstituted with water. Ab. Comms (1988) pp.62- 3; CALM (1992) p.658; Isaacs (1987) passim; Low (1988) p.150; Low (1990) passim; Petheram and Kok (1986) p.379.

2. APOCYNACEAE

Carissa lanceolata	Conkerberry	Food (Fruit), Fodder, Liniment (Sap)

Spiny shrub to 2 m, related to popular Natal Plum. Commonly found south from Robinson

§ Member, WANATCA

River, Drysdale River Station and Kununurra. Bears abundant sweet berries 7-10 mm long, black when ripe, any time of year following enough rain. CALM (1992) p.702; Isaacs (1987) p.71; Low (1988) p.168; Low (1990) pp.185,227; Petheram and Kok (1986) p.293.

Carissa ovata	Currant Bush	Food (Fruit)

Very similar to *C. lanceolata* but with ovate leaves, WA, NT & Qld. Low (1988) p.168

3. ASCLEPIADACEAE

Marsdenia australis	Bush Banana	Food (Fruit, Tubers)

Close relative of *M. viridiflora* widespread across the continent. Low (1988) p.164.

Marsdenia viridiflora Bush Banana Food (Fruit, Tubers) Climber to 2.5 m twining over fences and among foliage of shrubs and trees in the pindan country from One Arm Point past Broome and Derby. Young pods roasted like zucchini, and extremely rich in thiamine. Large watery tubers eaten raw, or sucked when thirsty. CALM (1992) p.715; Isaacs (1987) p.225; Low (1988) p.164.

See Cover illustration of this issue of WANATCA Yearbook.

4. CAPPARACEAE

Capparis lasiantha	Split Jack, Nipan	Windbreak, Food (Fruit)
Capparis jacobsii	Native Pomegranate	Shade, Food (Fruit)
Capparis mitchellii	Wild Desert Orange	Shade, Food (Fruit)
Capparis spinosa var. *nummularia*	Caper Bush	Food (pickled buds)

Climbing shrubs relatives of *C. umbonata*. Isaacs (1987) passim; Low (1988) pp.172-4.

Capparis umbonata	Wild Orange	Food (Fruit), Antiseptic (Bark, Leaves)

Tree or shrub to 8 m growing in open woodlands and rocky slopes, from Cape Bougainville and Kununurra south to Hammersley Ranges. Fruits August to October with large globular berry with woody pericarp to 45 mm, highly regarded by Aboriginal people who will often ripen green fruit in the hot sand. Ab. Comms (1988) p.74-5; CALM (1992) p.259; Cribb & Cribb (1982) p.174; Isaacs (1987) passim; Low (1988) pp.I72-4.

5. COMBRETACEAE

Terminalia arostrata	Nutwood	Food (Fruit, Nuts)
Terminalia grandiflora	Plumwood	Food (Fruit, Nuts)
Terminalia cunninghamii	Pindan Quandong	Food (Fruit, Nuts)

Semi-deciduous trees 12-15 m all related, growing in open woodland often on sandy soils variously across the Kimberleys from Kalumburu and Kununurra to King Leopold Ranges south to Camballin. Flesh and kernel both reported edible. CALM (1992) pp. 553-6.

Terminalia ferdinandiana	Billy Goat Plum, Gubinge	Food (Fruit, Gum), Antiseptic (Bark)

Scrawny tree to 15 m growing in open forests of the West Kimberley north of Derby,

as well as the western Top End of the Territory. Also known as the Vitamin C Tree for its world record fruit content of this vitamin, the sour fruits 15-25 mm long and available from March to July area popular Aboriginal snack food. Isaacs (1987) p.63; Low (1988) p.151; Low (1990)

Terminalia hadleyana	Wild Peach	Food (Fruit)
Terminalia petiolaris	Maroal	Food (Fruit, Gum)
Terminalia platyphylla	Wild Plum	Food (Fruit)
Terminalia seriocarpa	Damson	Ornamental, Food (Fruit)

Other terminalias worth closer attention. CALM (1992) pp. 553-7.

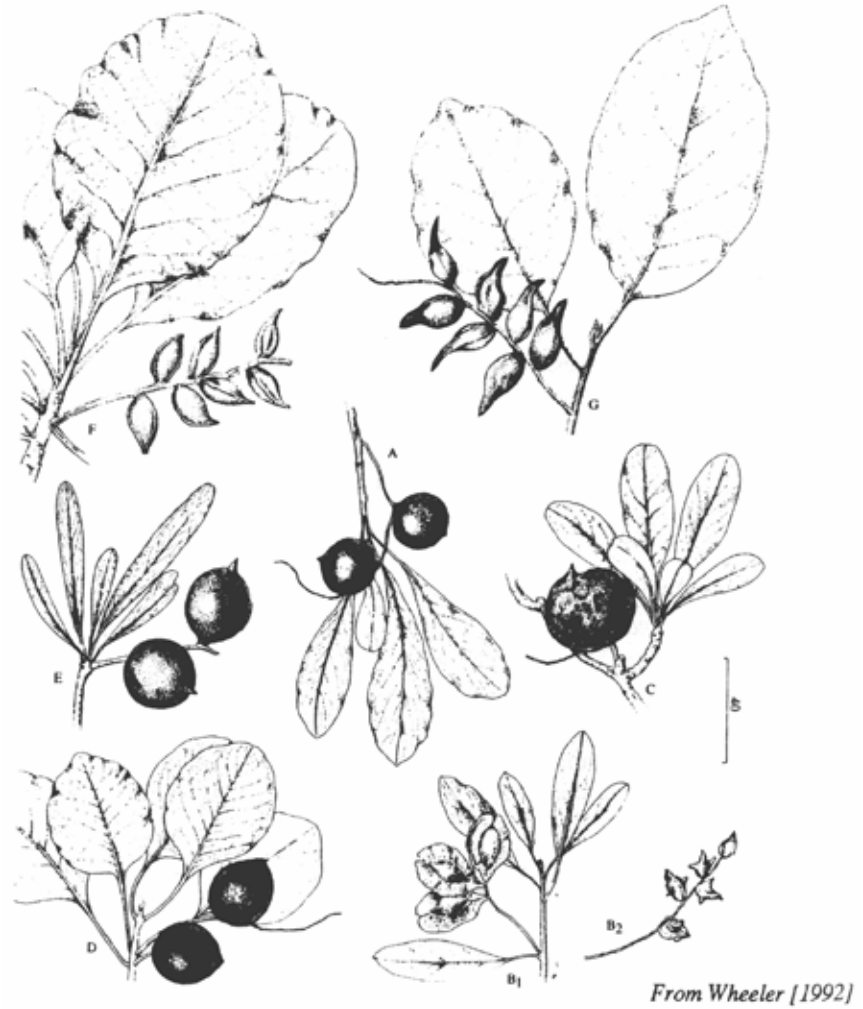


Fig. 168. COMBRETACEAE. fruiting branch. A - Terminalia arostrata. B - Terminalia canescens. B1 with normal fruits, B2 with abnormal fruits. C - Terminalia cunninghamii. D - Terminalia fitzgeraldii. E - Terminalia grandiflora. F - Terminalia hadleyana subsp. carpentariae. G -Terminalia hadleyana subsp. hadleyana.

6. LECYTHIDACEAE

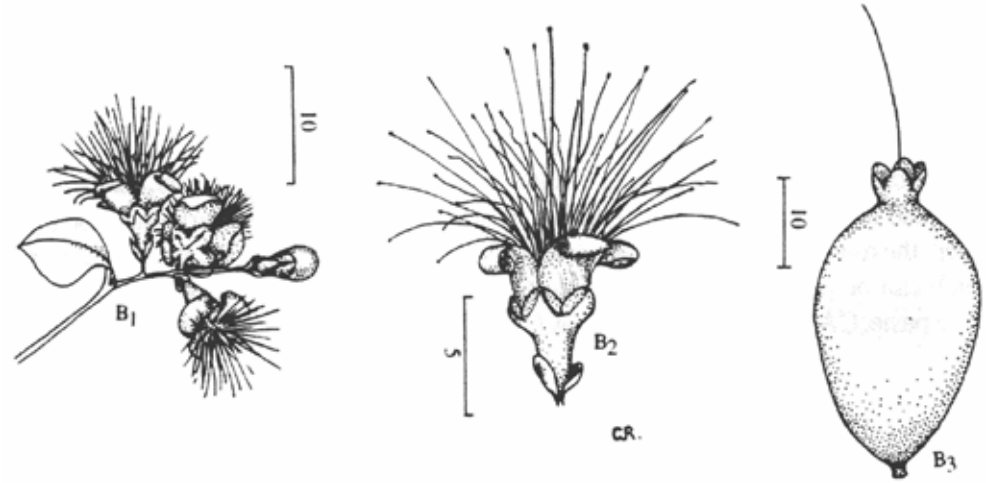
Planchonia careya	Cocky Apple, Mangaloo	Food (Fruit), Twine, Fish Poison (Bark)

Tree or shrub 8 to 13 m common in open woodland from Cape Londonderry south to the Dampier Peninsula and across to Kununurra, NT & Qld. Fruit and seeds available November to January are an important bush tucker, and apart from its other uses its macerated leaves are said to cure ulcers. Ab. Comms (1988) pp. 178-9; CALM (1992) p.236; Isaacs (1987) p.62; Low (1988) p.149; Low (1990) passim; Petheram and Kok (1986) p.507.

7. MORACEAE

Ficus opposita	Sandpaper Fig	Shade, Food (Fruit)
Ficus platypoda	Rock Fig, Desert Fig	Shade, Food (Fruit)

Shrubs or trees 6 to 8 m widespread throughout the region and across to NT & Qld, the latter extending as far south as Warburton. Fruits from the Sandpaper Fig are much sweeter, while the Rock Fig is also considered sacred by many of the Aboriginal people. CALM (1992) pp.80- 2; Isaacs (1987) passim; Low (1988) pp. 147,175; Low (1989) passim; Low (1990) passim; Petheram and Kok (1986) pp.461-3.



Planchonia careya. 1) raceme; 2) flower; 3) fruit [Wheeler]

8. PROTEACEAE

Persoonia falcata	Geebung, Nanchee, Wild Pear	Food (Fruit), Salve (Inner bark)

Shrub 3 to 6 m high occurring along rivers and creeks from Bonaparte Archipelago south west to Anna Plains Station and across to Bungle Bungles. Round or oval fruits to 20 mm long ripen only after falling to the ground. A favourite food of kangaroos, rats, emus and feral pigs, as well as both Aboriginal people and colonial settlers. CALM (1992) p. 479; Isaacs (1987) p.214; Low (1988) p.134; Petheram and Kok (1986) p.503.

9. RUBIACEAE

Gardenia megasperma	Wild Gardenia	Shade, Food (Fruit)
Gardenia pyriformis	Wild Gardenia	Shade, Food (Fruit), Balm

Very pretty shrub or small tree to 6 m, especially when in flower. Found in open woodland, sandy plains and scree slopes, the former from Drysdale River National Park to Kununurra and the latter in pindan country from the Dampier Peninsula south to La Grange. Not much information available in extant literature, but my own discussions with Aboriginal elders indicate the favoured status of its fruit as bush tucker. Crushed leaves are also used as a balm to protect bare feet from the hot sand, or as an infusion for aches and pains. CALM (1992) p.910; Damp. Oral Hist. (1987) p.21.

10. SANTALACEAE

Santalum lanceolatum	Plumbush, Northern Sandalwood	Food (Fruit), Incense (Wood)

Shrub or tree to 6 m growing on sand or sandstone, sometimes on dunes and riverbanks. Widespread across southern Kimberleys south to Shark Bay and across to Leonora and Warburton. Also in all mainland states. Closely related to the sweet red desert Quandong (*S. acuminatum*), the round fruits to 14 mm are purplish black when ripe. They are a favourite bush tucker which can be pulped and dried for storage, while the kernels are often roasted and ground into a paste. CALM (1992) p.569; Low (1988) p.176; Petheram and Kok (1986) p.337.

11. SAPOTACEAE

Pouteria arnhemica	Big Green Plum	Shade, Food (Fruit)
Pouteria pohlmaniana	Big Green Plum	Shade, Food (Fruit)
Pouteria sericea	Black Plum	Shade, Food (Fruit)

Large shrubs or trees 8 to 10 m high in open forests and thickets variously from Cape Londonderry to King Leopold Ranges, Mitchell Plateau and Drysdale River National Park. The flesh surrounding a large seed is reported being much sweeter as it dries like a prune, and is extremely popular among children. CALM (1992) pp.269-70; Damp. Oral Hist. (1987) p.51.

12. VERBENACEAE

Vitex acuminata	Black Plum	Shade, Food (Fruit)
Vitex glabrata	Black Plum	Shade, Food (Fruit)

Tree 3-4 up to 14-20 m high in gullies, vine thickets and forest from the extreme north of the region south to Drysdale River National Park on the one hand, and Dampier Peninsula across to Bungle Bungles on the other. Like Wild Mango cited above, Black Plums are an extremely important Aboriginal bush tucker, the globular fruits 12-14 mm long supporting large gatherings for meetings and Law business from December to February. Wheeler (1992) p.793. Too little information in extant literature, perhaps because of secretive nature of Law business associated with it.

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THE FUTURE FOR ALMONDS IN AUSTRALASIA

DAVID NOËL§
Tree Crops Centre
PO Box 27, Subiaco, WA 6008

The almond-growing industry in Australasia is quite old and well-established. It is also quite small on world standards. However, it appears to have the capability of massive expansion, even to the stage of becoming the leading world producer.

World production and trade in almonds is dominated by the USA and Spain (see figure 1). In 1992-3 the USA produced about 250,000 tonnes of almond kernels, while Spain grew about 72,000 t. All other almond-producing countries came in under 20,000 t - Australia's figure was 4,300 t [Global, 1994].

The interesting thing is the production per hectare obtained in these two countries. In the USA, their production was from about 160,000 ha, equal to 1.56 t/ ha; for Spain the figures were 600,000 ha and 0.12 t/ha.

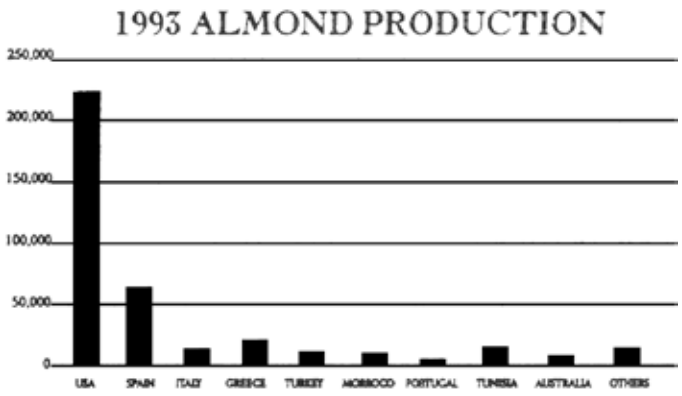

Figure 1. World almond production, 1993 [Global, 1994]

What was the reason for this vast difference? All the US production was from California, while most of Spain's production was from its Mediterranean-coast area (Fig. 2). The climates of these areas are not too different, so it was not that. The main difference appears to be in the production approaches used.

The Californian growers have a much higher investment per hectare of orchard. This is in irrigation equipment, mechanization, orchard management and fertilization, pollination (bees), and, last but by no means least, research.

Let us look at each of these, remembering that land in California is much more expensive than that in Spain, and so must be worked much more intensively to earn its keep - this is the bottom line with almond yields per hectare. Then we can look at how these factors might transfer to Australia.

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Irrigation. Virtually the whole of Californian production is irrigated, while most of the Spanish production not only relies on natural rainfall, but is also sited in naturally 'dry' country, regarded as unsuited to more productive crops. Almonds are a crop which are probably better suited to irrigation rather than equivalent rainfall, as flowering and leaf growth are disadvantaged by the humid conditions occurring with rain.

Mechanization. Californian orchards are highly mechanized, while Spanish almond trees are often just one feature in a mixed family smallholding without much equipment at all.

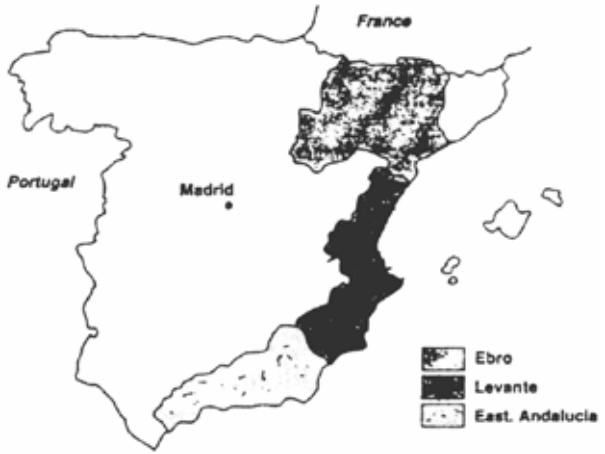

Fig. 2. Major almond growing regions of Spain [Murua, 1993]

Orchard Management. In California the almond orchards are intensively managed, with great attention paid to insect control, pruning, and fertilizer and trace element requirements. In Spain the trees tend to fend for themselves and produce what they can.

Pollination. According to Traynor [1993], almonds require a set of 30-60% of all blossoms for a bumper crop, while a 5-10% set is all that is needed for most orchard crops. For this reason, no commercial almond grower in California would consider operating without factoring beehive hire into their budget. From the other side, almond pollination hire is the major income source for Californian beekeepers, and they chase this business. Pollination in Spain is mostly left to nature.

Research. Although research on almonds does take place in Spain, far more effort is put in the USA, not only by government organizations, but also by universities, individual growers, and grower organizations. The Americans operate naturally under a 'research ethic' where every grower tries to work out ways to do things better - and make more money! The investment in this area is diffuse and not easy to quantify, but is undoubtedly huge.

Relative world changes

It seems undeniable that it is this concentration of investment, in both operations and research, which has put the Californians at the top of the almond business. But they have not always been there.

Right up to 25 years ago, in the late 1960s, Italy was the world's major almond producer. In 1960 California had about 45,000 ha under almonds, and in 1969, the largest almond orchard in the world was a 250 ha planting at Fresno, California. By 1990, California had over 172;000 ha in almonds, with more than 30 orchards over 500 ha and one over 4000 ha.

To attain this leading position, the Californians have had to learn not only to grow well, but also to sell well. They now totally dominate world trade - over 80% of almonds sold on world markets are grown in California. In fact Alston [1993] has pointed out that the market responses of the almond trade are such that US growers can make more money from their crop by restricting their exports and selling more at home. While such market manipulation may be perfectly legitimate, he points out that the long-term effect of such actions may be to encourage non-US growers to step up their production.

Back in Australasia

What then are the prospects for building up a massive almond industry in Australia? When the factors operating in the existing large almond-producing countries are considered, they look very favourable.

Figure 3 shows potential almond producing areas for Australia, on the basis of an industry run on similar lines to California. The map shows two types of area, one in which almonds should grow under natural rainfall, the other where rainfall would have to be supplemented by irrigation.

Obviously these potential areas are huge, covering almost half the continent. Southeast Australia, Tasmania, and New Zealand are not prospective because of spring frost or generally high humidity during the summer. But everywhere else which experiences a fair amount of chilling in winter and to which water is available naturally or through irrigation can be considered.

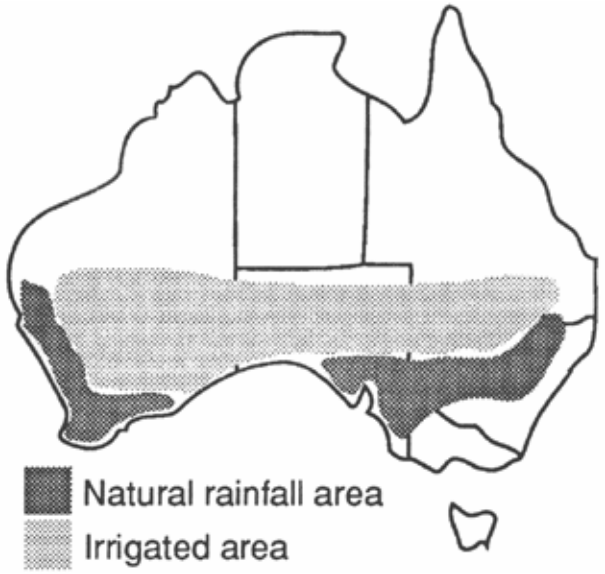

Fig. 3. Potential almond production areas of Australia

When compared with existing growing countries, the areas marked do not seem unreasonable. Australia's 1993 production of 4,300 tonnes is much lower than the 17,500 t in Turkey, the 16,000 t in Tunisia, or even the 8,200 t in Morocco, not generally thought of as a nut producer. In Western Australia, a commercial almond orchard exists at Northampton, around 28 degrees latitude, the same as Morocco. In other continents, this latitude corresponds to Ensenada in Baja California, Mexico, or to Kuwait in the Middle East.

Land prices in most of the areas marked are much lower than in Spain, and far, far lower than equivalent land in California. Even so, it would probably be a mistake to repeat the Spanish experience and try to grow almonds under natural rainfall, even where the rainfall makes this possible.

The keys to a successful major almond industry in Australia are probably twofold. The first concerns control of water, the second industry structure.

Water

Australia is rightly thought of as a dry continent - although, it has been pointed out, the water available per head of population is much greater than it is in the USA. Also, the potential for making use of natural rainfall is much greater in an area like the West Australian wheatbelt than it is in California.

In California, with its extensive mountains and limited flatlands, most rain falls in the mountains and must be brought by irrigation canal or pipe line from huge public dams to the dry valley sites. In the low-relief WA wheatbelt lands, rainfall can be carefully harvested on a grower's own property with networks of banks and small dams.

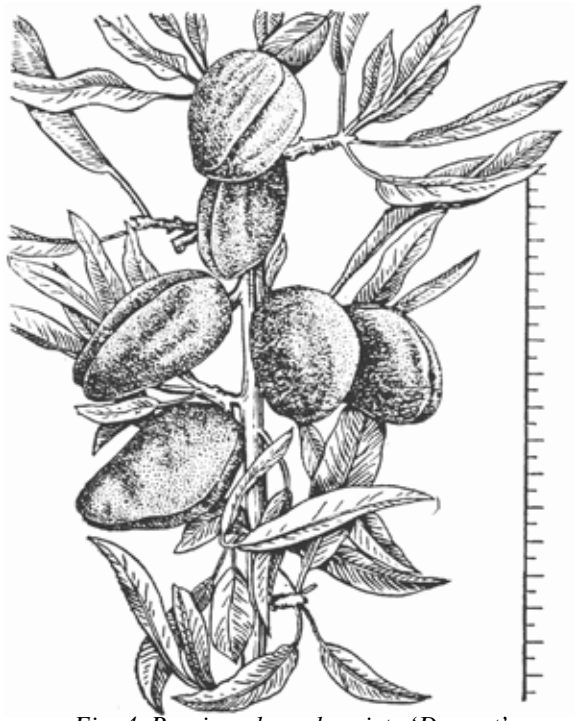

Fig. 4. Russian almond variety 'Dessert'

Effective rainfall can easily be multiplied to any desired degree simply by allocating the use of this stored water. If a 100-hectare property in a 400 mm rainfall zone collects all the rainfall over the whole area and uses it on a 50-hectare almond orchard, that orchard thinks it is getting the 800 mm/year it requires! Although this is an unfamiliar concept for Australian farmers, not one which can be used with conventional field crops, it has actually been used for centuries in places such as north Africa.

Industry Structure

To duplicate the Californian industry success, most of the same investment, research, training, pollination, farm equipment, cooperative handling and processing plant factors would apply.

These costs are major, however even here, Australia has some notable advantages, such as lower land costs. Another big plus is the fact that Australia is free of major bee pests, tracheal and varroa mites, which beset all commercial US beekeepers.

These mites can be controlled, but the inspection and treatment needed is expensive and has a major effect on beekeeping economics in California, resulting in higher charges to almond growers.

Incidentally, Canadian bees are still mite-free, and could be brought into California for almond pollination (but not sent back). There is a possible opportunity here for Australian beekeeepers to supply hives or queens to California.

Politically and strategically, perhaps the easiest way to build a major almond industry in Australia might be to encourage Californian growers to take up joint-venture operations here, when they would bring their own expertise and capital with them. This would be a very cheap way for Australia to get the industry structure needed.

Beyond California

Everything so far has been about the almond industry as it grew up and currently exists. There are possibilities beyond this.

As I have pointed out previously [Noel, 1985], the genes which form the basis of commercial almond industries have travelled a long way round the world from their original centre of origin in Central Asia. At each stage of these travels, the genes have been put through a sieve, as it were, to select characteristics such as cold-hardiness, fruitfulness, and good kernel size and flavour.

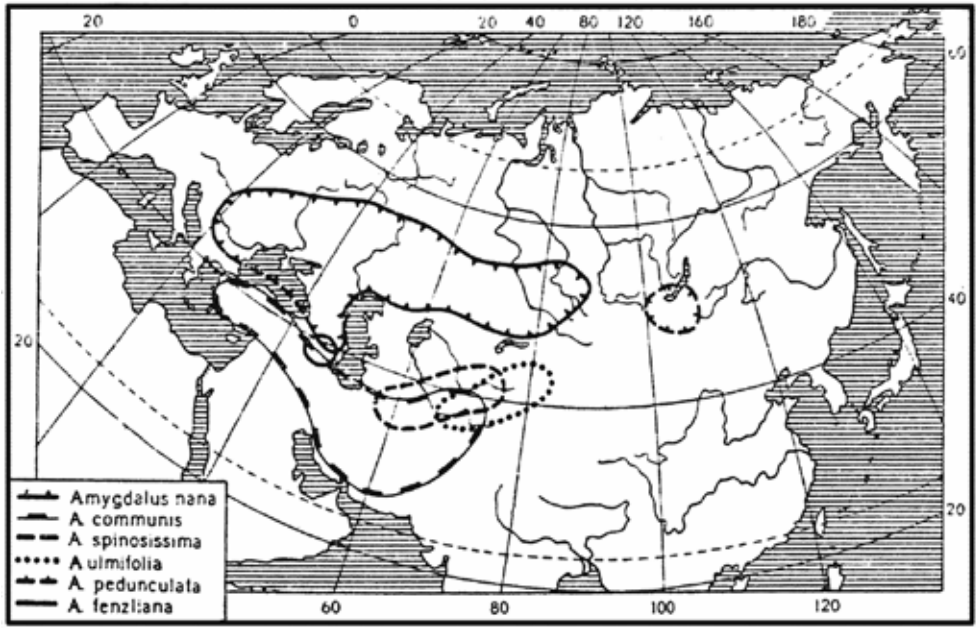

Fig. 5. Distributions of wild almonds in Asia

The result is a gene pool which must be considered effete and limited in its ability to grow under extreme conditions. There are possibilities for going back to the almond's origins to pick up all manner of useful genetically-based characteristics.

Figures 5 and 6 show two maps. The first [from Bakhteev] shows the natural distribution of six species of almonds in Asia. Our familiar almond was bred from *Amygdalus communis*, which the map shows as a southern species, in the same latitudes as modern commercial producers.

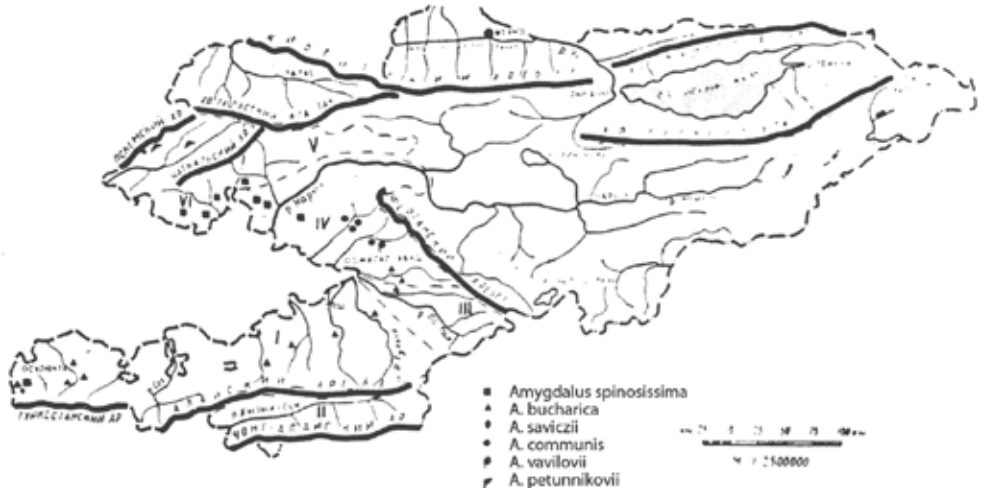

Fig. 6. Distributions of wild almonds in southwest Kirgizia

The second map [from Okhoba] shows the distributions of six almond species, mostly different from those on the first map, in the mountainous Central Asian country of Kirghizia, formerly one of the republics of the USSR. From all these species, extending from the frozen tundra of Siberia down to the deserts of the Persian Gulf, genes could be taken to create almonds able to grow under a much wider range of conditions than the almond we know today.

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THE VERSATILE KAYA TREES OF JAPAN AND CHINA

NOBORU MOTOHASHI §

Department of Medicinal Chemistry, Meiji College of Pharmacy 1-22-1, Yato-cho Tanashi-shi, Tokyo 188, Japan

ROGER MEYER §

Allergan Pharmaceuticals

2525 DuPont Drive, Irvine, California 92715 USA

Introduction

Indigenous to the mountainous regions of Japan and China are the pine-like trees known in Japan as Kaya. The Kaya of Japan is scientifically known as *Torreya nucifera* (Japanese kaya) and its Chinese relative as *Torreya grandis* Fort. The genus name of both, *Torreya*, came from American botanist and chemist John Torrey.

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Fig. 1. Torreya nucifera (Japanese kaya)

The genus has representatives in both Asia and North America. The North American relatives include the California nutmeg (*Torreya california*), stinking cedar (*Torreya taxifolia*), and the yew (from which the new, exciting anticancer drug taxol has been found).

All of these trees belong to the family Taxaceae, which are distinguished from their close relatives, the Pinaceae (pines), by their dioecious flowers (separate male and female plants like the kiwifruit, *Actinidia deliciosa* or the gingko, *Ginkgo biloba*), fleshy fruit, and an embryo with only 2 cotyledons. Usually the Torreya trees have long, bad-smelling leaves, and a large ovoid fruit which resembles a drupe but actually is a large seed surrounded by a fleshy aril.

Both Kaya species are evergreen with needle-like leaves and tree form very similar to the Himalayan cedar, *Cedrus deodar*. Older trees grow to about 25 metres in height and 2.5 metres in diameter. The bark of a young tree is blueish-grey and, when the tree ages, its bark peels off.

Their flowers open in April and May. The egg-shaped male flower is yellow and the female flower is green. The fruit, actually an aril, is 2-4cm ellipse which surrounds the single seed. This seed is only somewhat smaller than the fruit itself (2-3 cm by 1-1.5 cm) and is similar to the Japanese apricot or almond. However, the flesh of the fruit is not edible - only the seeds are edible.

The wood of the Japanese Kaya trunk is very hard, hence, it is very suitable as a building material.

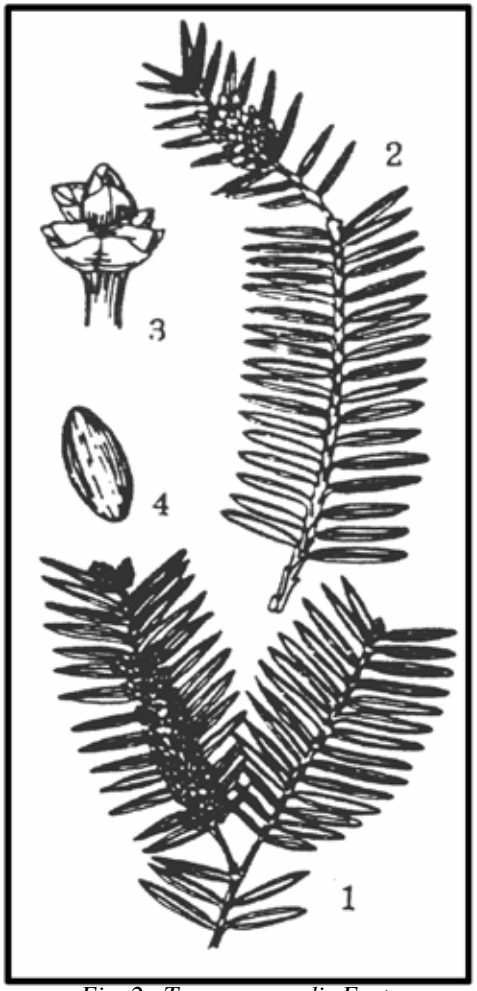

Fig. 2. Torreya grandis Fort. (Chinese kaya)

Torreya nucifera (Japanese kaya)

This tree is used throughout Japan as an ornamental tree and can often be seen in the grounds of Japanese temples. The wood of the trunk is very hard, hence, it is suitable as a building material or as a material for artisans. In the last situation, Kaya is used to sculpt statues of Buddha as well as for making board games such as 'Go' and 'Syohgi' which are types of Japanese chess.

As discussed earlier, only the seeds themselves can be used for a food source. They may be dried to be eaten out of hand or used whole or cracked in cakes. Japanese Kaya powder is just the ground, dried nuts which can be used like a wheat flour. Additionally, a seed oil can be expressed which is used for cooking.

Although used in foods, the seeds do contain alkaloids which in past times were used in illegal abortions in Japan.

The leaves of the Kaya contain volatile oils which are burned as a mosquito repellant.

Fig. 3. Kaya nuts from a Sydney Asian Food store

Torreya grandis Fort. (Chinese Kaya)

The Chinese have used their Kaya tree for centuries in folklore medicines. Seed preparations were used for various worm infestations in humans. They made medications for these parasites which infect the intestinal tract. These parasite problems included the oxyurids (pinworms), *Ancylostoma duodenale* (hookworms), and filariasis.

Different medications were made from the flowers for the treatment of edema and also treatment for the disease tutsugamushi (akamushi, akaworms). The bark of the tree was found useful in the treatment for swelling and pains of rheumatism. For this, a mixture was made from the bark of the Chinese Kaya and another medicinal plant.

The two species of Kaya presented here have been utilized in many ways by the people of the Orient. They have provided a source of food, building materials, and many medicinals for those people. Perhaps, with addition plantings, further value to man will be found.

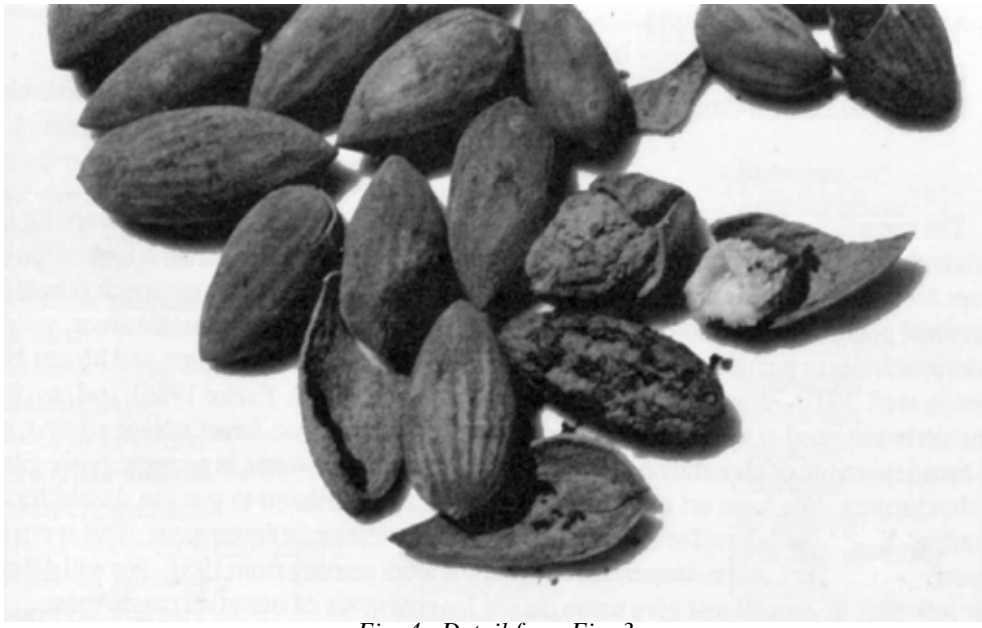

Fig. 4. Detail from Fig. 3

INTRODUCTION AND DOMESTICATION OF RARE AND WILD FRUIT AND NUT TREES FOR DESERT AREAS

AVINOAM NERD
JAMES A. ARONSON,
YOSEF MIZRAHI
Department of Life Sciences, Ben-Gurion University of the Negev
PO Box 1025, Beer-Sheva 84110, Israel

INTRODUCTION

The range of crops that can be grown commercially in hot desert regions is very limited. This is specially true for orchard crops. The purpose of our research program is to develop new crops for hot desert areas through introduction and domestication. Our approach is based on perennial plants from two sources: wild plant species from arid and semiarid areas, yielding nutritious fruits or nuts eaten by the local people (Wehymeyer 1966, Felger and Moser 1976, Biesele et a1. 1979, Felger 1980, Fox and Norwood-Young 1982, Taylor 1986); and rare fruits that can be obtained in local markets or from growers of rare fruits. Israel's Negev desert: with its broad spectrum of climatic conditions and types of soil and water, is an appropriate site for such a project. We have set out to exploit the Negev's variation to test the suitability of a number of plant candidates for introduction and domestication in desert areas. This is our first report on the project, and summarizes four years of work starting from 1984. We will describe our activities in general and give some details regarding six of our plant candidates.

METHODOLOGY

Suitable plant candidates, i.e., wild or semi-domesticated perennials yielding tasty, nutritious fruits or nuts as well as fruit trees not commonly cultivated in developed countries, were selected on the basis of information collected from rare fruit growers and investigators. The common and botanical names and families of the plant candidates are listed in Table 1. With the exception of *Opuntia ficus-indica* and *Ziziphus mauritiana*, which were introduced as cuttings and grafted plants, respectively, all the plant material was obtained from seeds collected in the wild or obtained from growers of rare fruits.

Seeds were germinated and plants established under quarantine conditions, then transferred to a nursery. Introduction orchards were established throughout the Negev desert (Fig. 1). Each of the introduction orchards has distinct climate and water quality characteristics (Tables 2-4). To eliminate the effect of random local conditions each species was planted in three separate blocks at each site. Five to ten plants were used for each species per block.

All orchards are equipped with drip irrigation systems. Each tree is supplied with a 2-litre/hour dripper. When the canopy has developed either the dripper is replaced with one of larger capacity, or additional drippers are added. Fertilization with NPK is given via the irrigation system. Sequestrene 134 is applied to correct iron deficiency symptoms. All irrigation and

fertilization regimes were adapted from the recommendations of the Extension Service for mango trees grown in the Negev area (Frenkel and Zohar 1987). The following operations relevant for plant establishment are being carried out at all locations: growth measurements; phenological observations; climate, soil, water, and mineral analyses.

At the next stage, fruit and nut yields and quality will be determined, followed by clonal propagation of the selected clones and rootstocks.

Table 1. List of candidate species

Botanical Name	Common Name	Family
Fruits		
Casimiroa edulis	White sapote	Rutaceae
Crytocarpa edulis	Ciruelo	Anacardiaceae
Diospyros digyna	Black sapote	Ebenaceae
Dovyalis caffra	Kei apple	Flacourtiaceae
Hylocereus undatus	Pitaya	Cactaceae
Inga vera	Ice cream bean	Mimosaceae
Manilkara zapota	Sapodilla	Sapotaceae
Mimusops angel	Angel	Sapotaceae
Opuntia ficus-indica	Prickly pear	Cactaceae
Pachycereus pringlei	Cardon	Cactaceae
Santalum acuminatum	Quandong	Santalaceae
Sclerocarya birrea subsp. *caffra*	Morula (Marula)	Anacardiaceae
Stenocereus gummosus	Pitahaya agria	Cactaceae
Stenocereus fhurberi	Pitahaya dulce	Cactaceae
Strychnos cocculoides	Monkey orange	Loganiaceae
Vangueria infausta	Mmilo	Rubiaceae
Ziziphus mauritiana	Ber (Indian jujube)	Rhamnaceae
Nuts		
Bombax glabra	Malabar	Bombacaceae
Cordeauxia edulis	Yehib	Caesalpiniaceae
Ricinodendron rautanenii	Mongongo (Manketti)	Euphorbiaceae

PROMISING SPECIES

Cordeauxia edulis

Yehib is an evergreen shrub native to arid zones on the borders of Somalia and Ethiopia. The plant produces pods usually containing a single seed weighing 2-3 g and rich in starch and sugars. The seed is tasty and is used by nomads as a staple food. It is also sold in local

markets. The Yehib has been described as a drought tolerant plant and is an endangered species (Miege and Miege 1979, National Research Council 1979).

Seeds germinated well and seedlings grew under quarantine conditions and then in the nursery. Upon transfer to the various locations growth was inhibited, followed in many cases by death. With the exception of a few survivors at Qetura, the yehib plants did not become established in most of the orchards. Growth of the survivors occurred from May until October but was very slow both in the nursery and in the orchard (Fig. 2 and 3). Yellowing of leaves was common in many plants, generally followed by death. The survivors also showed some yellowing of leaves; this phenomenon was particularly marked in mid-summer, when temperatures can reach up to 48C, but it was also observed in winter.

Table 2. Climatic data for the four introduction sites

Parameter	Qetura	Neot Hakikar	Besor	Ramat Negev
Mean daily temperature (C)				
Hottest month (August)	30-32	32-34	26-28	26-28
Coldest month (January)	14-16	14-16	12-14	8-10
Annual number of days with temperature of:				
35°C or more	125-150	126-150	0-10	11-25
10°C or less	1-25	1-25	76-100	126-150
Average pan evaporation rate (mm/day)				
Hottest month	15	14	8	10
Coldest month	4	5	3	3
Annual rainfall (mm)	<40	<40	200	90

Ricinodendron rautanenii

Mongongo is a large, dioecious, deciduous tree which grows in the wild on sandy soils between latitudes 15° and 21°S in southern Africa. The fruit of the tree has a thin edible flesh and a pleasant-tasting kernel contained in a hard-walled stone. The kernel weighing about 1.2 g is rich in fats (-40%) and proteins (-38%) and plays a central role in the diet of the !Kung San food gathering and hunting people of the Kalahari desert (Biesele et al., 1979, Fox and Norwood-Young 1982). The mongongo fruits abscise green when mature, and start ripening (skin colour change to brown, flesh softening and taste development) a few days later.

Seeds germinated after treatment with (2-chloroethyl) phosphonic acid (ethephon) (Keegan and Van Staden 1981). Seedlings were transplanted successfully in all orchards. At Neot Hakikar after a brief growth spurt in June the plants turned yellow, showed the typical leaf burn symptoms of NaCl damage, and subsequently died. At Qetura the main growth period occurred during the spring in mid-summer growth slowed down. At the Besor location winter dormancy broke very late (in June), and growth continued until November (Fig. 4, 5).

This location is much cooler than Qetura (Table 2). In all locations some of the trees showed signs of leaf yellowing, which was diagnosed as iron deficiency and corrected by applications of iron. The healthiest-looking trees are those growing at the Besor plot (Fig 5).

Table 3. Water quality at the four introduction sites

Parameter	Qetura	Neot Hakikar	Besor	Ramat-Negev* Fresh water	Ramat-Negev* Brackish water
EC (dS/m)	3.20.6	3.70.2	0.9	0.9	6.10.1
pH	7.70.3	7.60.2	7.40.1	7.50.1	7.20.3
ion content (mg/l)					
Na+	25990	30010	957	957	10805
Ca++	2629	20811	511	452	2279
Mg++	10313	1333	294	294	837
CI-	58852	88522	29025	240	18005
$S0_4$-	823228	36043	492	472	4905

Values in the Table are means SD of samples taken throughout the last year.
* At this location we are in the process of establishing plants for comparison of fresh and saline water irrigation.

Table 4. Soil properties at the four introduction sites

Parameter*	Qetura	Neot Hakikar	Besor	Ramat Negev
Texture	sandy loam	sandy loam	sandy loam	loam
Conductivity (dS/m at 25°C)	0.63-3.39	1.34-6.13	0.6-2.1	0.7-2.3
pH	7.4-7.7	7.3-7.7	7.7-8.3	7.9-8.5
Total $CaC0_3$ (%)	6-10	14-32	2-12	8-27

*Soil was analysed to depth of 120 cm.

Sclerocarya birrea* subsp. *caffra

Marula is a large, dioecious, deciduous tree which grows wild in northern South Africa and parts of eastern Botswana. The flesh of its fruit is very juicy and aromatic and is eaten fresh or processed, yielding quality jams, juices and alcoholic beverages. Inside the stone is a very small tasty nut. The fruit serves as an important source of vitamin C for the rural people (Shone 1979, Taylor 1986). When mature, the green fruit abscise followed by a skin colour change to yellow, flesh softening and aroma development. These changes occur 7-10 days after abscission. Recently Prof. Holtzhausen (pers. communication) of the University of Pretoria selected improved clones producing large fruits up to 100 g in weight and with a variety of skin colours.

Seeds germinated after the operculum had been opened (Teichman et al. 1985). All plants were transferred successfully to the orchards. Breaking of winter dormancy occurred at Qetura first, then at Besor and Neot Hakikar. The slowest growth rate was recorded at Neot Hakikar. While growth was steady at Besor, at Qetura, rapid growth occurred from June to August followed by slower growth in September and October (Fig. 6,7). Neot Hakikar is characterized by high salinity due mainly to NaCl, and many plant species failed to survive there. Marula did not show any signs of salinity leaf burns. At Qetura three- year-old male and female trees started to flower and fruit developed.

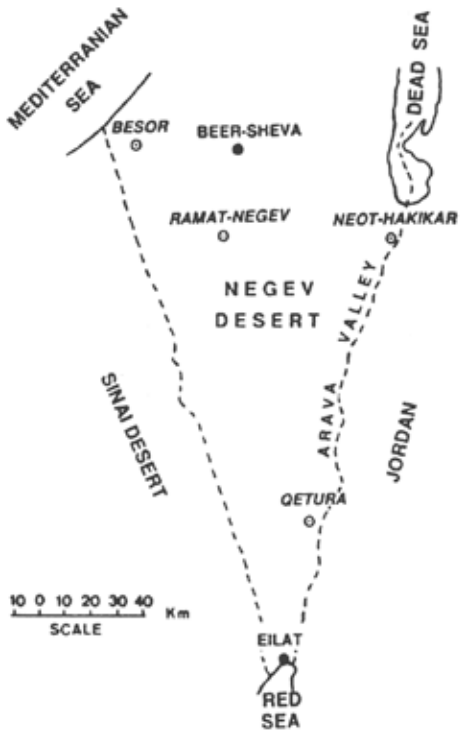

Fig. 1. Site of experimental orchards established in the Negev desert

Stenocereus gummosus

Pitahaya agria, a columnar cactus which grows wild in the Sonora and Baja California deserts of Mexico, produces variously coloured edible fruits resembling those of prickly pear. In many cases the thorns of the fruits abscise upon ripening. The seeds are small and can be eaten without difficulty, unlike those of the prickly pear (Felger and Moser 1976).

The seeds germinated rapidly; however, first development was very slow, and it took two years for seedlings to reach a size suitable for transplanting (a height of ca. 10-15 cm). The slowest growth rate was at Neot Hakikar. Cessation of growth occurred only during the mid-winter months (December, January, and February). At Qetura three- year-old plants reached a total shoot length of 160 cm (Fig. 8, 9).

Casimiroa edulis

White sapote is a medium-sized evergreen tree from central America which can be found in backyard gardens. Growers of rare fruits in California and Florida have selected a number of high-yielding cultivars with improved fruits. The fruits are medium to large with a thin green-yellow skin and cream-white sweet flesh (Batten, 1984). Our seeds were obtained from the collection of Mr. and Mrs. Chambers of Fallbrook, California and from trees growing in Israel.

The seeds germinated easily and seedlings transplanted well at all locations. At Neot Hakikar the plants turned yellow with severe symptoms of NaCl leaf burn; they survived for a while and then died. Fig. 10 shows plant growth at Besor and Qetura. At Qetura growth started in March/April and slowed down in the hottest months, namely July and August. At this time the leaves showed some symptoms of yellowing and tip burns, which vanished in the autumn. Despite these difficulties, development at Qetura is satisfactory (Fig. 11). At Besor the fastest growth occurred in May-August, and damage to leaves was not observed.

Ziziphus mauritiana

Ber is a medium-sized evergreen thorny tree believed to be of African origin. Ber is grown commercially on a wide scale in the hotter areas of India, and is reported to be salt- and drought-tolerant (Alexander 1984). The fruits can reach the size of a plum and when ripe develop a thin, yellow-brown skin enclosing a tasty, white, sweet flesh.

Many cultivars are known in India of which two, 'Gola' and 'Seb', were introduced by us to Israel. They were grafted onto *Z. spina-cristi* (native to our region) and onto *Z. abyssinica*. Development at the various sites on each of the two rootstocks is successful; a one-year-old plant at Qetura is shown in Fig. 12.

Figure 2. Surviving yehib plant at Qetura (3 years old) (October 1988)

PROBLEMS

The first problem one faces when seeds are collected from the wild is that they often fail to germinate or that the germination rate is low. In the wild it is sufficient for some seeds to germinate every few years to ensure a steady population. Indeed, one of the mechanisms by which a population maintains itself under drought conditions is by staggering germination over a long period of time (Koller 1972). This is the case for the mongongo and marula which we collected from Botswana. Some work has already been done by various authors for both species. Mongongo can germinate effIciently if the exocarp is removed and the seed treated with either ethylene or ethephon (Keegan and Van Staden 1981). Marula can be forced to germinate by opening the operculum found in the very hard and thick exocarp (Teichman et al. 1985). Using these techniques we obtained over 80% germination for mongongo and 100% for marula. All other species germinated without special difficulty.

The next stage after establishment in the nursery is planting the seedlings at the various locations. Among the species studied, yehib showed a very high mortality rate. While the reason has not yet been established, we speculate that damage to the very long roots in the shallow nursery containers may have been partially responsible. We found that growth rate of the roots was 15 times faster that of the shoots. It appears that Besor is too cold for yehib, since during two consecutive years it died in the spring after a spell of low temperatures. In any case, this shrub grows very slowly. Despite these difficulties several yehib plants at Qetura are now three years old and are continuing to grow. Vegetative propagation will be considered in the future. In addition, as soon as seeds become available from these plants we will try to sow seeds directly in the field in order to avoid damage to the root system.

There is no way of predicting the success of the various species at each locations. Both marula and mongongo were introduced from Botswana (a semiarid zone), yet there are considerable differences in performance between the two species. Mongongo failed at Neot Hakikar, probably due to NaCl salinity. Marula is growing well in all locations despite some inhibition of growth at Neot Hakikar. In the latter orchard only a few species have survived and are still growing. These include ber (which was introduced from India) and various cacti including pitahaya agria but excluding *Hylocereus* species, which suffered both from the extreme

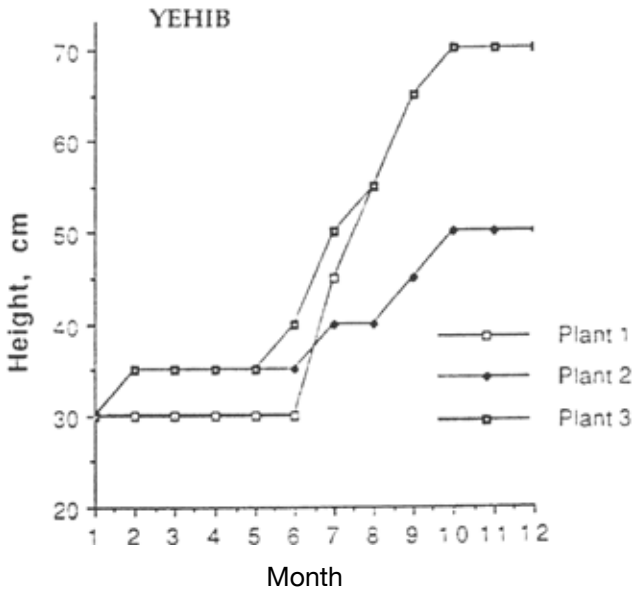

Figure 3. Growth of individual yehib plants at Qetura during 1987. Seedlings were planted in 1985. Plants died at all other locations.

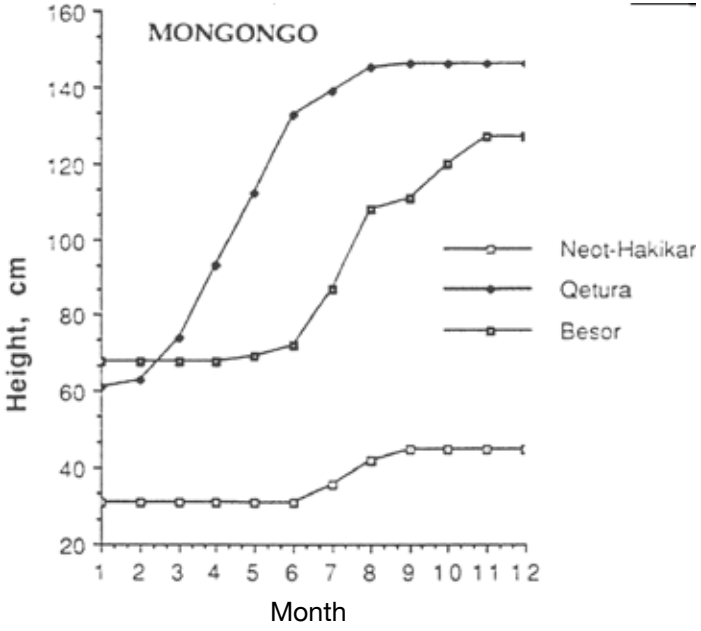

Figure 4. Growth of mongongo plants at three locations during 1987. Seedlings were planted in 1986. After initial growth at Neot Hakikar, all plants showed leaf yellowing followed by leaf burns from NaCl salinity and died. No. of plants: 29 (Qetura), 13 (Neot Hakikar), 27 (Besor).

Figure 5. Well-developed 3-year-old mongongo tree at Besor (October 1988)

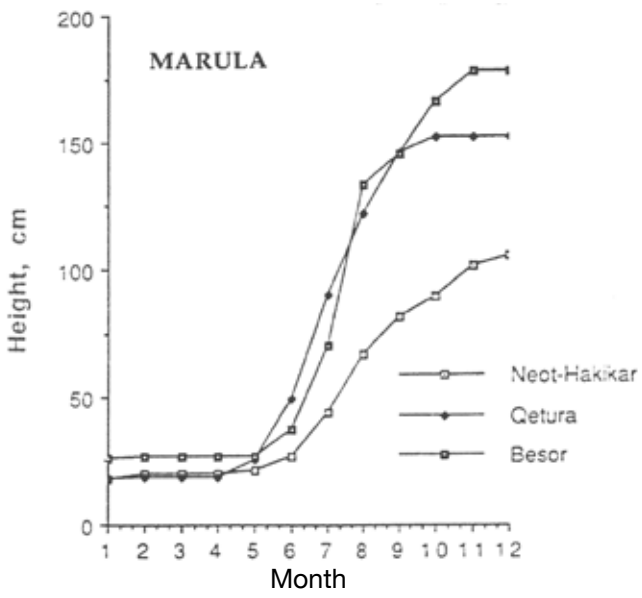

Figure 6. Growth of marula plants at three locations during 1987. Seedlings were planted in 1986. No. of plants: 30 (Qetura), 29 (Neot Hakikar) and 30 (Besor).

light and from the extreme salinity. Ciruelo is also growing very well at this location. The sulfate salinity at Qetura is less harmful to the new plant introductions than the NaCl salinity characteristic of Neat Hakikar. Mango and pummelo on a proper rootstock (13-1 and sour orange, respectively) are grown commercially at Qetura, but are unable to survive at Neot Hakikar. White sapota grows well at Besor. It seems to tolerate cold weather but not very high temperatures. Given special care and proper selection of rootstocks and cultivars, the plant might also be grown at Qetura. To draw definite conclusions about the performance of a species at a particular location it is obligatory to test in situ.

Aside from simple survival, successful economic performance, which depends on yields and product quality, requires evaluation.

Selection of rootstocks and scion cultivars will have to be performed for promising species in the future. Correspondingly, proper vegetative techniques will have to be developed for each of the plant species that grows successfully. These rare and wild fruit trees deserve much more attention from the scientific community than they have so far received.

Figure 7. Fast-development 3-year-old marula tree at Qetura (Octover 1988)

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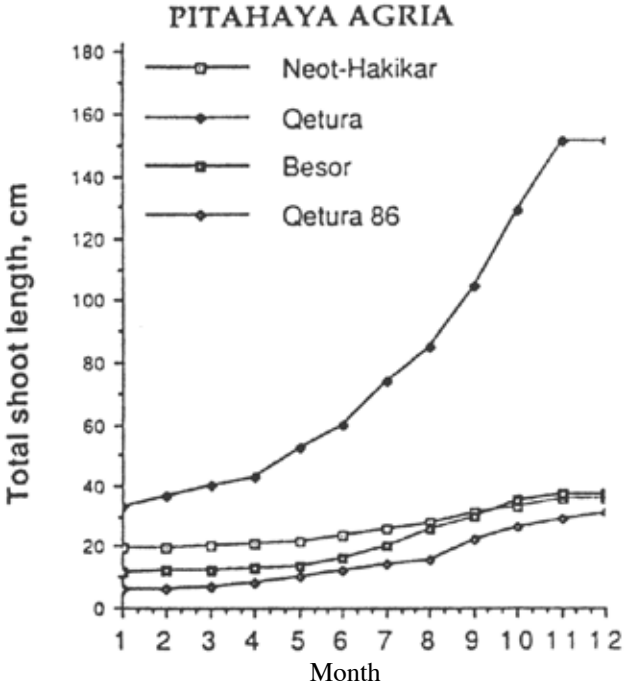
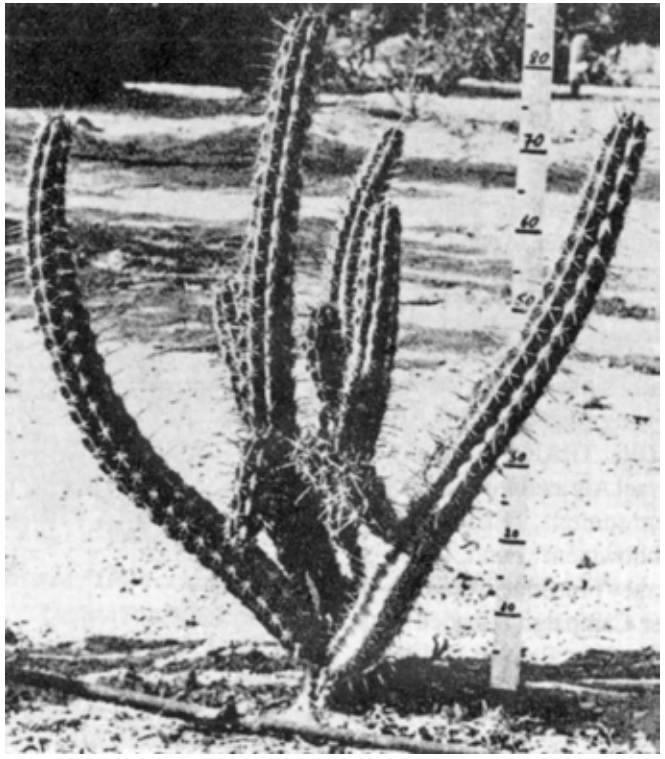


Figure 8. Growth of pitahaya agria plants at three locations during 1987. Seedlings at Neot Haldkar and Besor were planted in 1986. Since seedlings at Qetura were planted one year earlier, growth in 1986 is included. No. of plants 30 (Qetura), 20 (Neot-Hakikar), 30 (Besor).

Figure 9. Pitahaya agria cactus (3 years old) at Qetura (October 1988)



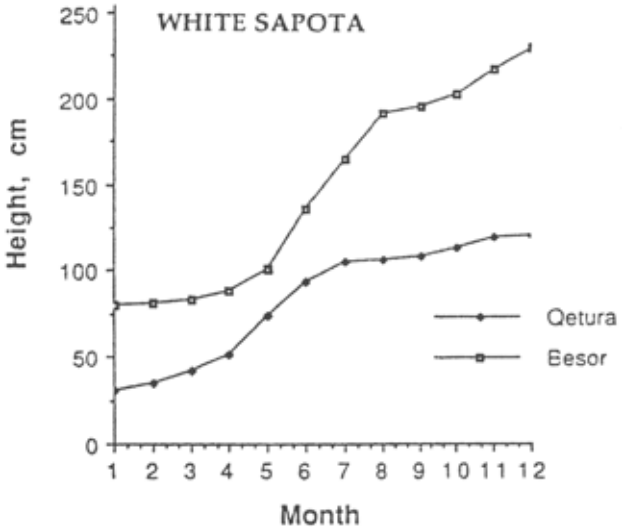


Figure 10. Growth of white sapota plants at two locations during 1987. Seedlings were planted in 1986. No. of plants: 14 (Qetura), 30 (Besor). All the white sapote plants died at Neot Hakikar after showing symptoms of severe leaf burn from NaCI salinity. At Qetura some plants showed leaf yellowing, especially during midsummer months.

Acknowledgements

The authors express their thanks and appreciation to Mr. Ehud Tzeeri from Neot-Hakikar, Elaine Soloway from Kibbutz Qetura, Mr. Rafi Rotem from the Besor Experimental Station, and Avraham Karadi of the Institutes for Applied Research for their skillful help in this research.

This research was partially supported by the following agencies: US-AID CDR; GlARA-Germany Israel Agriculture Research Agreement; PEF-Israel Endowment Fund; New Jersey Freedom From Hunger Campaign (Headed by Mr. W. Brach); and the Israeli Ministry of Agriculture.

Figure 11. White sapote (3 years old) at Qetura (October 1988)

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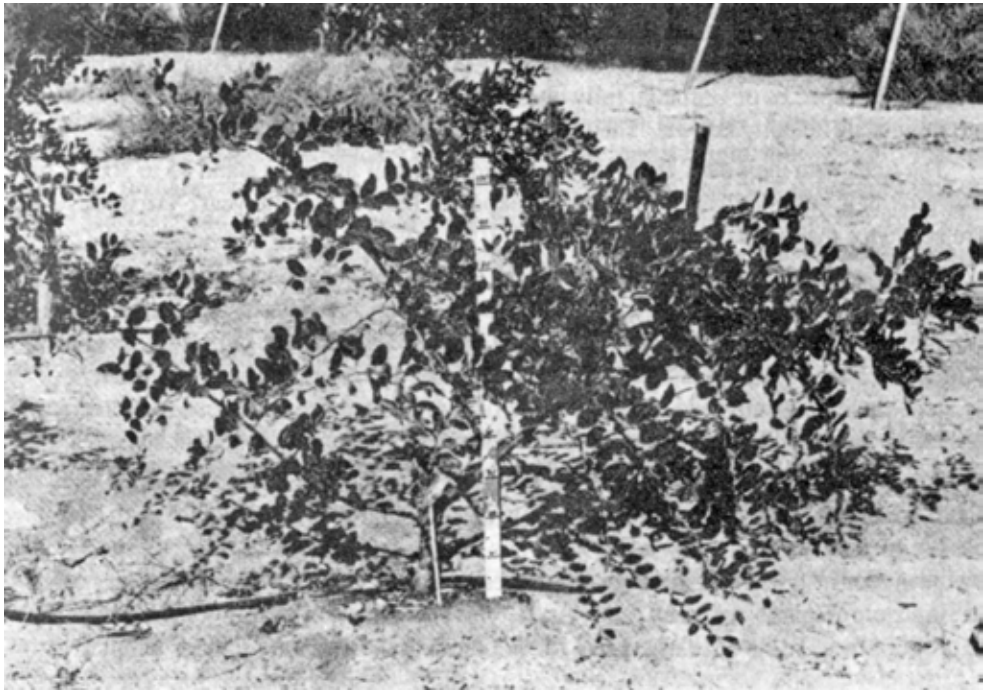


Figure 12. One-year-old ber tree, 'Gola' cultivar, grafted on Ziziphus spina-cristi at Qetura (Oct. 1988).

[Based on a paper presented at the First National Symposium: New Crops: Research, Development, Economics, Indianapolis, Indiana, October 23-26,1988. Also published in 'Advances in New Crops', edited by Jules Janick and James E. Simon. Timber Press, Oregon].

THE MANGOSTEEN AND RELATED SPECIES

OTIS WARREN BARRETT

This article is extracted from the author's 1928 book The Tropical Crops', published by the Macmillan Company in New York. It is still one of the best available summaries of the mangosteen family fruits, most of which remain notably neglected. At the time of publication, Barrett was the Agricultural Director at the Department of Agriculture and Labor, Porto Rico (nowadays spelled Puerto Rico).

The world's best-flavoured fruit is generally conceded to be the mangosteen, *Garcinia mangostana*. This is only one of an outstanding group of fruit-trees of Asia and Africa; there are over 200 species of Garcinia, fully one-third of which bear edible fruits, many of which are not yet sufficiently known. The family is the Guttiferae.

The trees with their dark green shining leaves and stiff branches stand 15 to 30 feet high. The growth is very slow; no fruit should be expected before the tenth year. Two crops a year are borne for many years.

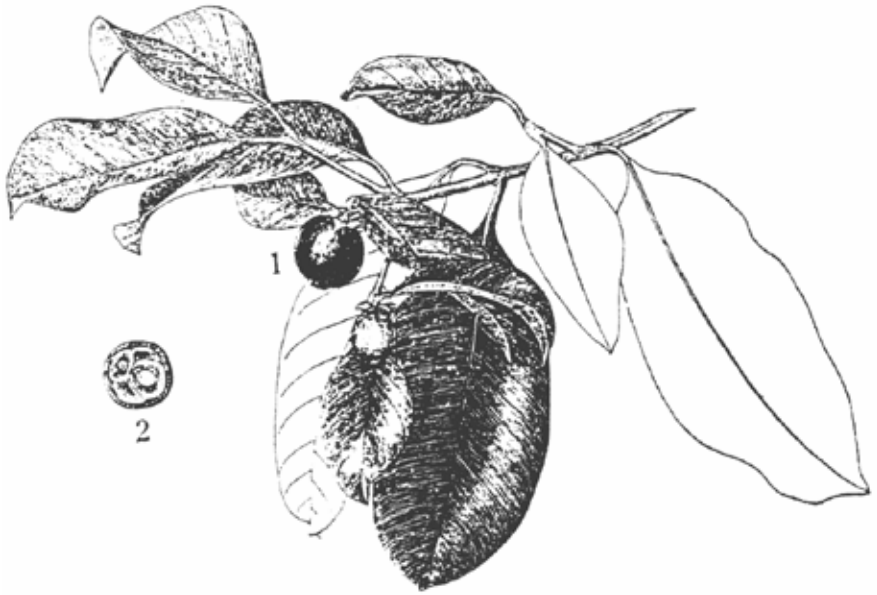
The oblate-globose fruits are dark purplish, 2 to 3 inches in diameter, and bear the two large and two small leathery sepals adherent to the base. The pericarp is fleshy and half an inch thick; it contains a white latex superficially and a purplish juice within. The pulp is snow-white with crimson veins; the texture is melting, very little fibre and exquisite juice. In the five or six sections there is usually one viable and one or two aborted seeds. These sections may be squeezed out or scooped out with a spoon. The pulp contains 16.8 per cent sugar.

Strange to say, there seems to be no variation in mangosteen fruits, whether grown in Cambodia, Java, or Trinidad. There are only a few thousand trees in the New World; Dominica has the greatest number, Trinidad the next; two trees in Porto Rico (introduced from Trinidad by the author in 1903) have been giving two crops a year, a better performance than obtains in Singapore orchards, for many years. An effort is being made by a large concern in Honduras to produce these fruits on a large scale for shipment to the northern markets at fancy prices.

Garcinia

While the species does not vary, the genus does. No less than 210 species of Garcinia have been described; mostly Malaysian, but Africa has a good number. The United States Department of Agriculture has spent a large amount of time and money not only to introduce the mangosteen but also a considerable number of its sister species into tropical America and Hawaii.

The matau or gamboge tree, *Garcinia tinctoria*, of south India and Malaya promises to become popular in tropical America. The peach-shaped fruit is bright yellow, 2 to 3 inches



Garcinia celebica L. [Ochse]

in diameter and very thin-skinned. The flavour of the yellow melting pulp is between that of a good strawberry and a sour apple; with sugar and cream it is an excellent breakfast fruit. The tree attains 40 feet and is a sure and heavy cropper. The fruit does not decay quickly. It has already begun to vary in Porto Rico.

The baniti, *Garcinia dulcis*, is very similar to the matau. It is native to the Philippines, Burma, and Malaya. It cultivated in Java. Subacid forms are known, but usually the fruits are very sour.

The bruas, or mangis hutan, *G. hombroniana*, of the Malay Peninsula and Nicobar Islands, is closely related to the mangosteen. The tree is larger but the fruit only 2 inches in diameter, and redder than the superior sister species. The white juicy pulp has the flavour of the peach. It is cultivated.

The kokam, or katambi, *G. indica*, a native of Western India, is cultivated around Bombay and in Mauritius. It has been fruiting in the West Indies for some thirty years. The fruit resembles a small mangosteen as to colour and shape, but the pulp is sour and deep purple. "Kokam butter" is made from the oily seed.

The kariis, *G. laterifolia*, is indigenous to the Philippines and Java, where it is called djawura. The roundish or mandarin-shaped fruit is 1 to 1.5 inches in diameter. Sweet forms occur in Java, sour in the Philippines.

The tromeng, *G. oliveri*, of Indo-China, has oblong reddish fruits about 2 inches long, very acid but popular. The pulp is sliced and preserved with salt.

The kadis, *G. barrettiana*, is endemic in the great Cotabato Valley of Mindanao where it forms a tree 15 to 20 feet high. The fruit is of an unusual colour, light orange, mandarin-shaped, and 2 to 2.5 inches in diameter. The pulp is orange, juicy, subacid, and of good flavour; the fleshy pericarp also is edible. This is one of the most promising of the new garcinias.

The bunag, *G. moooreana*, is another recently discovered garcinia, endemic in Jolo and Palawan islands in the Philippines. The fruit is much like the mangosteen but a little smaller and sour-fleshed. The flavour is very agreeable.

The roi, *G. benthami*, of Indo-China, is a large tree, bearing fruits about 2 inches long, smooth, and obpyriform. The pulp is white, acid, and of agreeable flavour.

The hila, goraka, or aradal, *G. cambogia*, of Ceylon and western India, is a small tree with drooping branches, like the binucao. The fruit is yellowish or reddish, about the size of an orange, with six or eight deep longitudinal grooves in the fleshy pericarp. The pulp is acid but pleasant. The Singalese dry it and use it in curries.

The kirasa, *G. celebica*, indigenous to the Malay Archipelago, is closely related to the mangosteen. The white fleshy pulp is acid.

The hussur, *G. cornea*, has long been known from Malaya and has now been reported from Burma. The dark purple fruit is roundish and about 1.5 inches in diameter; the pulp is subacid, white, and pleasantly flavoured.

The cowa, *G. cowa*, is a large handsome tree, 40 to 50 feet high, of Burma and Assam. The fruit resembles the hila, yellowish, deeply grooved, orange size, and with a mammillate apex. Both pulp and pericarp are well flavoured.

Garcinia laterifolia Bl. [Ochse]

One of the most promising of the oriental garcinias is the Asam gelugur, *G. atroviridis*, a cultivated and wild tree, 30 to 50 feet, indigenous to the Malay Peninsula. The orange-yellow roundish fruit is some 3 inches or more in diameter; the pericarp is fleshy, firm, and acid; the pulp is translucent and very sour for eating fresh, but excellent stewed with sugar, according to H. N. Ridley.

The kelabang, *G. bancana*, is a large tree of the wet swampy jungles of Banka, Sumatra, and the Malay Peninsula. The ovoid fruit is green and fleshy and relished by the natives.

The binukao, *G. binucao*, is indigenous to the Philippines. The tree has long, straggling drooping branches and very abundant fruits of various sizes closely attached to the short branchlets. The mandarin-shaped fruits are

greenish-yellow, 1 to 2 inches in diameter. The pulp is very acid. It fruits heavily in Porto Rico.

An Indo-Chinese species, *Garcinia cochinensis*, has subglobose fruits 2 inches across, reddish- yellow, fleshy, and pleasantly acid. Another, *G. costata*, is a tall tree in the mountain forests of Perak Province in the Malay Peninsula. Its fruits are tomato-shaped, 2 by 3 inches, with many longitudinal grooves, pale rose to red.

The malabu, *G. cumingiana*, of northern Luzon is, according to P. J. Wester, a medium -sized tree which should be tested as a stock for the mangosteen. The fruit is roundish, 2 inches in diameter, fleshy, acid, and edible.

The tjeuri, *G. dioica*, of Java, is a first class fruit-tree. The fruit resembles a small mandarin in size and shape; it is pale yellow and has a refreshing flavour.

Garcinia dioica Bl. [Ochse]

The trameng, *G. delpyana*, is a tall tree indigenous in Indo-China. The globose, smooth, yellowish fruit, about 1.5 inches in diameter, has a spongy pericarp and a pleasant-tasting pulp.

The pildis, *G. dives,* is a widely distributed Philippine tree with roundish fleshy edible fruits, nearly an inch in diameter.

The kandis, *G. globulosa*, of the Straits Settlements, is one of the best of the garcinias found by Ridley in that rich region. This forest tree attains 50 or 60 feet. The fruit is berry-like, orange-colored, round, pulpy, and of a pleasant flavour. It is abundantly productive. Another species, *G. parvifolia*, of that region, has the same name and similar acid fruits.

Another large forest tree of the Malay Peninsula and Sumatra, the kandis gajah, or sibangor, *G. griffithii*, has very large shining leaves and bears large mandarin-shaped fruits, 2 by 3 inches, greenish-yellow, juicy, and acid.

Wester [1927] reports still other garcinias from the partly explored Indo-China region, as follows:

G. harmandii, the remir, is a tree of compact growth. The fruits are purplish, nearly an inch across, with sweet pulp of pleasing flavour.

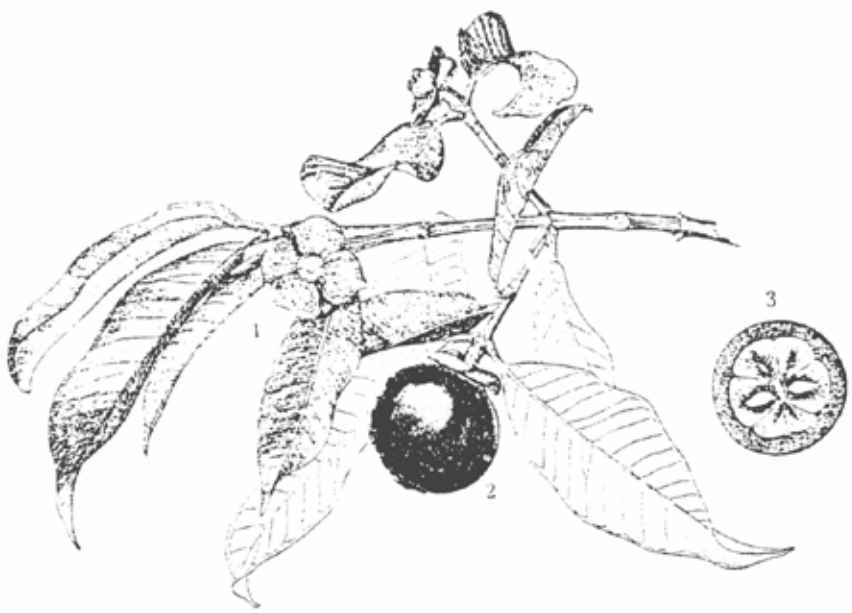
G. fusca, the bua lueur, is a small tree with ovoid or roundish, pointed, smooth, fleshy

fruits with a good but acid taste.

G. loureiri, the buanha, is a good-sized tree which is occasionally cultivated. The fruit is short -oblong, 2 inches long, and grooved. The pericarp is yellow without and reddish within, an unusual colour arrangement. The pulp is white, acid, and agreeable. The natives dry the sliced pericarp and salt it; cooked with rice it gives a fine flavour.

G. merguensis, the sonve, is a handsome tree which bears roundish fleshy fruits the size of a large grape. This species runs over into Burma and down into the great Peninsula.

G. planchoni is a large tree of the steamy jungles. The fruit is orange-like, about 3 inches in diameter, greenish-yellow, grooved and covered with wart-like protuberances. The thick pericarp is fleshy, acid, and, like the pulp, of an agreeable flavour. The natives dry the fruit in slices for consumption during the off season. Pierre, the authority on Indo-Chinese trees,



Garcinia mangostana L. [Ochse]

states that this species merits cultivation.

Other Oriental Garcinias of promise are:

The cherapu, *G. prainiana*, is a small tree resembling the mangosteen. The 2-inch roundish fruit is smooth, yellow, and has an acid edible pericarp and a subacid pulp. According to Ridley the cherapu is eaten like the mangosteen. It is native to the great Peninsula.

The tikul, *G. pedunculata*, is a rapid-growing 60-foot tree of Bengal and Sylhet. This is one of the largest-fruited species of the genus, the orange-like fruit measuring sometimes more than 4 inches in diameter. The yellow pericarp is very acid, but, like the pulp. of pleasant flavour. The natives use the fruit in many ways: dried in curries, and as an "ade" fruit. It is cultivated.

The bubi-kowa, *G. paniculata*, is a forest tree of the Bengal and eastern Himalayan mountains. The fruit is round, yellow, like a large cherry; the high-flavoured pulp reminds one of

the mangosteen.

The selapan, *G. macrophylla*, of Sumatra has a pomiform acid fruit relished by the natives. The kirindur, *G. lanceofoelia*, of Assam and Burma, bears plumlike orange-yellow fruits which are "much esteemed by the native inhabitants."

Australia has a meritorious member of the genus, *G. mestooni*. The roundish fruit, 2 by 3 inches, is smooth, green, fleshy, and of a pleasantly acid flavour.

Besides those already mentioned, several other Philippine Garcinias are entering cultivation. Most of the thirty known species there are not yet studied pomologically.

The kamani, *G. rubra*, occurs in the southern part of the Archipelago. The yellow to red subrotund fruits are over an inch in diameter, and, according to Wester, "fleshy, acid, and edible."

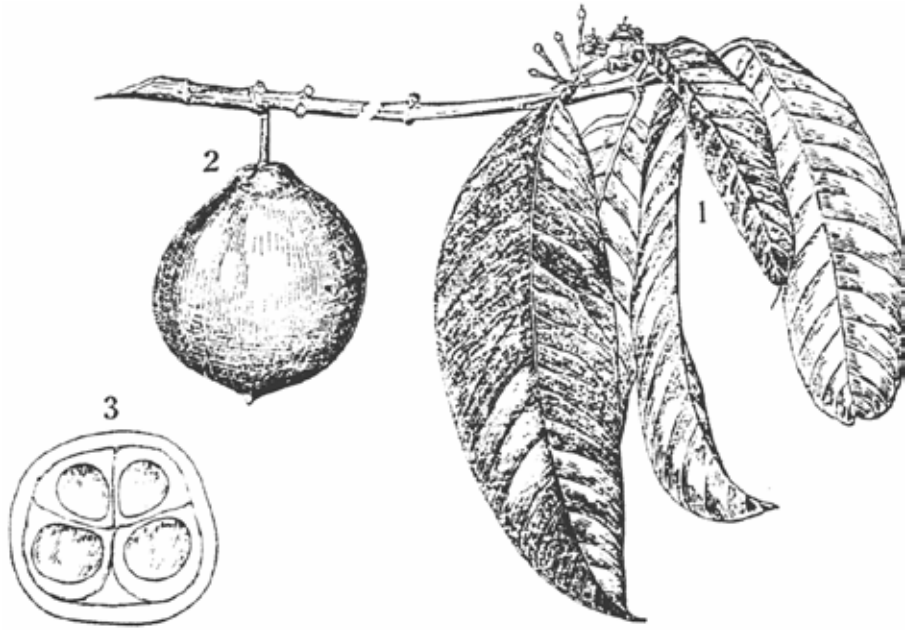
The tamil, *G. tetrandra*, occurs with the preceding species. Its fruits are larger and quite sour and of a flattened shape.

The kabangla, *G. mindanensis*, is a small slender tree of 30 feet. The fruits are acid, but quite edible, about 1.5 inches across. The flowers are red.

The danealan, *G. subelliptica*, is a 30- to 40-foot tree of the eastern coast of Luzon. The yellow flattened fruits, 2 inches across, are fleshy and acid.

The katuri, *G. venulosa*, is endemic to the Philippines. The 2-inch fruit is smooth, greenish, and has an appetising pulp.

The kanubi, *G. vidalii*, occurs throughout the Archipelago. The fruit looks like the mangosteen but has fleshy acid pericarp yellowish instead of purple, and the pulp is sour instead of deliciously sweet; the seeds are ten or more, but cultivation would probably alleviate that



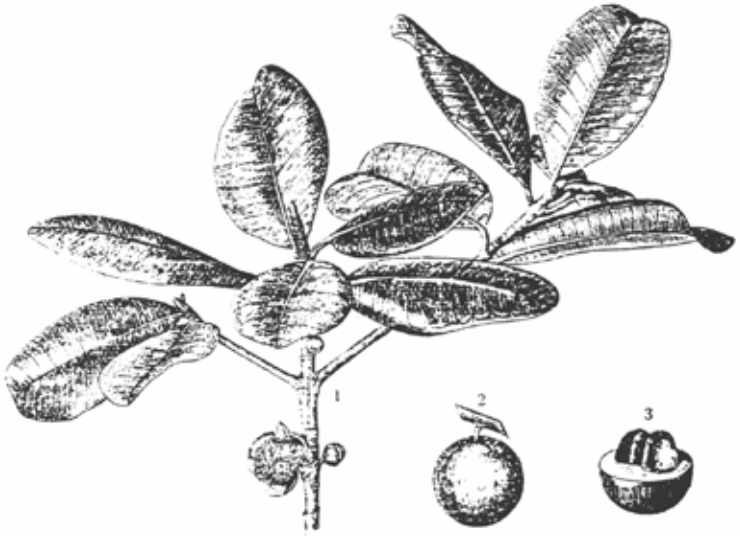
Garcinia dulcis (Roxb.) Kurz [Ochse]

factor.

Continental Africa has several very interesting garcinias out of the eighty which have been described to date; and already sixteen species have been listed from the dark jungles of Madagascar.

The pama, or imbe, *Garcinia livingstonei*, is a coarse-branched tree, 15 to 30 feet high, fairly common along the low veld of Portuguese East Africa. The fruits are reddish-purple, covered with a blue bloom, like the old-fashioned blue plums. The shape of the fruit is oblong, about 2 to 2.5 inches long by half that diameter. The fleshy pericarp and the highly colored pulp are used by the M' chopes, Bitangas, and other tribes of that region in preparing a purplish claret-like wine. The imbe has fruited in southern Florida but probably it is too exacting in its ecological requirements for general cultivation.

The ntu, *Garcinia conruana*, is a native of the Cameroons. This giant species attains a height of 90 feet or more. The roundish fruit, 1.5 inches in diameter, is reddish-yellow, with orange-colored pulp. The seeds also are edible.



Mammea americana L. [Ochse]

The umbindi, *G. gerrardi*, is a large shrub, native of Natal and Zululand. The black ovoid fruit is nearly an inch long; the colored pulp has only one seed.

The mdogolo, *G. wenzeliana*, is almost the only garcinia which is a woody climber. This vine of tropical Africa has sweet juicy fruits, like small grapes, and of agreeable flavour.

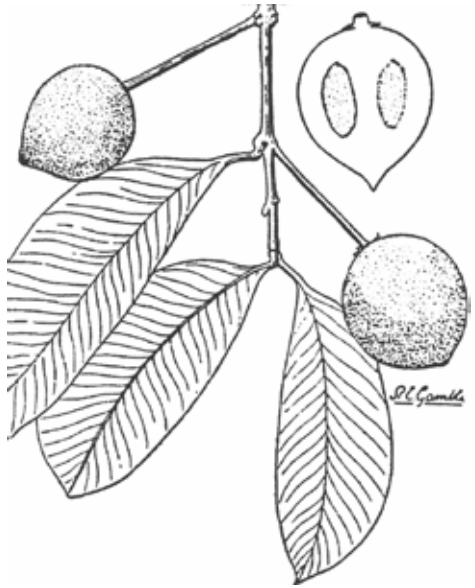
Among the many species of Garcinia which have been introduced by the United States Department of Agriculture in the attempt to find a suitable stock for the mangosteen, one from Hongkong, *G. oblongifolia*, has borne fruits whose flavour suggest the mangosteen.

Mammea

The mamey, *Mammea americana*, is native to the West Indies and northern South America, and is a close relative of the garcinias. It has spread fairly well to Mexico and to southern

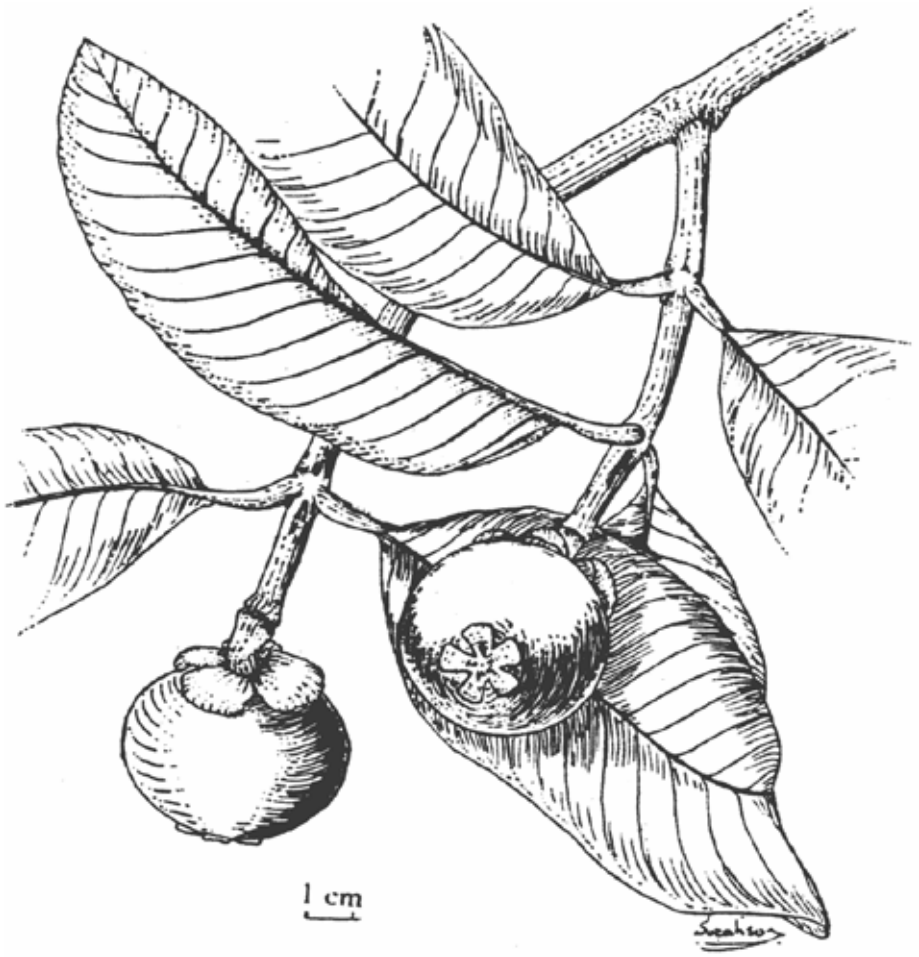
Brazil; but, though introduced over a century ago, it has never succeeded in the tropics of the Old World. It is a striking tree, 40 to 60 feet high, with a dense head of stout branches which are always full of the very darkest green shining thick leaves 4 to 5 inches long.

The fruit is from 4 to 8 or even 10 inches in diameter, roundish or flattened, but tapering slightly toward the tip; no two fruits are quite the same size or shape. The leathery rind of the mamey is greyish or yellowish-brown and bark-like. The pulp is always firm but not really fibrous; orange, or in some forms yellowish or reddish; tough but edible till fully ripe; the fruits vary greatly in time of ripening, from a few to many months, thus keeping up an almost continuous crop. The seed, one (or occasionally, in large fruits, two or three), is large, irregular-shaped, and rough; the pulp may or may not adhere closely.



Rheedia braziliensis [Popenoe]

Garcinia dulcis (Roxb.), Kurz [Fruit]



Garcinia mangostana L, [Fruit]

There are, contrary to common belief, three or four varieties of mamey; one is quite juicy, one dry; some trees bear sour-pulp apricot-flavoured fruits; others sweet; some mawkish, some spicy. Few persons accustomed to good fruits relish it raw. Cooked with plenty of sugar and spice it is very decidedly improved. The jam is good, if lime juice or some other fruit, like the iba (Cicca) be added. Mamey paste is a staple dulce throughout Latin America, cheaper than and inferior to the 'pasta de guayaba.' Mamey pulp, as a filler for higher-grade fruit pastes and butters, has a good value. It deserves wide cultivation in the Orient. The word Mammea was modelled on the Antillean Arawak name mamei. Mamee-apple and Santo Domingan apricot are West Indian synonyms.

Rheedia

Two or three species of Rheedia, related to Garcinia, are native to tropical America.

The madroño, *Rheedia madruno*, is a lemon-shaped fruit cultivated in Colombia and neighbouring countries. The pulp is whitish, juicy, sub-acid, and aromatic.

The berba, *R. edulis*, of Central America, has yellowish sub-acid flesh; the fruit is grape-like, borne in clusters.

The cupi, *R. cupi*, of the Orinoco Valley, is another fruit-tree requiring study.

The bakupari, *R. brasiliensis*, is indigenous in southeastern Brazil, a handsome tree according to Popenoe [1920]. The fruit resembles a large lime, orange-yellow; the pulp is snow-white, translucent, in flavour resembling the mangosteen. It is well worthy of extended cultivation.

Another species, *R. macrophylla*, the bacury-pary, is cultivated about Para. The acid fruits resemble those of the bakuri, *Platonia insignis*, a large forest tree of northern Brazil. The orange-like fruit has a pleasantly acidulous white pulp. It is entering domestication and already can be bought in tins.

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THE CANISTEL

ROSEMARY J. DU PREEZ
Institute for Tropical and Subtropical Crops
Private Bag X11208, Nelspruit1200, South Africa

Introduction

As a result of recent reports in the popular press, on the radio, and exhibitions, there has been an unprecedented interest in cultivating more exotic types of fruits in South Africa. We have looked at a number of these fruits with the idea of starting small commercial industries to allow farmers to diversify, especially in situations where some of the more traditional fruits are close to over-production. The canistel appears to be one such fruit that has the potential to develop a small commercial industry.

The canistel is the showiest fruit of the family Sapotaceae but has generally been under-evaluated, both in horticultural literature and by those who have a casual acquaintance with it. It is sometimes erroneously recorded as native to northern South America where related, somewhat similar species are indigenous. Apparently it occurs wild only in southern Mexico, Belize, Guatemala, and El Salvador (Morton, 1987). Colloquial names applied to this fruit include: egg-fruit, canistel, ti-es, yellow sapote (Morton, 1987).

The Canistel [Johns]

Classification

The canistel, *Pouteria campechiana* Baehni, has been the subject of much botanical confusion as evidenced by its many synonyms: *P. campechiana* var *nervosa* Baehni; *P. campechiana* var *palmeri* Baehni; *P. campechiana* var *salicifolia* Baehni; *Lucuma campechiana* HBK.; *L. heyderi* Standl.; *L. laeteviridis* Pittier; *L. multiflora* Millsp.; *L. nervosa* A.DC.; *L. palmeri* Fernald; *L. rivicoa* Gaertn.; *L. rivicoa* var *angustifolia* Miq.; *Richardella salicifolia* Pierre; *Sideroxylon campestre* T.S.Brandeg.; *Vitellaria campechiana* Engl.; *V. salicifolia* Engl.

The canistel is closely related to the lucmo and abiu (Scholefield, 1984). The abiu, *Pouteria caimito* Radlk (syns. *Lucuma caimito* Roem. & Schult.; *Achras caimito* Ruiz & Pavon) is also occasionally known as the yellow star apple. The lucmo, *Pouteria lucuma* O.Ktze. (syns. *P. insignis* Baehni, *P. obovata* HBK., *Lucuma obovata* HBK.) is also known as lucuma, lucumo and mamon (Morton,1987).

Distribution

The canistel is cultivated in its countries of origin and also in Costa Rica, Nicaragua, Panama, Puerto Rico, Jamaica, Cuba, the Bahamas, and Florida (Morton,1987). Trees that were planted from fruit bought in Cuba are growing in Colombia. The canistel is also included in experimental collections in Venezuela. The tree was introduced at low and medium elevations in the Philippines before 1924 and it reached Hawaii probably around the same time. Attempts to grow it in Singapore were not successful. In 1949 there were a few canistel trees growing in East Africa (Morton,1987).

Description

Tree

The tree is erect and generally no more than 8 m tall (Ruehle, 1967; Morton, 1987). However, in favourable conditions the tree can reach 20 to 30 m with a trunk diameter of 1 m (Scholefield,1984 Morton, 1987). The tree is slender in habit or with a spreading crown, it has brown furrowed bark and abundant white, gummy latex (Ruehle,1967; Morton,1987). Young branches are velvety brown (Morton, 1987).

Leaves

The bright green and shiny leaves are alternate but mostly clustered on newer growth at the ends of the branches (Ruehle,1967; Morton,1987). The leaves are relatively thin, short to long stemmed, oblanceolate, lanceolate-oblong, or obovate, bluntly pointed at the apex, more sharply tapered at the base, 110 to 280 mm long and 40 to 80 mm wide (Morton,1987).

Flowers

The flowers are small and borne in clusters or solitary in the leaf axils or at leafless internodes of young wood (Ruehle, 1967; Morton,1987). The flowers have slender pedicels and are five to six lobed, green to cream coloured, silky-hairy and approximately 8 to 11 mm long (Scholefield, 1984; Morton, 1987). The flowers are bisexual and fragrant (Morton, 1987).

Flowering extends from January to June in Mexico. In Cuba flowers are borne mostly in April and May although some trees flower throughout the year (Morton, 1987).

The fruit is extremely variable in shape and size, and may be nearly round, with or without a pointed apex, or it may be somewhat oval, ovoid, or spindle shaped. It is often bulged on one side and there is a five pointed calyx at the base which may be rounded or with a distinct depression (Morton, 1987). Fruit length varies from 50 to 170 mm and diameter from 40 to 75 mm with a weight of up to 1.5 kg (Scholefield, 1984; Morton, 1987). Unripe fruit is green skinned, hard and gummy internally. On ripening the skin turns lemon-yellow, golden- yellow or pale orange-yellow, is very smooth and glossy except where occasionally coated with light brown or reddish-brown russeting (Morton, 1987).

The fruit flesh is yellow to orange-yellow, mealy with a few fine fibres. The texture has been likened to a cooked mealy sweet potato or to the yolk of a hard boiled egg (Ruehle, 1967; Morton, 1987). The flavour is sweet and somewhat musky. The ripe pulp from some

seedlings is less dry and mealy than others (Ruehle, 1967). Picking the fruit when mature, but several days before it softens, tends to reduce dryness of the pulp (Ruehle, 1967). The seeds, usually one to three, are ovoid to oblong 20 to 50 mm in length and 12 to 32 mm wide. They are hard, glossy dark brown except on the straight or curved ventral side where they are dull light brown, tan or greyish white (Ruehle, 1967; Morton, 1987). Both ends are sharp tipped (Morton, 1987).

The fruit matures mostly from November to February in Florida, but individual trees may produce fruits at other times (Ruehle, 1967). The fruits mature from September to January or February in the Bahamas. In Cuba the main fruiting season is from October to February, but some produce more or less continuously throughout the year (Morton, 1987). The canistel thus appears to come in to production in late autumn and winter when few other tropical fruits are available.

Food value per 100 g of edible portion of canistel (Morton, 1987)

Calories	138.8
Moisture	60.6 g
Protein	1.68 g
Fat	0.13 g
Carbohydrates	36.7 g
Fibre	0.1 g
Ash	0.9 g
Calcium	26.5 mg
Phosphorous	37.3 mg
Iron	0.92 mg
Carotene	0.32 mg
Thiamine	0.17 mg
Riboflavin	0.01 mg
Niacin	3.72 mg
Ascorbic acid	58.1 mg
Amino acids:	
Tryptophan	28 mg
Methionine	13 mg
Lysine	84 mg

Fruit Composition

Canistels are rich in niacin and carotene (provitamin A) and have a fair level of ascorbic acid (Morton, 1987). The table gives the food value per 100 g of edible portion of the canistel.

Varieties

Great seedling diversity exists and some selections have been made but apparently no named cultivars exist (Scholefield,1984). Certain types are so distinct that they have been recorded as different species in the past. The spindle shaped form was the common strain in the Bahamas for many years. The rounded, broader form began to appear in special gardens in the 1940's, and the larger types were introduced from Florida in the 1950's (Morton,1987).

In 1945, large, symmetrical fruits were being grown under the names *Lucuma salicifolia* and yellow sapote at the Agricultural Research and Education Centre and at Palm Lodge Tropical Grove, Homestead, Florida but these were later classified as superior strains of canistel (Morton, 1987). Some fruits are muskier in odour and flavour than others, some are undesirably dry and mealy, some excessively sweet. An excellent, non-musky, fine textured, rounded type of medium size has been selected and grown on a ranch in Martin County, Florida. There is considerable variation as to time of flowering and fruiting among seedling trees (Morton,1987). A selection programme has been initiated in Puerto Rico (Martin, 1976).

Climatic And Soil Requirements

Climate

The canistel is widely adapted and grows well in a tropical or subtropical climate (Scholefield,1984). It is about as hardy as the sapodilla (Ruehle, 1967) which can withstand temperatures of -3 to -2 C for several hours. It has survived cold winters in areas of Florida but has never reached fruiting age in California. It is usually found up to elevations of 1400 m. It requires no more than a moderate precipitation and does well in regions that have a long dry season (Morton,1987). The tree is fairly wind resistant (Ruehle, 1967).

Soil

The canistel is tolerant of a wide range of soils - calcareous, lateritic, acid-sandy, and heavy clay. It grows well on deep, fertile well-drained soil but is said to be more fruitful on shallow soil. It can be cultivated on soil considered too shallow and poor for most other fruit (Morton, 1987), provided drainage is good (Scholefield,1984).

Propagation

Propagation is usually by means of seeds (Ruehle, 1967). Seeds lose their viability quickly and should be planted within a few days after removal from the fruit. If decorticated, seeds will germinate within two weeks; otherwise there may be a delay of three to five months before they sprout. The seedlings grow rapidly and begin to bear within three to six years. There is considerable variation in yield, size and quality of fruits (Morton,1987).

Vegetative production is recommended to hasten bearing and to reproduce the best selections. Side veneer, chip bud and cleft graft are commonly used (Scholefield,1984; Morton,1987). Air-layering has also been successful. Cuttings of mature wood will root but are extremely slow to root and this method is thus not often used (Ruehle, 1967; Morton, 1987).

Culture

As the canistel is not grown commercially there is very little known about its cultural requirements. Mulching is beneficial in the early years. A balanced fertilizer applied at time of planting and during periods of rapid growth is advisable but the tree does not demand special care. Outstanding branches should be pruned to avoid wind damage and to shape the crown (Morton, 1987).

Pests and diseases

Few pests and diseases attack the canistel. The only recorded pest is scale insects which were noted in Florida (Ruehle, 1967). In Florida the leaves of the canistel are attacked by a rust (*Acrorelium lucumae*). Fruit spot (*Colletotrichum gloeosporioides*), leaf spot and scab (*Elsinoe lepagei*) and leaf necrosis (Gloeosporium) have also been recorded in Florida for the canistel. The tree is, however, generally nearly always vigorous and healthy (Morton, 1987).

Harvesting And Storage

Harvesting

Fruits should be harvested by hand when mature but still firm (Scholefield,1984). The fruits should be clipped to avoid tearing the skin. If left to ripen on the tree, the fruits split at the stem end and drop. A severe drop in temperature will also cause firm, mature fruits to split and drop to the ground (Morton, 1987). Experience is needed to determine the correct stage for picking (Scholefield, 1984).

Storage

If kept at room temperature the fruits will ripen and soften in three to ten days. They should not be allowed to become too soft and mushy before eating. Ripe fruits can be kept in good condition in a refrigerator (ca. 4 C) for several days (Morton, 1987).

Freshly picked, firm fruits have been successfully shipped from Florida to New York and Philadelphia. Unfortunately no studies have been made to determine optimum temperature and humidity levels for long term storage and shipment (Morton, 1987).

Uses

Food Uses

The fruit is well liked by some for eating fresh, but is disliked by others because it is not crisp and juicy like so many other fruits (Ruehle, 1967; Morton, 1987). Some Floridans enjoy the fruit with salt, pepper and lime, lemon juice or mayonnaise either fresh or after light baking (Morton, 1987). The pureed flesh may be used in custards or added to ice creams just before freezing. A rich milkshake is made by combining ripe canistel pulp, milk, sugar, vanilla and other seasoning (Morton, 1987).

Canistel pulp has also been used in preparing pancakes, cupcakes, jam and marmalade (Morton, 1987). The fruit can also be dried and processed into a powder which can be added to desserts and ice cream (Scholefield, 1984). Some companies in the Tropics have expressed interest in the processing of this fruit (Campbell, 1976).

Other Uses

Latex extracted from the tree in Central America has been used to adulterate chicle. The timber is fine grained, compact, strong, moderately to very heavy and hard, and valued especially for rafters and planks in construction. The heartwood is greyish brown to reddish brown and blends into the sapwood which is somewhat lighter in colour. The darker the colour the more resistant to decay (Morton, 1987) .

Medicinal Uses

A decoction of the astringent bark is taken as a febrifuge in Mexico and applied to skin eruptions in Cuba. A preparation of the seeds has been employed as a remedy for ulcers (Morton,1987). In 1971, a pharmaceutical company in California studied a derivative of the seed which seems to be active against seborrhoeic dermatitis of the scalp (Morton, 1987).

Conclusion

The Canistel would probably lend itself well to orchard cultivation if the necessary cultural research was done. However, the critical factor which will determine the success of any

plantings is the market acceptability. This has not been determined as most canistels which are sold on local markets are sold primarily to people of Latin American origin. During a recent visit to Chile, Dr J. Terblanche, previous Director of the ITSC, found canistels to be a common product on local markets. Development of such a crop will take a great deal of organized effort. Coordinated research in culture, harvesting, handling, shipping and processing is required if a profitable industry is to be established.

The Institute wishes to initiate and conduct feasibility studies on the Canistel with a view to possible commercialisation. However, this will involve the need to assess as wide a range of selections as possible, to investigate and develop management strategies for local conditions. The initial process in developing this crop will necessitate the assembling of a gene pool of the best selections from around the world. These selections can then be screened for climatic suitability, productivity, fruit quality and storage characteristics, product uses, consumer appeal and pest and disease susceptibility .

A mature canistel fruit. Photo: N. Galpin

Only high quality fruit from selected cultivars should be marketed and a strong consumer demand should be developed, fruit should be promoted, and the public informed and educated on the eating characteristics and potential of the fruit.

We are aware that people may have canistel growing in their gardens. We would like to identify as many of these sources as possible and obtain fruit and seeds from these trees as this will give a wider basis to the selection programme. If anyone does have such a tree it would be appreciated if they could contact the Institute.

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AUSTRALIAN ESSENTIAL OILS

A.R. PENFOLD
F.R. MORRISON

[This very useful source document was published in 1947 by CSIRO as Chapter 11 of The Commercial Timbers of Australia, *by I.H. Boas. A.R. Penfold was Director, and F.R. Morrison was Economic Chemist, at the Sydney Technological Museum.]*

Essential oils are the odoriferous oily substances obtained almost exclusively from plant sources. These oils, sometimes called the volatile oils, are commonly obtained from various parts of plants by distillation in a current of steam. They occur in the most varied parts of plants - in the leaves, buds, fruit, bark, wood, and the roots.

The Australian flora is noted for the wealth and diversity of its essential oils, which have been a source of great scientific and commercial interest since the earliest days of settlement in Australia. The first article of export from Australia in 1788 was a quarter gallon of eucalyptus oil distilled from the leaves of the 'Sydney peppermint' (*Eucalyptus piperita*) growing on the fore shores of Port Jackson. The essential oils of the eucalypts have created the greatest interest for three-quarters of the flora of the Continent consists of the trees of this great genus. The most intensive and extensive researches have been conducted on the oils of the eucalypts, followed by those of the so-called 'Tea Trees' (*Melaleuca, Leptospermum.,Kunzea, Baeckea*, &c.)

The important work of Baker and Smith, entitled 'Eucalypts and their Essential Oils' published first in 1902 and subsequently in 1920 described the oils from 180 species of eucalypts. These investigators published a second comprehensive volume dealing with the essential oils of the Australian pines, covering such wide genera as *Callitris, Araucaria, Agathis, Dacrydium, Phyllocladus,* and *Podocarpus*.

Since the publication of these volumes, further research has been accomplished at the Sydney Technological Museum and readers are referred to the extensive series of papers published by Penfold and Morrison in the Journal and Proceedings of the Royal Society of New South Wales from 1920 to date. Other important papers have also been published in collaboration with Dr. J. L. Simonsen, F.R.S., and his associates in the Journal of the Chemical Society, London, over the same period.

These investigations have stimulated the exploitation of Australian essential oils and have induced the various Forestry Departments to evince a greater interest in them as a source of national wealth, whether it be by increased revenue through royalties or by the conservation of forest areas where essential oil-bearing trees predominate.

It should be noted that as a general rule (there are exceptions, of course, to every good rule) those eucalypts which are exploited for their timber contain very little oil in the foliage, whilst those which are utilized for essential oils are of little use for timber. The wood of these trees is used primarily for fuel.

Fig. 1. Crude still for distillation of eucalyptus oil

The fixing of prices for eucalyptus oils in July, 1943, which helped to stabilize the eucalyptus oil industry, gave a renewed interest to the possible utilization of the foliage of trees felled for timber. It may yet prove commercially practicable to distil the oil from such leaves by utilizing steam from the timber mills, thereby salvaging foliage which is usually burnt. The leaves of other timber-yielding trees such as *Doryphora sassafras, Atherosperma moschatum,* and *Daphnandra micrantha* (all three commonly known as 'sassafras' trees), might also be distilled for the oil present in the leaves and bark.

Consideration is now being given to the utilization of waste sawdust from trees such as *Callitris glauca, C. calcarata*, &c., and coachwood (*Ceratopetalum apetalum*). The waste wood and sawdust from the mills cutting huon pine (*Dacrydium franklinii*) on the west coast of Tasmania have, of course, been used for quite a long time for the production of a valuable essential oil present in the wood.

It is not practicable in this short article to discuss the essential oils of the many Australian plants which have been investigated. It has, therefore, been restricted to a brief account of the principal commercial oils.

Eucalyptus Oils

Although botanists have described between 500 and 600 species and varieties, less than 24 species are exploited today for their essential oils. The following information, taken from a supplement to Bulletin No.2 issued by the Sydney Technological Museum in August, 1943, summarizes the principal commercial species and their economics.

In response to a specific request we have reviewed the industry as it stands today after four years of war. We have summarized the present day uses of commercial eucalyptus oils. It should be revealing to those who still cling to the old-fashioned notion that three drops of the oil on sugar for curing a cold is the fullest extent of its use.

The industry was written up in a very interesting way by Dr. Ernest Guenther who published his review in the 'International Export Chemist' for February, 1943. It is a very reliable account, but is essentially a compilation from the well known publications of this Museum. The information that will be of most value to enquirers at the present time is as follows.

Species Distilled and Their Location	Yield of Oil per 1000 lb foliage, lb*	Price per lb, s/d*	Uses
E. polybractea, Wyalong, New South Wales, and Bendigo, Victoria	20	3/0 (since increased to 3/6)	Medicinal
Eucalyptus australiana, southern district New South Wales, Bathurst district New South Wales, and Alexandra, Victoria	30	2/6 (since increased to 3/-)	Medicinal
Eucalyptus australiana (containing phellandrene)	30	1/8	Disinfectants and mineral flotation
Eucalyptus phellandra, Braidwood and south coast New South Wales and mountain ranges extending into Victoria	30-50	1/7	Same
Eucalyptus dives, coastal ranges, New South Wales and Victoria; especially Braidwood, New South Wales, and north east Victoria for synthetic thymol and menthol	30-45	1/8	source of piperitone
Eucalyptus dives, var. 'C'. (phellandrene free), Batlow Tumut-Tumbarumba district, New South Wales	30-33	2/6 (since increased to 3/-)	Medicinal
Eucalyptus dives, var. 'C'. (containing phellandrene)	30-35	1/8	Industrial
Eucalyptus dives, var. 'A'. Braidwood, New South Wales; Trentham,	40	1/7	Mineral flotation
Eucalyptus macarthuri, Moss Vale and Wirigello districts, New South Wales	2	25/- (not fixed by P.C.)	Perfumery
Eucalyptus citriodora, north coast district of Queensland around Mount Morgan and Gladstone	8-10	6/6	Source of citronellal

Species Distilled and Their Location	Yield of Oil per 1000 lb foliage, lb*	Price per lb, s/d*	Uses
Eucalyptus cneorifolia, Kangaroo Island, South Australia	20	1/9	Medicinal
Eucalyptus elaeophora, principally Bendigo district, Victoria	20-25	2/8	Medicinal
Eucalyptus sileroxylon, principally Bendigo district, Victoria	20-25	2/8	Medicinal
Eucalyptus leucoxylon, principally Bendigo, Victoria	20-25	2/8	Medicinal
Eucalyptus radiata (*E. numerosa*), 3 southern districts of New South Wales	0-35	1/7	Disinfectants and mineral flotations
Eucalyptus radiata (*E. numerosa*), var. 'A'. New South Wales. (Similar to *Eucalyptus dives* in composition)	45	1/8	Same as *Eucalyptus dives*
Eucalyptus virilis, Bendigo district, Victoria	15-20	2110	Medicinal
Eucalyptus lumosa, Wyalong, New South Wales and Bendigo district Victoria	15-20	1/10	Medicinal

Prices at the point of production for all species except *Eucalyptus macarthuri* were fixed in July, 1943, by the Commonwealth Prices Commissioner.

EXPORTS·

Year	Gallons	Value £A
1938-1939	134,207	86,714
1939-1940	164,971	130,422
1940-1941	184,175	206,082
1941-1942	190,192	208,282
1942-1943	51,945	94,050
1943-1944	62,823	124,148
1944 1945	67,730	136,297

* According to the acting Commonwealth Statistician.

* [Conversion notes: 1/6 = 1 shilling and 6 pence = 15 cents. 1 lb = 1 pound weight = 454 grams. 1 gallon = 4.5 litres. £ = 1 pound money = $2.00.]

These exports were made up of 65-70 per cent medicinal oil and 30-35 per cent industrial oils prior to the control on the export of *Eucalyptus dives* oil. The medicinal oils would consist approximately of the following species:

Species	Approximate percentage
Eucalyptus polybractea	33
Eucalyptus sideroxylon	20
Eucalyptus leucoxylon	20
Eucalyptus australiana and *E. dives* var. 'C"	20
Remaining varieties	6

Total Annual Production (years 1941 and 1942)

(Based on estimates received from distillers)

Industrial oils	120,000 gallons
Medicinal oils	110,000 gallons
TOTAL	230,000 gallons

Australian consumption for years 1941 and 1942 averaged 50,000 gallons per annum.

Industrial oils 40,000 gallons

Medicinal oils 10,000 gallons

Uses of Eucalyptus Oils

All eucalyptus oils are refined by redistillation before sale with the exception of Eucalyptus dives (export controlled since January, 1941) and *E. phellandra*. The first runnings, consisting of volatile aldehydes and some terpenes, as well as the final residues, find use in industry. Particulars of their utilization are given in Bulletin No. 17 of the Sydney Technological Museum.

Some of the uses of the principal constituents are given hereunder:

1. *Volatile aldehydes* (principally isovaleric), are used in various proprietary preparations including disinfectants, sheep dips, &c.

2. *Pinene* and other terpenes are used in the manufacture of certain blended turpentines.

3. *Cineol*, the principal constituent of medicinal eucalyptus oils, has a very restricted use. Production rarely exceeds a few tons per annum. It is used in pharmacy and confectionery and to a limited extent as a clothes cleaner.

4. *Phellandrene* is obtained as a by-product in the separation of piperitone from Eucalyptus dives and allied species, and is in heavy demand as a general solvent. In association with piperitone and other constituents it is sold as a blended eucalyptus oil for mineral flotation.

5. *Terpineol*, the well-known perfumery constituent of hyacinth odour, is separated from the high boiling fractions of *Eucalyptus australiana*, *E. dives* var. 'c' &c.

6. *Eudesmol*, the principal sesquiterpene alcohol of eucalyptus oils, is a very satisfactory fixative for perfumes required for industrial purposes.

7. *Eudesmyl acetate*, This is prepared by acetylating eudesmol. It is used as a war-time substitute for oil of bergamot and its constituents. It blends fairly well with lavender oil.

8. *Piperitone (commercial). assaying 90 to 95 per cent. ketone*. This ketone is prepared by a well known Victorian firm. Piperitone of high laevo-rotation is available in ton lots. It is the raw material for the manufacture of synthetic thymol and menthol.

Synthetic Thymol. This very valuable antiseptic agent is produced from piperitone separated from Eucalyptus dives in which it occurs to the extent of 45 to 50 percent. Australian requirements are approximately two tons per annum.

Synthetic Menthol. This is also prepared from piperitone and is used extensively for confectionery, medicinal purposes, soaps, tooth pastes, and to a limited extent for medicinal cigarettes. Australian requirements are approximately twelve tons per annum.

Future of the Eucalyptus Oil Industry

The future of the industry depends upon the extent to which new areas are developed, but essentially upon the conservation of the principal oil yielding species, such as *Eucalyptus dives* and *Eucalyptus australiana* (see Presidential Address to the Royal Society of New South Wales in May, 1936, page 26). It has also been shown by S. Smith-White (*J. Aust. Inst. Agric. Sci* .. Vol. 6. No. 4, December 1940) that certain areas of eucalyptus country are more profitable under eucalypts.

The Sydney Technological Museum has already established experimental plots for the propagation and cultivation of high oil yielding species of *Eucalyptus*. This experimental work will also provide data for the correct planting and handling of the trees with a view to obtaining maximum growth and yield of oil.

The method used for the distillation of eucalyptus oils is very simple and cheap. Figure 1 shows a typical bush still. It consists essentially of a 400-gallon tank with a tight lid and a fireplace below for heating the water. The leaves are charged into the tank and covered with water. The lid is closed and the fire lit. The steam together with the volatile oil is condensed in a long pipe which is cooled by water. The condensate is collected and the crude oil separated. In some plants more elaborate arrangements are made. A good supply of water is essential.

Tea Tree Oils

Under this heading are grouped three useful essential oils produced from the following species, *Melaleuca alternifolia, M. linariifolia,* and *Leptospermum citratum*.

Melaleuca linariifolia. This 'paper bark' tea tree occurs abundantly in the North Coast Districts of New South Wales and Queensland. It follows the water courses and flourishes in all swampy situations.

The leaves and terminal branchlets when subjected to steam distillation yield a pale lemon coloured essential oil to the extent of 1.2 to 2 per cent, according to whether the material is old or young growth, i.e., 1,000 lb of leaf material will yield from 15 to 20 lb of oil.

Fig. 2. Same as Fig. 1, but showing the arrangement for loading and discharging

The odour of the oil is not easy to describe, except perhaps to state that it is very pleasant, with a characteristic myristic or nutmeg odour. The chemical and physical characters of the crude oil are as follows:

Specific gravity 0.8927 to 0.8992

Optical rotation +3.30 to +6.80

Refractive index 1.4752 to 1.4780

Ester No 1.3 to 2.7

Ester No after acetylation 58 to 82

Solubility 0.8 vols in 80 per cent alcohol (by weight)

The principal constituents which have so far been identified are as follows: alpha terpinene, cymene, cineol (variable, usually 16-20 per cent, but sometimes contains up to 50 per cent), delta' -terpinenol-4, sesquiterpenes, &c.

The oil possesses marked germicidal properties. It is used principally in the manufacture of soaps. It cannot be used in lieu of *Melaleuca alternifolia* oil as the cineol content exceeds 10 per cent.

Melaleuca alternifolia. This paper-bark tea tree bears a superficial resemblance to *Melaleuca linariifolia*, but is quite a distinct botanical entity, although until recently it was looked upon as a variety of *M. linariifolia*. The tree is very common in the North Coast District of New South Wales, being especially abundant in the Clarence and Richmond River Districts, New South Wales. The tree is not so tall as *M. linariifolia*, although it possesses a

similar habitat, following the water courses and flourishing in swampy situations. It is more compact than *M. linariifolia*, and some of the areas are so thickly wooded that it is impossible to penetrate the growth except by felling and cutting a path.

This essential oil bears a close resemblance in general chemical and physical characters to that obtained from *M. linariifolia*. From 1,000 lb. of leaves and terminal branchlets is obtained about 18 lb of pale lemon-tinted oil with the same pleasant myristic or nutmeg odour mentioned under *M. linariifolia*. Many commercial samples are practically water-white. The chemical and physical characters are as follows:

Specific gravity 0.8950 to 0.9050

Optical rotation + 6.80 to + 9.80

Refractive index 1.4760 to 1.4810

Ester No 2 to 7

Ester No after acetylation 80 to 90

Solubility 0.6 to 0.8 vols 80 per cent alcohol (by weight)

Cineol content under 10 per cent

The principal constituents which have so far been identified are similar to those found in the oil of *M. linariifolia*, viz: d-alpha-pinene, and terpinene, cymene (cineol 8 percent), delta' terpinenol-4, sesquiterpenes, &c.

The complex mixture of constituents constituting the crude oil has been found to possess a high germicidal value when tested against pure carbolic acid using *B. typhosus* as test organism, being from eleven to thirteen times more powerful or effective in destroying typhoid germs than carbolic acid under similar conditions. The pleasant odour together with the high germicidal efficiency, and at the same time non-poisonous properties, have resulted in the industrial applications of this oil in germicides, solvents, &c., as well as refined uses in medicine and therapeutics. It has been used extensively during the war as the principal germicidal agent in 'cutting' oils.

The standardized oil is of great value in surgical work. This is chiefly due to its power of penetrating pus, and of mixing with it in a manner which causes it to slough off, leaving a healthy surface. Some idea of the wide field of usefulness in which this oil has found application can be gauged from the following conditions which have responded to treatment:

Perionychia, empyema, gynaecological conditions, skin conditions (epidermophyton infection, psoriasis), impetigo contagiosum pediculosis, ringworm, tinea (albuginea), throat and mouth conditions (acute nasopharyngitis, catarrh, thrush, and 'aphthous' stomatitis, tonsillitis and ulcers of the mouth, sore throat).

Leptospermum citratum. *Leptospermum citratum* is a very attractive 'lemon scented' tea tree found growing sparsely at Copmanhurst, New South Wales, and at Springbrook and Palm wood, Queensland. The leaves and terminal branchlets yield a very pleasant and valuable essential oil possessing a strong pleasant lemon odour, modified by that of citronellal. From 1,000 lb of plant material is obtained from 10 to 15 lb of a pale lemon coloured oil

containing about 85 per cent of citral and citronellal; the citral content varies from 45 to 50 per cent.

The chemical and physical characters of the crude oil are as follows:

Specific gravity 15/15° 0.8792 to 0.8856

Optical rotation +3.5° to +5°

Refractive index at 20° C 1.4688 to 1.4757

Solubility in 70 per cent alcohol (by weight) 1 to 1.2 vols.

Total aldehydes (citral and citronellal) 75 to 85 per cent.

The balance of the oil contains the alcohols geraniol and citronellal and their formic and acetic acid esters, sesquiterpenes and sesquiterpene alcohols, and less than 1 per cent of eugenol.

At present there is insufficient raw material to meet commercial requirements. About 100 gallons per annum are produced in Australia and sold at £10 per gallon. Practically the whole of the production is sent to essential oil firms in Melbourne and Perth. The citral produced from this oil is superior to that prepared from any other essential oil with the possible exception of *Backhousia citriodora*.

A few small experimental plantations have been established in Australia, but they are not yet in commercial production. Oil has recently been brought to Australia from Kenya Colony where plantations were established a few years ago with seed from Australia. The price of the oil is lower than the present selling price of the Australian-produced oil. It is said to be about 4s 6d per pound. A full account of the plantation in Kenya Colony is published in the Bulletin of the Imperial Institute. Vol. XL. No. I, January-March, 1942.

Other Essential Oils

Huon pine wood oil. The oil from the sawdust and waste wood of the well known huon pine of Tasmania, *Dacrydium franklini*i, has been of commercial importance for many years. The wood is noted for its white ant and borer resistant properties, due no doubt to the large amount of oil which it contains, usually from 3 to 5 per cent on the weight of the wood.

The oil, which is of a pale yellow colour and heavier than water contains from 90 to 95 per cent of methyl eugenol. The oil possesses a Rideal-Walker coefficient of 10 to 12. It has been found to be of value for the treatment of perionychia, tinea, cuts and wounds, and as a preservative for casein preparations. A notable war-time application has been its use in the manufacture of optical glass, for it possesses a refractive index of 1. 5330. Peace-time production was about 1,200 gallons per annum.

Sandalwood oils. The production of oil from the roots and butts of sandalwood in Western Australia has been a very important industry for many years past. The trade in this oil increased from 6,870 lb weight in 1921, to about 100,000 lb weight in 1930, but subsequently settled down to an average of 30,000 lb of oil per annum.

For many years a violent controversy raged about the quality and chemical composition of the oil from Western Australia. It is to the credit of the Western Australian manufacturers that they continued to improve the oil until it became equal in quality to the better known and well established East Indian sandalwood oil. Both oils contain sesquiterpene alcohols to the extent of 90 to 95 per cent; the santalols are the principal alcohols in both.

Important investigations on the chemistry of this oil were undertaken by the chemists of the Sydney Technological Museum in collaboration with Professor J. L. Simonsen, F.R.S. of the University College of North Wales, Bangor, and associates.

The work is still incomplete, for the elucidation of the structure of the other alcoholic bodies associated with santalol has not yet been accomplished. The oil from Western Australian sandalwood has suffered much in competition with the East Indian oil through changes in botanical nomenclature. The sandalwood tree in Western Australia was first known as *Santalum spicatum* or *Santalum cygnorum*, then changed to *Fusanus spicatus*, and finally to *Eucarya spicata*. The East Indian wood is known as *Santalum album*.

The bulk of the oil was shipped in pre-war days to the United Kingdom and Germany where it was used extensively in the manufacture of perfumes for soaps. Australian oil is now officially recognized for medicinal purposes by the British Pharmacopoeia.

Before leaving the subject of sandalwood mention should be made of a small tree, *Eremophila mitchelli*, which is widely distributed in the drier areas of New South Wales and Queensland, and known vernacularly as 'bastard' sandalwood or 'budda'. It is a matter for regret that this tree is exploited almost entirely for firewood, with a consequent loss of considerable quantities of essential oil which is present to the extent of 3 per cent. This oil has been thoroughly investigated and its composition almost completely elucidated.

The oil was found to consist almost entirely of three crystalline substances; eremophilone, melting point 42°C; 2-hydroxyeremophilone $C_{15}H_{22}O_2$ m.p. 66-67°; and 2-hydroxy-l:2-dihydroeremophilone $C_{15}H_{24}0_2$, m.p. 102-103°. These substances are of very great academic interest, and are the first naturally occurring sesquiterpene ketones and hydroxy-ketones to be found in nature.

The oil has been shown to possess marked fixative properties, but up to the present has not secured a market. No doubt the ramifications of the sandalwood industry have militated against its exploitation. Possibly it will come into its own when supplies of sandalwood in Western and South Australia become depleted. Under the name of 'rosewood' it has, however, been exported from Queensland to the East, where it is no doubt used for incense purposes as a substitute for genuine sandalwood.

Boronia megastigma. Another plant of considerable popular interest which has been exploited for its delightful perfume is *Boronia megastigma*, the brown boronia of Western Australia. *Boronia megastigma* is a shrub about six feet in height, found in the swampy situations in the south-west of Western Australia. Girls and youths are employed as pickers of the bloom from plants which are gathered from Crown lands in the extreme south-west of Western Australia, as for example, such districts as Mount Barker, Albany, Bridgetown, and Greenbushes. The blossom is removed with specially made combs constructed from

inverted horseshoe nails attached to a container. In good country pickers will gather about three pounds of blossom per hour.

So far as we are aware, this is the only boronia which is exploited for commercial purposes. This is readily understandable, for no other boronia occurs so abundantly as *Boronia megastigma*. The flowers are used for the production of concrete otto, which is prepared by two leading essential oil producers in Western Australia. Very limited quantities of the concrete otto are exported, for most of it is used in Australia, where it forms the basis of some beautiful creations of the perfumer's art. The chemical composition of the concrete otto was investigated by one of us (A.R.P.) in 1927. Beta-Ionone is one of the principal odoriferous constituents.

Australia is unusually rich in essential oil yielding plants. A considerable number have been thoroughly investigated by Australian chemists, special attention being given to such important genera as *Eucalyptus, Melaleuca, Leptospermum, Boronia, Prostanthera, Zieria,* &c.

With the exception of those described in this article, comparatively few have been commercially exploited. Nevertheless, many of the oils are noted for their unique composition, for many remarkable substances have been isolated from them. Readers who wish to know more about these unusual essential oils in the Australian bush and the chemistry of the many new substances isolated from them should peruse the numerous papers appearing in the Journal and Proceedings of the Royal Society of New South Wales and the Chemical Society, London. In addition to those enumerated above, essential oils from such widely distributed genera as *Backhousia, Baeckea, Calythrix, Callistemon, Darwinia, Dysoxylon, Eriostemon, Geijera, Eremophila, Murraya, Phebalium* have also been investigated.

Submission of Articles

The WANATCA Yearbook is devoted to useful longer articles, likely to have continuing reference value, about any aspects of nuts, fruits, and other tree or perennial crops.

Articles would be gladly received from any source - there is no requirement to be a member of WANATCA. If the text is available on a computer or word-processor disc (Macintosh is preferred), this is greatly appreciated.

The WANATCA Yearbook is produced at the Tree Crops Centre for the West Australian Nut & Tree Crop Association Inc.

Please send articles or enquiries to:

The Editor. WANATCA Yearbook, PO Box 27, Subiaco. WA 6008. Australia

WEST AUSTRALIAN NUT & TREE CROP ASSOCIATION (Inc)

Founded in 1974, the Association has built up a wide membership among professional growers, amateurs, researchers, horticultural bodies, libraries, nurseries, and investors. Members are based throughout the State, all over Australia, and in many overseas countries.

Membership fees cover subscriptions to all WANATCA publications. Currently these are: a quarterly magazine, **Quandong**; the **WANATCA Yearbook**; and the **Australasian Tree Crops Sourcebook**.

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West Australian Nut & Tree Crop Association Inc

PO Box 565, Subiaco, WA 6008, Australia