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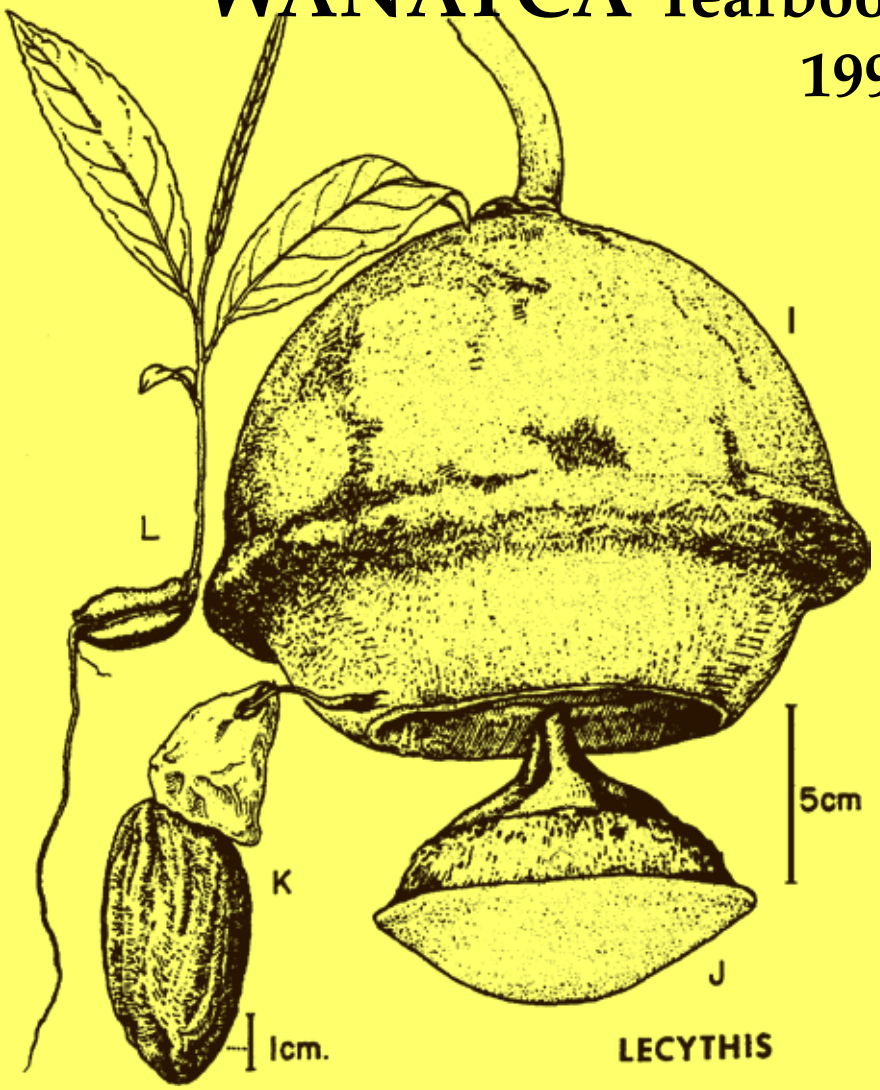

The Sapucaia, *Lecythis usitata* (I-J), *L. minor* (K) (see page 77)

West Australian Nut and Tree Crop Association (Inc)

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

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CASTANOPSIS: THE EVERGREEN CHESTNUT FAMILY

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The genus *Castanopsis* belongs to the Beech family (Fagaceae) and over a hundred species have been recorded from the region of South East Asia stretching from North Eastern India to Japan, including the southern half of China, and as far south as Papua/New Guinea including the Philippines, Indonesia and Malesia; the highest number of species (70) are found in Indo China and Malaya (Krussman et al., 1984). In addition two species are natives of western Northern America.

In a recent survey of the sub group *Castaneoideae* within the family Fagaceae, Praglowski (1984) has shown that, based on pollen morphology, the genus *Castanopsis* consists of approximately 150 species with a subtropical to tropical, mainly Asian, distribution and that the genus can easily be delimited from other closely related species.

Although the genus is now confined to two widely-separated regions of the world, palynological and fossil evidence suggests that the genus *Castanopsis*, and its related genera, formerly had a much wider distribution. For example, it occurs in the sub-Oligocene strata in Hungary (Palfalvy, 1978); in Cretaceous deposits in the USSR (Shilin, 1983); from early Pliocene sites in Italy (Bertoldi, 1988) and from various other European sites from the Oligocene to the upper Miocene (Mai, 1989).

The genus is used for timber, tannin extraction, and animal fodder, and of the over 100 species, Tanaka (1976) lists 28 species that are a source of food for human consumption. In this paper we examine the genus from the point of view of its food potential as well as trying to sort out its complex taxonomy by bringing to the attention of readers recent studies on the Chinese species, most of which is written in Chinese.

CASTANOPSIS (D. Don) Spach

The following general description is gleaned from various sources and serves to introduce this large genus; later descriptions will be given of the economically important species.

The genus was first described by Spach in 1842 and the genus consists of evergreen trees and shrubs intermediate between the two well established genera *Castanea* (the chestnut) and *Quercus* (the oak). The bark is scaly and astringent. The leaves are either alternate and two ranked or, sometimes, spirally arranged and are entire, leathery and the margins either entire or serrated. The underside of the leaves are frequently clothed in scales.

Male flowers are borne on upright, branched or simple spikes with 10-12 stamens. The female flowers are found on specialised short spikes at the base of the male spikes, and bear three styles indicating a tree-celled ovary.

The fruits are nuts which ripen only in the second year. They are enclosed in an asymmetrical, egg-shaped involucre (husk) which bears spikes or tubercules or sometimes transverse ridges. The husk opens by splitting to expose the brown nuts.

Of the more than 100 species recorded only a few have any commercial value.

Taxonomy and Distribution

As with any large assemblage of individuals, classification of the hundred-odd species of *Castanopsis* has lead to a great deal of confusion. The 1895 edition of Index Kewensis lists only 36 species worldwide, though other species have been added in the supplements.

Regional works frequently list species that have a particular use in that region. For example, Burkill (1966) lists 8 species from Malaya that are used either for timber or for their edible. nuts. This author also quotes other sources which list, for example, 12 species producing edible nuts in Indo-China; six species with edible nuts in Indonesia; and one doubtful species in the Philippines.

In his authoritative account of the family Fagaceae in Malaysiana, Soepadmo (1972) lists 34 species of *Castanopsis*. He states that the genus has been recorded from most areas of S .E. Asia except the eastern half of Java and the lesser Sunda Islands; the largest number of species is found in Borneo.

Ohsawa (1987) has delimited the distribution pattern of *Castanopsis* in East Asia and his figure illustrating this is reproduced as Figure 1.

This author has also commented on the fact that 34 species of *Castanopsis* occur in Yunnan, which is nearly twice the number found in the mountains of Malaysia. He suggests that this distribution pattern indicates a different evolutionary history between the two areas. Ohsawa (1987) also states that *Castanopsis* reaches its northern limit in Japan, where only one species is found.

In North America only two species are recognised; *C. chrysophylla* (syn. *Chrysolepis chrysophylla*), a tall tree growing to 40 m with dark green leaves bearing a scurf of yellow gold scales and creamy-white flowers); *C. sempervirens* (syn *Chrysolepis sempervirens*), a shrubby tree up to 3 m high with large solitary fruit; also listed is *C. chrysophylla* var. *t* an intermediate-sized tree with shorter leaves and of doubtful taxonomic status. Neither of the North American species appear to be grown for any commercial gain, though Krochmal and Krochmal (1982) suggest that the nuts are considered good eating when roasted and served with butter.

In China are found the largest assemblage of species, but these have not been thoroughly monographed and a great deal of nomenclatural confusion still exists. For instance Lee (1935) describes 34 species including some varieties, the Iconographica Cormophytorum Sinicorum (1972) describes 29 species, many of which coincide with Lee's (1935) list, and the more recent Flora Silva of China (Zheng, 1985) lists 40 species, again with some overlap with the two previous works but with some additional descriptions.

It has been announced that the new Flora of China project has completed its review and reassessment of the family Fagaceae, but at the time of writing this has yet to appear in print. However, I have managed to obtain from Professor Huang Cheng Chui of the South China

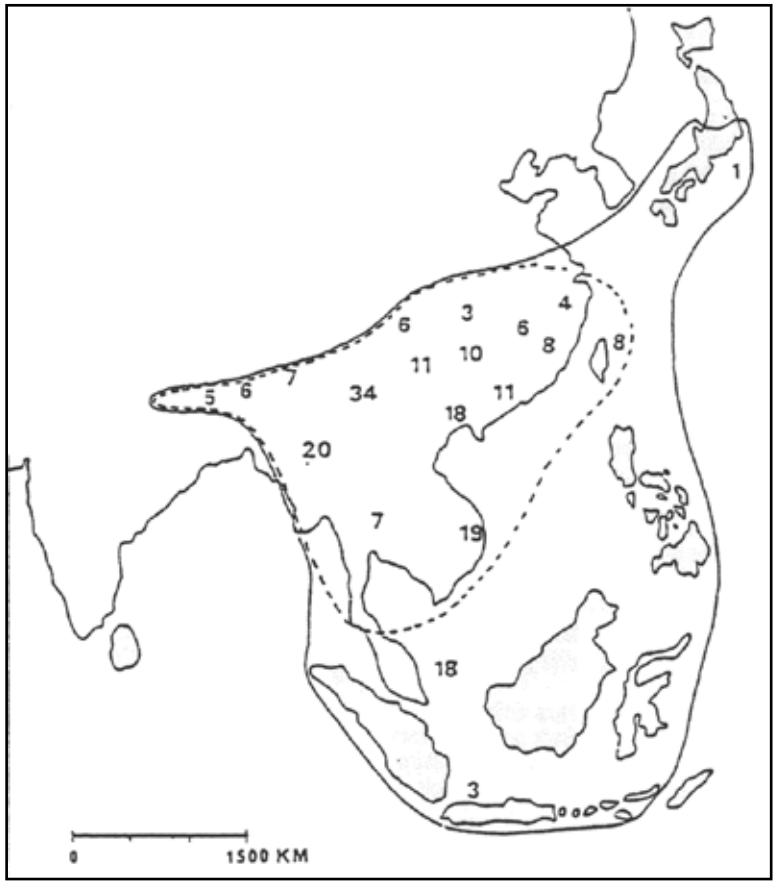


Fig. 1. Distribution and diversity of Castanopsis in East Asia. The area encircled by the full line indicates the generic area in East Asia, and that within broken lines shows the areas having at least one common species. (From Ohsawa. 1987)

Institute of Botany a list of the 64 species of *Castanopsis* that will be included in this definitive revision of the Flora of China. This list contain 22 new specific epithets and rejects many names mentioned in other Chinese accounts of the Family Fagaceae. One can therefore safely assume that the Chinese species listed in the Table 1 below (and marked by an asterisk) are, for the present time, the most authoritative and up-to-date listing of species from China.

The following species, mentioned by Wang (1961) in his work, "The Forests of China" do not appear on Huang's updated and authoritative list and are therefore of doubtful authenticity and should not be used:

.... *(to page 12)*

Table 1. Species of Castanopsis

SPECIES	DISTRIBUTION	SPECIAL FEATURES	RELATED SPECIES	REFERENCE
1. *C. acuminatissima* (Bl) A.DC.	India, Upper Burma, Kweichow, Yunnan, New Guinea, N. Sumatra, Malaysia	Fertile throughout the year. Cupule covered with tubercules not spines. Produces suckers around the base of the tree.	*C. tribuloides* *C. echidnocarpa* *C. ferox* from Burma and India; *C. cuspidata* from Japan	Soepadmo (1972)
2. *C. argentea* (Bl) A.DC.	Sumatra and Java	Silvery underside to leaves. Edible fruit eaten roasted or cooked. (Tanaka, 1976)	*C. hystrix* from Burma	Soepadmo (1972)
*3. *C. argyrophylla* King ex. Hook	S. Yunnan; Laos, Borneo, Thailand, India	Very long(25 cm) fruit stalk; underside of silvery-grey.	----------	Zheng (1985)
4. *C. blumeneana* (Korth) Rehder	Yunnan, Maung Hun	Cupule bears minute, scale-like prickles	---------	Lee (1935)
5. *C. borneensis* King	Borneo, Sarawak, Brunei and Sabah		*C. johorensis* & *C. wallichii*	Soepadmo (1972)
6. *C. brevispina*	Formosa	Quality timber; does not shrink or warp	----------	Howard (1951)
7. *C. buruana* Miq	Borneo, Moluccas	Cupule bears spines set in 405 curving rows. Survives following constant burning	*C. acuminatissima*	Soepadmo (1972)
8. *C. calathiformis* (Skan) Rehd. et Wils.	Yunnan	Cupule scaly. Mature fruits have a disagreeable odour.	*Synaedrys calathiformis* Koidzunmi; *Quercus calathiformas* Skan	Zheng (1985) Lee (1935)
*9. *C. carlesii* (Hemsl.) Hyata	China, south of the Yangsi River	Nuts edible. Bark produces resin. Timber for furniture and farming tools.	*Quercus carlesii* Hemsl.	Zheng (1985)
10. *C. catappaefolia*	Malay Peninsula	Only 1 specimen recorded. Male inflorescence not seen.	---------	Soepadmo (1972)
11. *C. caudata*	Fukien, Chekiang, Kiangsi, Guangdong	Leaves very thick and leathery. Small fruits enclosed by a prickly cupule	---------	Lee (1935)
*12. *C. ceratacantha*	Szechuan, Yunnan	Cupule bears very long spines.	*C. tribuloides* var. *longispina* King.	Zheng (1985) Lee (1935)
*13. *C. cerebrina* (Hick. et A. Camus) Barn	S.E. Yunnan	Young branches and underside of leaves hairy	*Pasania cerebrina* (Hick et A. Camus)	Zheng (1985)
*14. *C. chinensis* Hance	Yunnan, Guangdong	Nuts a source of oil and starch used in brewing. Wood contains resin.	*Castanopsis chinensis* Sprach	Zheng (1985) Lee (1935)
15. *C. chingii* Camus	S.E. of Taishan in S. Chekiang	Very small (5mm) fruits. Nuts are eaten roasted (Tanaka, 1976)	---------	Lee (1935)
16. *C. chrysophylla* (Dougl.) A.DC. Giant chinquapin	N. America; Oregon & Washington, West of the Cascade Mntns.	A tall tree bearing spiny fruit developed in clusters. Non commercial crop.	*Chrysolepis chrysophylla* (Hook.) Hjelmiquist *C. chrysophylla minor*.	Menninger (1977) Everett (1981)
*17. *C. chunii* Cheng	S. Yunnan; Guangdong, E. Szechuan	Thick leathery leaves.	--------	Zheng (1985)
18. *C. clemensii*	Borneo on Mt Kinabalu & Mt Trusmadi	Male inflorescence and mature cupule not known.	*C. oviformis*	Soepadmo (1972)
*19. *C. concinna*	Chekiang, Guangdong	Cupule bears short sharp spines. Evergreen leaves. Wood used for furniture.	*Cormophytorum sinocorum*. Lee gives the authority as Champ. ex Benth. Zheng gives the authority as Hance.	Lee (1935) Zheng (1985)
20. *C. concolor* Rehder & Wilson Rehdr. et Wils.	Yunnan, Szechuan	Spines in patches on cupule. Scented flowers.	near to *C. armata* Sprach.	Lee (1935)
21. *C. costata* (Bl.) A.DC.	Peninsula, Borneo & Nunukan Islands	Edible nuts (Tanaka 1976) Wood moderately hard and used for furniture (Burkill, 1966)	Cupule resembles *C. fulva* and *C. foxworthyi*. Nuts similar to *C. javanica*	Burkill (1966) Soepadmo (1972)
22. *C. curtisii* King	Malay Peninsula	Inflorescence unknown.	Close to *C. nephelioides* & *C. rhaminfolia* but differing in leaf and cupule characteristics	Soepadmo (1972)
23. C. *cuspidata* Schottky	Very rare in China; Yunnan, Guangdong	Cotyledons of the nut are edible (Tanaka 1976)	Syn: *Quercus cuspidata* Thunberg; *Pasania cuspidata* Oersted *Lithocarpus auspidata* Nakai. See Lee (1935) for full list.	Lee (1935)
*24. *C. delavayi* Franch.	Szechuan, Yunnan, West of Talifu	Nuts edible. (Tanaka 1976) Starch used for brewing. Resin produced by cut wood. Good quality timber in Yunnan.	*Castanopsis* tsai Hu (Cheng 19)	Lee (1935) Zheng (1985)
25. *C. densinervia* Soepadmo	Borneo, Sabah	Black cupules, excentrically compressed.	--------	Soepadmo (1972)
*26. *C. densispinosa* Y.C. Hsu et H.W. Jen	S. Yunnan	Capsule bears (dense) spines	--------	Zheng (1985)
27. *C. diversifolia* King.	Yunnan, Maung Pan	Valuable source of timber in China	--------	Lee (1935)
*28. *C. echidnocarpa* A.DC.	S.E.Tibet, S. Yunnan, Laos, Thailand, Borneo, India	Capsule bears short or wart-like spines. Fruit stalk 10-18 cm long.	*C. longispicata* Hu	Zheng (1985)
29. C. endertii Hatus ex Soepadmo.	Borneo	Female flower stalk not known.	--------	Soepadmo (1972)
30. *C. evansii* Elmer	Philippines, Borneo	--------	--------	Soepadmo (1972)

SPECIES	DISTRIBUTION	SPECIAL FEATURES	RELATED SPECIES	REFERENCE
*31. *C. eyrei* (Champ. ex Benth.)	China, south of Yangsi River	Edible nuts. Bark produces resin. Timber for furniture.	Syn. *Quercus eyrei* (Champ.)	Zheng (1985)
*32. *C. fabri* Hance.	Yunnan, Maung Pan	Evergreen, thick leathery leaves.	--------	Zheng (1985)
*33. *C. fargesii* Franch.	Hupeh, Szechuan, Yunnan, S.Anweh	Nuts edible; starch used for tofu and brewing; the wood used for mushroom culture.	--------	Lee (1935) Zheng (1985)
*34. *C. ferox* (Roxb.)	S.& S.W. Yunnan, Borneo, India	Underside of leaf covered with waxy scales (powder).	---------	Zheng (1985)
*35. *C. fissa* B. Rehder & Wilson	Fukien and Hwang-tung	Nuts edible; timber used for furniture and house construction.	*Quercus fissa* Champ. & Benth. *Castanea regia* Hance *Pasania fissa* Oersted *Synaedrys fissa* Koidzumi.	Lee (1935) Zheng (1985)
*36. *C. fleuryi* Hick et A.Camus	S. & S.W, Yunnan, Laos	Small nuts (0.8-1.2 cm diameter)	*C. microcarpa* Hu	Zheng (1985)
*37 *C. fordii* Hance	Kiangsi, S. Hunnan, Guangdong, Fukien	Edible nuts; S. China's main durable timber.	-------	Zheng (1985) Lee (1935)
*38. *C. formosana* Hayata	Hainan, Guangdong	Evergreen with leathery leaves	-------	Lee (1935)
39. *C. foxworthyi* Schottky.	Malay Peninsula, Sarawak & Sabah	Shows different leaf morphology under different conditions	*C. kinabaluensis*	Soepadmo (1972)
40. *C. fulva* Gamble.	Cent. Sumatra, Malay Peninsula, Sarawak, Sabah, W. Kalimantan	Only one fruit in each cluster of 3 develops.	--------	Soepadmo (1972)
41. *C. greenii* Chun	S. Guangdong	Leathery leaves, large fruits	--------	Lee (1935)
*42. *C. hainanensis* Merr.	Hainan	Evergreen. Edible nuts. Wood hard and resistant.	--------	Zheng (1985) Lee (1935)
43. *C. hullettii* King	Malaya; from Penang to Singapore	Edible nuts; 6.73% tannin in bark.	*C. hystrix*	Burkill (1966)
44. *C. hypophaenicia* (van Seemen) Soepadmo	Sarawak, Sabah, Kalimantan	Female flowers not known.	*Lithocarpus hypophaenicia* (van Seement) Barnett	Soepadmo (1972)
*45. *C. hystrix* A.DC. (Hsiao-yeh) Kan-chii	Chekiang, Kweichow, Kiangsi, guangdong, Fukien, Yunnan, Szechuan	Nuts edible. Wood used for timber & paper pulp. Bark contains resin & tannin.	*Castanea hystrix* Hook. *Quercus rufescens* Hook.	Lee (1935)
46. *C. incana* Camus	Chekiang	Cupule with long green spines. Valuable timber tree.	--------	Lee (1935)
*47. *C. indica* D.C.	Yunnan	Edible nuts; wood used for furniture & construction.		Lee (1935)

SPECIES	DISTRIBUTION	SPECIAL FEATURES	RELATED SPECIES	REFERENCE
48. *C. inermis* (Lindl. ex Wall.	Sumatra, Malay Peninsula, Singapore	Nuts boiled or roasted in Malaysia	*C. sumatrana* A.DC. *Castanea inermis*. Lindl.	Soepadmo (1972) Burkill (1966)
49. *C. javanica* (Bl) A.DC.	Sumatra, Malay Peninsula, W. Java & Borneo	Male inflorescences not known.	--------	Soepadmo (1972)
50. *C. johorensis* Soepadmo	Central Sumatra Johore (Malaya)	Male inflorescences not known.	--------	Soepadmo (1972)
*51. *C. jucunda* Hance	Guangdong	Nuts edible, starch used in brewing. Wood used for furniture	--------	Lee (1935) Zheng (1985)
*52. *C. kawakamii* Hyata	Taiwan, Fukien, S. Kiangsi, Guangdong	Edible nuts. Wood used in furniture and ship building. Bark contains tannin & resin.	*C. greenii* Chun	Zheng (1985)
53. *C. kurzii* (Hance) Biswas	India, Assam	Densely pubescent cupule with distinctive rings.	*Q. kurzii* (Hance)	Biswas (1969)
*54. *C. kweichowensis*	N.W. Guangsi, S. Kweichow	Female inflorescence up to 28 cm long.	---------	Zheng (1985)
*55. *C. lamontii* Hance	Guangdong	Spineless cupule. Nuts edible.	*C. robustispina* Hu	Lee (1935)
56. *C. lucida* (Nees) Soepadmo	Malay Peninsula, Singapore, S.W. & N.E. Kalimantan	Leaves thick and covered with hairs.	*Alseodaphne lucida*, *C. hullettii* King ex Hook.	Soepadmo (1972)
57. *C. malaccensis* Gamble	Thailand, Sumatra, Malay Peninsula, Singapore	Female flower stalks not yet found. Nut edible but causes diarrhoea. Timber sinks in water.	*C. hullettii*	Soepadmo (1972) Burkill (1966)
58. *C. megacarpa* Gamble	Malay Peninsula, Borneo, Singapore	Very large spiny fruits. Nuts said to be be poisonous but can be eaten, causing flatulence. Bark a valuable source of tannin.	*C. ridleyi* Gamble *C. javanica*	Soepadmo (1972) Burkill (1966) Corner (1988)
*59. *C. megaphylla* Hu.	S.E. Yunnan	Underside of young leaves bear star-like short hairs.	--------	Zheng (1985)
*60. *C. mekongensis* A. Camus	S.W. & S. Yunnan, Laos	Spherical capsule, 4-5 cm diameter, covered with spines.	*C. fohaiensis* Hu *C. wangii* Hu *C. lantsanhensis* Hu	Zheng (1985)
61 *C. microcarpa* Hu	S. Yunnan	Small capsules (1-1.3 cm). Stalk of capsule very short.	--------	Iconographica Cormophytorum sinicorum (1972)
62 *C. microphylla* Soepadmo	Sarawak, Sabah, Kalimantan	Mature cupule and fruits unknown.	*C. acuminatissima*	Soepadmo (1972)
63. *C. motleyana* King.	Borneo, Philippines	----------	*C. pearsonii*	Soepadmo (1972)

SPECIES	DISTRIBUTION	SPECIAL FEATURES	RELATED SPECIES	REFERENCE
64. *C. neo* Cavalierier, A. Camus	Kweichow on Fan-Ching Shan	Leathery leaves and small fruits. Cupule with branched spines.	--------	Lee (1935)
65. *C. nephelioides* King ex Hook.	Malay Peninsula	---------	*C. rhamnifolia*	Soepadmo (1972)
66. *C. oligoneura* Soepadmo	Sabah	Cupule with thick stiff spines. Ripe fruit warty.	--------	Soepadmo (1972)
*67. *C. orthocantha* Franch.	Yunnan	Very small fruits covered with very short spines. Wood used for furniture. Nuts edible. Starched used for building. Resin from wood.	*C. concolor* Rehd. et Wils *C. mianniugensis* Hu *C. yanshanensis* Hu	Lee (1935) Zheng (1985)
*68. *C. ouonbiensis* Hick. et A Camus	S.E. Yunnan, N. Vietnam	Underside of leaves densly covered with powdery scales? Cupule surface scaly.	--------	Zheng (1985)
69 *C. oviformis* Soepadmo	Borneo	Trunk with buttresses. Solitary fruit.	*C. clemensii*	Soepadmo (1972)
70. *C. paucispina* Soepadmo	Sarawak, Sabah	Cupule sparsely spined.	--------	Soepadmo (1972)
71 . *C. pedunculata* Soepadmo	North Borneo	Cupule almost smooth and a long stalk.	--------	Soepadmo (1972)
72. *C. philippensis* (Blanco) Vidal	Philippines	Fruits edible. Important timber tree	*Fagus philippensis*, close to *C. inermis*.	Soepadmo (1972)
*73. *C. platyacantha* Rehder & Wilson	Hunan, Kweichow, Yunnan, Szechuan	Edible seeds. Cupule ridged.	*C. orthocantha* Franch.	Lee (1935) Zheng (1985)
74. *C. poilanei* Hick et A. Camus	S.E. Yunnan, N. Vietnam	Midrib of leaves bears short hairs on the upper side and long hairs on the underside.	*C. tesselata* Hick et A. Camus	Zheng (1985)
75. *C. psilophylla* Soepadmo	Sabah, rare Sarawak, Kalimantan, Philippines	Fruits green in colour. Cupule bears bands of warts.	*C. inermis* *C. philippensis*	Soepadmo (1972)
*76. *C. remotidenticulata* Hu.	S. Yunnan	Leaf margin toothed. Underside of leaf covered with scales.	-------	Zheng (1985)
77. *C. rhamnifolia* Miq. A.DC.	Sumatra, Malay Peninsula	Fruit solitary with thick warty skin.	*Quercus rhamnifolia* Miq. *Castanea rhamnifolia* Miq. *C. armatra* Sprach.	Soepadmo (1972)
*78. *C. rockii* A. Camus	Yunnan	Fruits large (5 cm). Spines 2 cm long.	*C. lunglingensis* Hu	Zheng (1985) Lee (1935)
79. C. *roxburghiana* Biswas	Sikkim, Bhutan, E. Pakistan, Burma		Syn. *Quercus lancifolia* (*Q. lanceaefolia*) Schlect & Chan	Biswas (1969)
*80. *C. rufotomentosa* Hu	S.E. Yunnan	Young branches, leaf stalk & underside, stalk of inflorescence and cupule covered with brown scales.	-------	Zheng (1985)
81. *C. schefferiana* Hance	N.E. Sumatra, Malay Peninsula	Cupule lined with silky hairs.	*C. andersonii* Gamble	Soepadmo (1972)

SPECIES	DISTRIBUTION	SPECIAL FEATURES	RELATED SPECIES	REFERENCE
*82. C. sclerophylla Schott	Guangdong, Fukien, Yunnan, Shensi, Hunan	Nuts, source of starch made into tofu. Wood used in furniture.	*Quercus* sclerophylla Lindly, *Quercus* chinensis Abel, *C. chinensis* schottky, Synoedrys sclerophylla Koidzumi	Lee (1935) Zheng (1985)
83 *C. scortechinii* Gamble	Malay Peninsula	Male inflorescence not known. Cupule covered by a thick down of spines.	*C. fulva*	Soepadmo (1972)
84. *C. sempervirens* (Kell.) Dudley Sierra chinquapin	N. America, Oregon & Washington state	Bushy habit growing in dry, rocky areas.	*Chrysolepis sempervirens*	Lee (1935) Zheng (1985)
*85. *C. tcheponensis* Hick et A. Camus	S. Yunnan, Borneo, Laos	Leaf thin. Capsule bears long spines.	-------	Zheng (1985)
86. *C. tenuinervis* A. Camus	Yunnan on Kuyung Shan	Evergreen tree	*C. concolor* Rehder & Wilson	Lee (1935)
*87. *C. tibetana* Hance	Chekiang, Kiangsi, Fukien, Guangdong	Very spiny cupules. Nuts edible. Wood used for furniture.	-------	Lee (1935)
*88. *C. tonkinensis* Seem	Guangdong, S.W. Guangsi, S.E. Yunnan	Cupule bears small spines.	--------	Zheng (1985)
89. *C. tribuloides* A.DC.	Guangdong, Yunnan	Contains a number of varieties of doubtful authenticity.	*Quercus ferox* Roxbr. *Q. tribuloides* Lindly	Lee (1935) Zheng (1985)
90. C. *tungurrut* (Bl) A.DC.	Sumatra, Malay Peninsula, W. Java	---------	*Castanea tungurrut* (Bl)	Soepadmo (1972)
*91. *C. uraiana* (Hay.) Kanehira et Hatusima	Taiwan, Fukien, S. Kiangsi, Guangdong	Cupule covered with overlaping scales.	*Quercus uraiana* (Hay) *Lithocarpus uraiana* (Hay) Hayata	Zheng (1985)
92. *C. wallichii* King ex Hook.	Malay Peninsula	Edible nuts with a chestnut flavour (Burkill, 1966). 5.37% tannin in the bark.	--------	Soepadmo (1972)
93. *C. wattii* (King) A. Camus	Yunnan	--------	-------	Lee (1935)
94. *C. wenchangensis* Fu & Huang	Hainan (Guangdong) China	Smaller leaves than *C. hainanensis*		Fu & Huang (1969)

C. argyracantha	*C. chuniana*	*C. namdinhensis*
C. aramata	*C. fohaiensis*	*C. pachyrachis*
C. castanicarpa	*C. hickeli*	*C. tenuispinula*
C. chevalieri	*C. longispicata*	*C. wangi*

Similarly, many of the names given under the authority of Lee (1935) and Zheng (1985) are now doubtful, but they have been left in the table because many of them are commercially important trees which occur in other forest zones outside China, where further taxonomic revision is obviously necessary. The following species were found in Tanaka (1976) but no other reference to them can be found in the literature:

C. boisii	*C. lutchuensis*
C. brachycantha	*C. rufescens*

From a cursory glance at the above table it can be concluded that, despite a wide proliferation of names, not much information is available on the economic value of these trees. Taxonomic studies rely, of necessity, primarily on the accurate description of minute morphological characters and therefore any derived attributes such as the nutritional value of the seeds, the usefulness of the timber or the derivation of pharmaceuticals and industrially useful chemicals are not considered relevant in such a body of information.

Some species of *Castanopsis* have been, however, exploited as sources of useful products and some of these are described below.

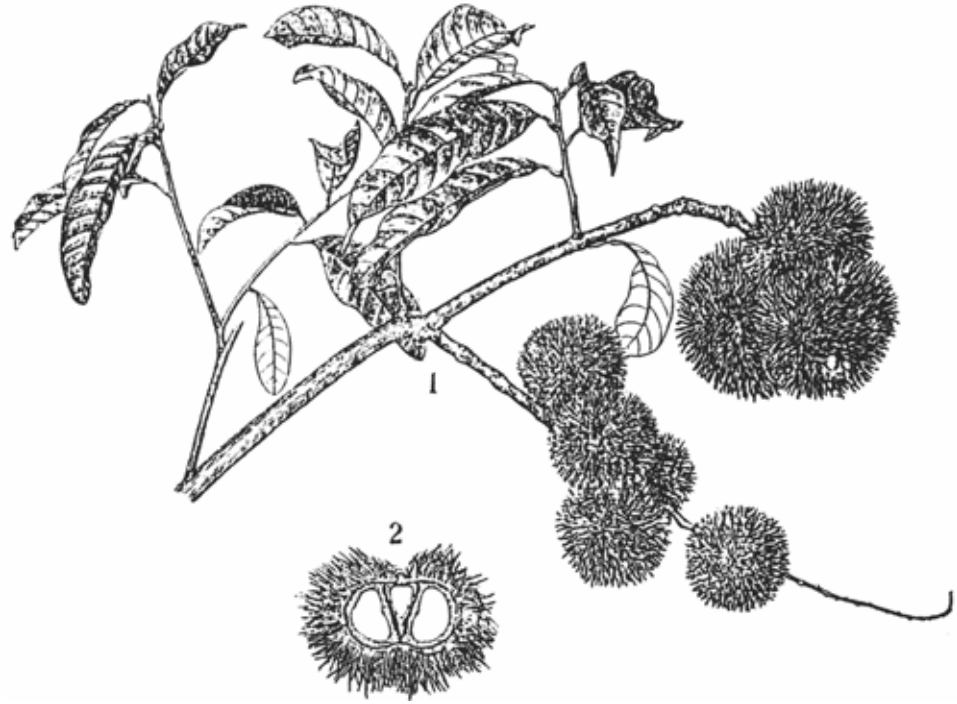


Fig. 2. Sarangan or Indonesian Chestnut, Castanopsis argentea [From: J. J. Ochse, Indische Vruchten, 1927]

1. ***Castanopsis fissa*** Rehder et Wilson [Syn: (*Quercus fissa* Champ & Benth; *Pasania fissa* Oersted; *Synaedrys fissa* Koidzumi]

Recent investigations at the Yunnan Academy of Forest Sciences have shown that this species is a particularly fast growing tree with many useful attributes.

It grows in natural stands in the S .E. of Yunnan on slopes between 700 and 1700 m. It also occurs intermittently in the states S. Kiangsi, S. Hunan, Guandong, Fujian and S. Kwaichow.

In Yunnan the tree grows in the wet monsoon evergreen forest and has the unique ability to withstand forest clearance, after which it becomes a pioneer species of the secondary forest and forms monocultural stands. It grows in deep, heavy, sticky soil at pH 4.5-6.5, and the trees can withstand temperatures as low as -5°C. It grows best in areas with an average annual rainfall of 1000 mm and can thrive where this level reaches 2000 mm.

The species grows best on slopes bearing deep soil and can tolerate a certain amount of shade when young; it requires full illumination at maturity. It has strong regenerative powers by means of its secondary buds, and cut stumps yield thickets of new growth within months of forest clearing.

The growth rate of the tree is very fast and, for example, a 23 year old specimen in secondary forest at 1470 m altitude was 22 m high with a girth of 300 cm. The peak rate of growth is around the 10th year and trees normally reach 16 m after 15 years. At this stage it is ready for timber production. Trunks are relatively straight making milling easy. Growth slows after 30 years.

Seeds are first produced at years 7-8, and at peak production each tree yields 50 kg of seed each year.

The tree produces a heavy leaf fall which converts, in turn, to a substantial litter layer and this fact, coupled with its rapid growth rate, makes it an ideal tree for afforestation programmes on barren mountain slopes.

Seeds contain a high level of starch and the bark yields tannin (see below).

2. Castanopsis cuspidata (Thunb.1 Schottky [Syn: *Quercus cuspidata* Thunb.; *Pasania cuspidata* (Thunb.) Oerst; *Lithocarpus cuspidata* (Thunb.) Nakai]

This tree occurs in only a few area of China but is common in the warmer parts of Japan (Honshu, Shikoku, Kyushu) and in Korea. The tree may be 50 ft tall and 10 ft in girth, and is found growing in damp ravines and as an important and agressive species in warm temperature broad-leaved evergreen forest where rapid growth has been recorded in 50 year old trees (Awaya et al., 1985). Factors affecting seed production in forest stands of this species near the Kyoto basin have been investigated by Saito et al. (1987).

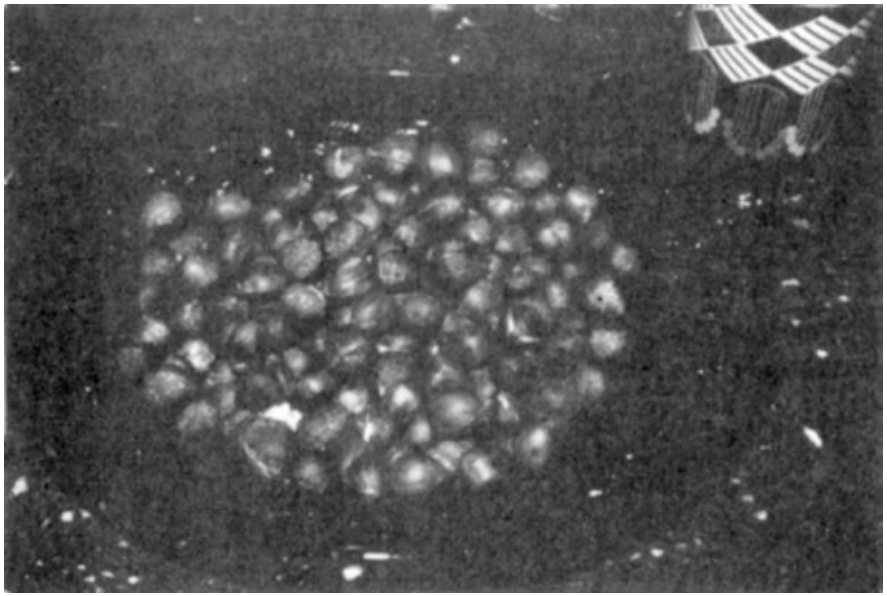
A closely related tree, *C. cuspidata* var. *sieboldii* (Makino) Nakai has thicker branches and larger nuts {Jisaburo Ohwi (1965)} and this tree is frequently referred to in the literature as *C. sieboldii* (Aramoto et al., 1985; Fujita, 1985; Shinzato et al., 1986; Shinzato et al., 1987).

The tree is considered to be an important hardwood in the Japanese timber industry (Fujita, 1985; Banshoya; 1986) while logs of this species have been used for growing shiitake mushrooms (Aramoto et al., 1985).

As with other species of the Fagaceae the bark and leaves of *C. cuspidata* contain tannins and related compounds (Nonaka et al., 1989) while the essential oils of *C. cuspidata* flowers contain a number of volatile and potentially useful components (Yamaguchi and Shibamato,

1979).

The nuts are said to be edible (Tanaka, 1976) and in Korea the fruits, particularly the seed cotyledons, are considered a delicacy (Tanaka, 1976).



Dish of pan-roasted Castanopsis nuts, Sulawesi, Indonesia [Photo: David Noel]

3. C. chrysophylla (syn: *Chrysolepis chrysophylla*) and *C. sempervirens* (syn. *Chrysolepis sempervirens*)

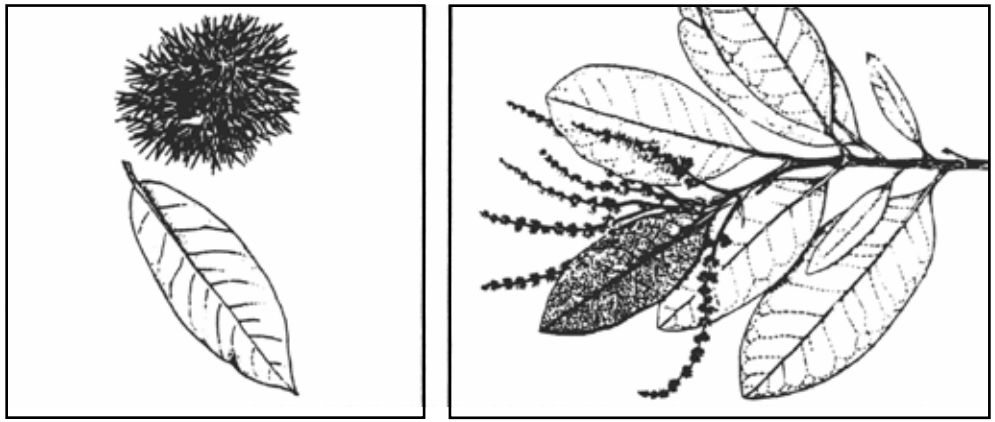
These are the two North American species, the nuts of which are referred to as "Chinquapins". Both species are widespread west of the Cascade mountains of Oregon and Washington, where they are abundant in the foothills of these ranges.

Menninger (1977) gives the following account of the nuts:

"Chinquapins, known as bushy chestnuts, are also grown as small trees in the Appalachian areas, extending south to middle Georgia. The trees are relatively resistant to chestnut blight. No efforts have been made in the United States to cultivate Chinquapins.

"The nuts are small, resembling chestnuts and are relatively hard to shell from the spiny burs. Chinquapin nuts are sweet, more palatable than chestnuts, and were prized as food by the Indians and early Americans. They have been traded or marketed for more than two centuries. The numerous burs are an inch and a half in diameter, commonly arranged in a spikelike cluster. The plant blooms in June and the brown nuts ripen in September. The burs contain one and rarely two nuts. The nuts are round, somewhat pointed at the top and about half as large as the American Chestnut. They have much the same appearance of small acorns.

"Chinquapins contain about 5% fat, 5% protein, 40% starch, and 1800 calories per pound. They are eaten raw, roasted in the shell and used similarly as chestnuts."



Leaf and flower (right) and leaf and burr (left) of Castanopsis chrysophylla [From Krochmal, 1982]

C. chrysophylla - The Giant Chinquapin - is native from Oregon to California, and specimen trees grow to more than 120 ft tall, with deeply furrowed bark and dark green leaves bearing golden-brown scales on the underside. The nuts are protected by densely spined fruit coats 1-1.5 inches in diameter.

C. semipervirens, known as the Sierra Chinquapin, is a native of dry rocky areas and is a broad shrub growing to 8 ft. The leaves resemble those of *C. chrysophylla* as do the fruits.

Everett (1981) also lists a variety known as *C. chrysophylla* minor, which grows either as a shrub or as a tree; it appears to be an intermediate type between the two typical species. It is characterised by having richly golden-yellow scales on the underside of the leaves.

Economic value of the genus

As many species of *Castanopsis* occupy an important niche in the forests of developing or under-developed countries it is not surprising that considerable efforts have been made to exploit the genus for economic gain. Their most important contribution to the economy of Southeast Asian countries is in the production of timber, though more recently wood from some species has been found suitable for pulping (Kai et al. 1974, 1975; Kitagawa & Kanasaki, 1975; Pasaribu and Silitonga, 1977). The species *C. indica* is also an important source of firewood in Nepal (Fox, 1984).

Other uses include the production of tannin, various essential oils and their somewhat limited use as fodder plants in parts of India (Kessler, 1981; Saha & Saha, 1986).

1. Nuts

Their role as nut-producing trees is confined to localized areas and, to date no efforts have been made to breed, or genetically engineer good quality nuts, though evidence suggests that the kernels are rich in nutrients suitable for human exploitation (Jackson & Boulanger, 1978; Bhumibhamon and Kanchanabhum, 1980; Bajracharya, 1980; Bajracharya et al. 1982; Bourke, 1981; Maskey & Shah, 1982). Burkill (1966) gives the following account of *Castanopsis* nuts in Asia:

"As the generic name indicates, they are closely similar to *Castanea*, the Spanish Chest-

nut; and the nuts which the various species produce can be arranged in a series from an edible state, almost equalling that of the Chestnut, to a quite inedible condition. *C. inermis*. *C. wallichii*, and perhaps *C. costata* give the best nuts among the Malayan species. The inferior species are commonly regarded as pigs' chestnuts.

"Chestnuts derived from three species of *Castanopsis* are used in the Himalayas, but none of the three extends southwards to Malaya, though one of them reaches Siam. A dozen species are said to furnish edible nuts in Indo-China, one of them being cultivated. In the Dutch Indies there are six species with edible nuts."

In addition to these, there is *C. chinensis*, sometimes called Chinese Chinquapin, cultivated in Yunnan and Kwantung, a big evergreen tree. The nut is eaten roasted, and is notable for its sweet smell; it is a popular food in many parts of Kwantung.

Also from the Philippines comes *C. philippensis*, of which Brown says:

"*C. philippensis* is a tree usually 15 to 25 metres in height. The fruit grows on spikes, and contains an edible, oblong nut up to 3.5 centimetres in length. The flavour resembles that of a chestnut. There are several other species of this genus in the Philippines, having edible nuts, but they are of little importance as a source of food."

Burkill describes the six species in Malaya that have edible nuts:

C. costata. A tree of moderate height found widely in western Malaysia; in the Peninsula it occurs in Perak. Wray records that the nuts are edible, in which respect this species agrees with *C. javanica* which is planted sparingly in Java for the sake of the nuts.

*C. hullett*i. A rather tall tree found here and there from Penang to Singapore. Alvin says that the prickly chestnuts are eaten boiled.

C. inermis. A rather tall tree found in Sumatra and the Malay Peninsula; in the Peninsula, especially in the north, it is frequently cultivated. The chestnuts, which lie in a spineless case, are edible, and are considerably used, parched, roasted or boiled. In southern Sumatra they are very common in the markets, in season. In Malaya they are not quite so often seen, but they are not neglected.

C. malaccensis. A tree found in Malacca, Negri Sembilan, and Singapore. Alvins said that the chestnut is edible; he adds that too many cause diarrhoea.

C. megacarpa. A rather tall tree found from Province Wellesley to Singapore, common in the lowlands. The chestnuts are edible. Ridley records, from Malay sources, that they purge and produce flatulence, but others say they can be eaten with impunity, though distinctly bitter. It is extremely probable that more than one species is confused in these statements.

C. wallichii. A rather tall tree, found from Penang to Singapore. The chestnuts, which lie in a very spiny case, are edible, and Ridley records this of them: "They are small and have a hard rind, which makes them troublesome to open. They have quite the flavour of the English chestnut, and are used by the Malays to ornament cakes."

Menninger (1977) gives the following account of *Castanopsis* nuts in two other tropical countries.

"The Forest Service at Lae, New Guinea, writes of *C. accuminatissima*: "This has nuts which are eaten either raw or cooked. This is a tree, often common in fagaceous forests, mostly between altitudes of 3000' to 7000', often associated with disturbance (landslips, cutting, etc.). Mature trees are characterized by profuse coppice growth from the base."

"For this book H.G. Hundley in Rangoon, Burma, sent three packs of *Castanopsis* fruits with this note:

"Fruits of *Castanopsis argyrophylla*, commonly called GON.

"Fruits of *C. tribuloides* var. *longispinus*, called KAT.

"Fruits of *C. tribuloides* var. *ferox*, called KYSIN.

"These are Burmese chestnuts that are roasted and eaten like the Chinese chestnuts."

2. Timber

The quality of timber from at least some species of *Castanopsis* is very high and, for example, Fraser (1978) gave an account of the activities of the Pacific Lumber Products Pty Ltd in Lae, Papua New Guinea which started production in 1976. Evidence from export figures suggest that wood from "New Guinea Oaks" (i.e. *Castanopsis* and *Lithocarpus*) is frequently substituted for European Oak (*Quercus*) in the furniture and joinery industries.

The physical property of *Castanopsis* timber has been investigated by Ginoga & Kamil (1973) and Karnasudirdja & Ginoga (1975) in Java; Shukla & Sharma (1979) and Shukla et al. (1987) in India; Pillsbury & Kirkley (1984) in California, U.S.A.; and Yin, Song & Wu (1987) in Nanjing, China.

In a search for new and exportable timbers from Malaysia, Wong (1976, 1982) checked the physical and mechanical properties of "berangan" (*Castanopsis*) and later Sim (1984) concluded that some species of *Castanopsis* are difficult to work as timber and are nondurable. The durability of selected Indonesian timbers to termite attack and terrestrial and marine fungi has been investigated by Suhirman (1984) who showed that *C. javanica* was susceptible to termites.

3. Extractable substances

The most important extracted chemicals from *Castanopsis* are various tannins usually obtained from the bark. For example, the Chinese Academy of Forestry (1981) were the corporate authors of a wide-ranging survey of tannin-bearing plants in China, and included in their survey species of *Castanopsis*. Later Nonaka et al. (1985) found a new class of gallotannins, possessing a unique shikimic acid core, in C. *cuspidata* var *sieboldii* Nakai in Japan. Other novel tannins were found in the same plant by Ageta et al. (1988a, 1988b) while a new class of tannins, the mongolicains A & B, were found in *Quercus* and *Castanopsis* by Nonaka et al. (1988). These authors also isolated and characterized a group of tannins related sugars, cercidinins A & B, from C. *cuspidata* var *siebaldii* (Nonaka et al., 1989).

Other extractable compounds from *Castanopsis* include anthocyanins (Yoshitama et al. 1972); terpenoids and steroids (Hui & Li, 1976a, 1976b; Pushpa Pant & Rastogi, 1977, 1978; Yamaguchi & Shibamoto, 1979). *Castanopsis cuspidata* var *sieboldii* has yielded good grade starch in Japan (Fujimoto et al. 1981) and flowers from the same tree yielded an essential oil (Yamaguchi & Shibamoto, 1979).

Conclusions

In this paper I have tried to unravel some of the taxonomic complexities that occur in the classification of an important, uncultivated, nut bearing genus of trees - *Castanopsis*. I have also given some indication of its economic value and obvious potential for exploitation.

The genus exhibits an adaptability to growth in geographical zones extending from the

topics to the cooler regions of China and Japan. The trees are fast growing and tolerate a wide variety of soil types. The nuts are edible and indication of their nutritional value show them to be as good as the widely grown, and closely related genus *Castanea* - the sweet chestnut.

Castanopsis is an important genus in areas of forest that are themselves under severe threat from overexploitation and, as no wide-range of scheme for their preservation and removal to new forest areas are being undertaken, there is every chance that some of the more useful species of *Castanopsis* may be lost to mankind within a few decades.

With this thought in mind it is essential that any organization with an interest in nut-bearing trees should take immediate steps to conserve the genus and bring it into cultivation; the germplasm is there for the taking and *Castanopsis* nuts retain their viability for months (personal observation). Therefore nuts from various geographical locations should be collected and germinated in Australian nurseries.

With selective isolation of the most vigorously growing and the heaviest croppers, suitable cultivars may be available for simple cross breeding experiments which may yield economically viable nut bearing trees. This is a mirror-image of the system that was used to select, for example, our present heavy cropping Chestnut trees - i.e. a simple, but somewhat protracted selection from wild types.

Castanopsis may provide subsequent generation of nut-growers with a new, novel and readily acceptable alternative to Chestnuts. In addition, spin-offs such as timber, tannin etc have yet to be exploited systematically. The time is ripe to begin this process of selection before it is too late and the trees are lost.

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BUDDING PISTACHIO NUT TREES

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Much has been written and spoken about budding root stock and existing pistachio nut trees. However, the true test is to have something simple which will produce the best results. More importantly, to have a procedure which can be performed by people with limited knowledge of the principles of plant growth.

Those of you who have tried in vain to bud-graft pistachio root stock will know how frustrating and time consuming it can be, especially when the end result is a failure year after year.

The basic requirement for budding is to have a close contact of the cambium layers (tissue between bark and wood) of both stock and scion.

Some favour budding with chip buds, using dormant wood in the Spring just after sap movement. Extensive experimenting has proved (for me) that the best time is mid January to early March when the sap is flowing at its peak, and now I only 'T' bud, using fresh budsticks taken from selected trees with large buds

The materials required are few and simple:

• Sharp and clean secateurs (preferably sterilised in methylated spirits or similar.

• Fresh budsticks which have been selected from trees free of virus diseases and other disorders. Budsticks should be placed in a bucket of cold water when cut, and kept cool until budding. Budding from these budsticks should be carried out the day the budsticks are cut and at a temperature preferably no less than 20 degrees centigrade.

• Very sharp and clean budding knife (also sterilised in methylated spirits or similar).

• Good budding tape or budding rubbers (aged, ie one year old so that they perish easily).

The simplest way of budding a root stock for pistachio nut trees is the common 'T' method. The incision is first made across the stock to be grafted (for the top of the 'T'), then a further incision is made from the top of the 'T' and down the stock for about 20 to 30 mm (Fig. 1)

Care must be taken to use only enough pressure on the knife blade to cut the bark so that it (the bark) can be freely peeled back from the wood using the back of the budding knife.

The bark at the junction of the cuts can be lifted slightly (Fig. 2) by a twist of the knife blade, and the flaps are then opened up by reversing the knife and sliding the bevelled bone end between the bark and wood. It is a good idea to splash cold water onto the area worked on to keep it moist.

To cut the bud from the budstick use the following procedure. Make the bud length about

§ Member WANATCA

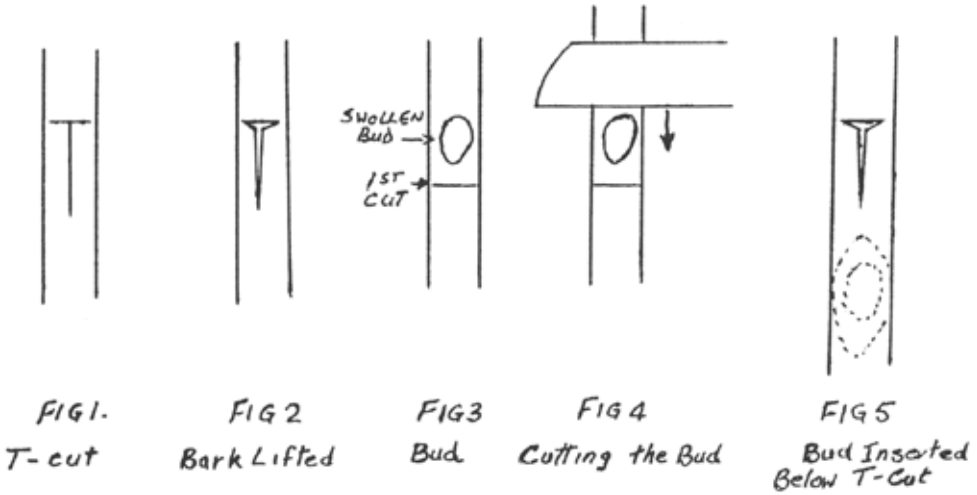

FIG 1. T-cut
FIG 2 Bark Lifted
FIG 3 Bud
FIG 4 Cutting the Bud
FIG 5 Bud Inserted Below T-Cut

20 mm. With a sharp knife, cut around the budstick below the bud (Fig. 3). Hold the budstick with the bud facing you and the index finger of the left (or right) hand directly under the bud to be removed.

Cut the bud away from the budstick with a continuous downward slicing movement of the blade, beginning 10 to 20 mm above the bud and finishing at the bottom cut (Fig. 4). The cut should be deep enough to show a sliver of wood sticking to the bark when removed. After removal of the sliver of wood, it is a good idea to lightly scrape about 2 mm of bark off each end of the sliver to expose the cambium layer. Then dunk it into a bucket of cold water to clean it and keep it moist.

To insert the bud, firmly hold the root stock with one hand, then with the other hand carefully slide the bud between the bark and wood where the incision was made for the 'T'.

Now push the bud down towards the roots to a distance of 10 to 20 mm below the base of the 'T' incision (Fig. 5). The bark will stretch and the bud should be under the bark and below where the incision was made. This is important as the knife wound will damage the underlying layer, and this will result in the death of the bud if it is over it. To complete the operation. firmly bind over the incision with budding tape or budding rubbers.

If the work has been successful the bud will quickly push away and within 2 to 3 weeks a shoot should appear in 20 to 30% of the buds. The rest will swell and remain dormant until next Spring. (The best result I have had was a shoot 320 mm long, one month after budding.) It is also possible the graft will flower the following year.

Finally all foliage below the graft should be cut off. If budding tape has been used, it can be removed during winter as the bud should be well established. It is desirable to secure the tree to a stake and to support the new graft.

As you can see there is nothing new about budding except that correctly choosing the time of budding and bud selection (fresh swollen and mature buds) are essential. Overall the success rate using the above procedure has been about 90%, compared with chip buds from dormant budsticks at about 10%.

Happy budding!!!

PECAN NUT VARIETY EVALUATION IN WESTERN AUSTRALIA

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Origins of the Pecan

Pecan nuts are native to North America. They were a staple source of protein for the North American Indians over their winters.

The first reference by European travellers to pecans was made in 1533. The name of the nut apparently derived from the Algonquin Indian tribe language and was originally pronounced "Pahkaan". French and other European influences caused a change in the pronunciation to the modern "Pecan".

Botanically the pecan was once classified as *Hicoria pecan*. However it is currently placed in the family Juglandaceae, genus *Carya*, and its botanical name is *Carya illinoensis*. Carya is derived from the Greek word Karyon, and Illinois is an area in which the nut is native.

The nuts were common along the banks of the Mississippi River in Texas and Alabama.

The indians traded the nuts with the European settlers. The first recorded export of nuts was in 1772 to England. Commercial production of pecan nuts was underway by 1880, when the nuts were fetching 10-15 cents/kilogram.

Current Research Objectives

The thrust of American research has been to breed new cultivars through cross-pollination of existing cultivars. This has been mainly concentrated in Texas at the USDA Research Station, where a prominent worker has been Louis Rosenberg.

There are now in excess of 1000 cultivars, of which 51 have known parentage, and only one parent is known for 105. With all these available cultivars evaluation standards have been established to determine those with the most market potential. A variety must possess certain characteristics, which include:

- Large size (3-5cm)
- Thin shells which promote easy shelling
- Straw coloured and plump kernel
- Bearing precocity
- Consistent bearing.

At the Stoneville Research Station near Perth, we are currently evaluating twenty cultivars, with regard to the above parameters. The trial was initiated in 1981; the trees were imported from the Eastern States.

Table 1. Pecan Nut Pollination Matrix

Variety ▼ / Pollinators →		Mahan	Mohawk	Cherokee	Kiowa	Cape Fear	W. Schley	Shoshoni	Wichita	Sioux	Tejas	Candy	Cheyanne	Sumner	Stuart	Moore	Chickasaw	Desirable	Ideal	Riverside	Burkett	Caspiana
Mahan*	+	E	E	E	G	P	E	G	E	G	G	E	P		E	P	E	P			E	
Mohawk*	+	G	E	E	P	P	E	G	E	P	G	E	P		E	P	E	P			E	
Cherokee*	+	G	E	E	P	P	E	P	E	P	P	E	P		E	P	E	P			E	
Kiowa*	+	P	G	P	P	E	P	P	P	P	P	P	E		G	E	P	E			P	
Cape Fear*	+	P	P	P	P	E	P	P	P	P	P	P	E		E	P	P	E			P	
W. Schley*	+	P	E	E	P	P	E	P	E	P	P	E	P		E	P	E	P			E	
Shoshoni*	+	P	P	P	P	E	P	P	P	P	P	P	E		P	E	P	E			P	
Wichita*	+	P	E	E	P	P	E	P	E	P	P	E	P		E	P	E	P			E	
Sioux*	+	E	P	P	E	P	P	E	P	E	E	P	P		P	P	P	P			P	
Tejas*	+	P	E	E	P	P	E	P	E	P	P	E	P		E	P	E	P			E	
Candy	+	P	E	E	P	P	E	P	E	P	P	E	P		E	P	E	P			E	
Cheyanne	+	P	E	E	P	P	E	P	E	P	P	E	P		E	P	E	P			E	
Sumner	+																					
Stuart	+	E	P	G	E	P	P	E	P	E	E	P	P		G	P	P	P			P	
Moore	+	P	E	E	P	P	E	P	E	P	P	E	P		E	P	E	P			E	
Chickasaw	+	P	E	E	P	P	E	P	E	P	P	E	P		E	P	E	P			E	
Desirable	+	P	E	E	P	P	E	P	P	E	P	E	P		E	P	E	P			E	
Ideal	+																					
Riverside	+																					
Burkett	+	P	E	E	P	P	E	P	E	P	P	E	P		E	P	E	G			E	
Caspiana	+																					

* Signifies cultivars with most potential.

Pollination legend: P=Poor compatibility; G=Good compatibility; E=Excellent compatibility

Pollination

Pollination studies on all cultivars were undertaken in 1988. These involved monitoring male catkin shedding and the female pistillate receptivity. Male catkins are borne on two year old wood. As the catkins release pollen they change colour from green to a pale yellow. Pollen shedding is initiated by the unequal drying of the catkin anther causing it to open longitudinally.

Female flowers are found on the end of the current season's growth. The stigmatic surface of the flower indicates its receptivity to male pollen by its colour. Stigmatic surfaces change from green when not receptive, through to a yellow or red tinge when receptivity is apparent. Once the flower's receptivity has passed, the stigmatic surface turns dark brown.

Pollination of pecans is only carried out by airborne pollen, and to a lesser degree gravity. Because of the lack of influence by insects, any cultivar requiring cross pollination (Table I) needs to be planted in reasonable proximity to its conjugate cultivar.

Table 1 gives a summary of cultivar cross-pollination requirements as determined from two years' data. It is at the moment purely an indicative guide, but does bring out the strongly hermaphroditic nature of a large proportion of the cultivars. This is an extremely important parameter that needs continual monitoring as it ultimately determines the numbers of each variety that need to be planted for pollination purposes.

It is also relevant in planting design. The current push in the USA is to initially plant at high density (5 m x 5 m) to increase yields per hectare in the early years. In about year twelve, when the trees have attained reasonable size and yields, every second tree is culled. If cultivars requiring cross pollination are planted into such a system without careful consideration then the pollen available could be inadequate.

In the Stoneville trial, none of the trees came into production until 1987. From Table 2 it can be seen that some cultivars, namely Shoshoni, Sioux, and Cherokee, are more precocious than others. Table 2 also shows the average numbers of nuts per kilogram for each cultivar, an important factor in cultivar evaluation, especially for those nuts to be processed prior to marketing.

Pollination requirements as noted in this table are derived from the information in Appendix A, which was also used to construct the pollination matrix in Table 1.

Table 2. Pecan Variety Evaluation Summary

	Ave Tree Yield, kg		Nuts	Pollination	Maturity	Tree
	1987	1988	per kg	Requirement	Time	Vigour
Burkett	0.8	0.6	145	A	Late May	2
Candy	0.6	1.5	201	D	Late April	3
Cape Fear*	1.9	3.9	134	A	Late May	4
Caspiana	-	0.2	123	n/a	Mid May	3
Cherokee*	2.4	4.6	130	A	Late May	4
Cheyenne	1.1	1.5	155	B	Late May	4
Chickasaw	0.4	1.2	141	A	Late May	4
Desirable	0.1	0.1		D	Late May	3
Ideal	0.6	1.5	144	B	Late May	4
Kiowa*	1. 6	4.9	121	D	Late May	4
Mahan *	1.2	1.3	83	C	Late May	3
Mohawk*	0.5	1.2	104	A	Mid May	4
Moore	-	2.5	185	C	Mid May	3
Riverside	0.1	0.1	121	B	Mid May	5
Shoshoni*	1.8	3.1	148	D	Late April	5
Sioux*	2.3	2.2	165	A	Late May	3
Stuart	0.2	0.2	107	A	Mid May	2
Sumner	0.4	0.6	133	n/a	Late May	3
Tejas*	1.1	1.8	158	A	Mid May	3
W. Schley*	0.7	1.4	147	A	Mid May	4
Wichita*	1. 7	2.8	159	A	Mid May	3

*Signifies cultivars with most potential.

Pollination requirement: A=self fertile; B=requires cross pollination, male sheds pollen before female is receptive; C=self fertile, male commences pollen release marginally before female is receptive; D=requires cross pollination, females receptive before males shed pollen.
Vigour assessment: 1=very poor; 3=average; 5=exceptionally vigorous.

It is evident that of the ten most favoured cultivars, only two - Kiowa and Shoshoni - are dichogamous (require cross-pollination). For these two, Cape Fear is the favoured pollinator. With pecans, as with hazelnuts, lack of pollination results in poor kernel filling.

It has been noted by Sharpe (1958) that six to ten leaves are required to carry a single pecan nut through from pollination to maturity. Harvesting, as distinct from maturity, commences when the husk round the nut splits. Nut maturity requires at least six weeks drying post harvest; this reduces the nut water content and increases the oil content, which improves palatability.

Nutrition and Irrigation

The formation of nuts places a nutritional drain on the tree, therefore the tree's leaves (food factory) need to be maintained at optimal nutritional status. It is a fallacy that pecans don't need nutritional supplements. As with any organism, energy is paramount in attaining its optimum performance.

Adequate fertilizer applications are needed by the tree in its first three years. This is important for physiological development to take place, thereby establishing a good root system for efficient uptake of nutrients to be applied in subsequent years.

For initial planting, soil pH should be adjusted to 6.5 and a basic mix as in Table 3 should be applied at 300 gm/sq m. Pecans also have a high affinity for both zinc and manganese, especially in their early years. These are best applied as foliar sprays during the growing season at respective rates of 1.5 g/L and 1.0 g/L. Appendix B gives an annual fertilizer regime of NPK to be applied to the soil in spring.

Table 3. Basic Fertilizer Mix

Superphosphate	50.0
Copper sulphate	1.0
Zinc sulphate	2.0
Magnesium sulphate	2.5
Manganese sulphate	2.5

Irrigation is a factor that needs to be addressed in the first few years of the trees' development.The tree naturally has a very extensive root system, developing a very deep tap root early on. This is able to adequately provide the tree with its water requirements. However it is wise to maintain irrigation on the trees as it promotes feeder roots nearer the surface, facilitating fertilizer uptake.

Cultivars

From observations on the production of trees at Stoneville Research Station in the past three years, we have begun to formulate opinions on the best ten cultivars for our conditions. Eleven cultivars were evaluated on two main rootstocks, Apache and Riverside. Of these, rootstock influence at this early stage has little significance on nut quality or yield.

MAHAN: monogamous precocious variety producing large nuts (83/kg). It was named in 1927, the only known parent being Schley. The nut has a golden brown colouring with sparse black markings extending 50% of the nut length from the calyx end. The nut is elongated and cracking the shell takes some effort, but is more than compensated for by the ease of kernel removal and flavour.

MOHAWK: another monogamous cultivar which has quite large nuts (104/kg). Parentage is from a Success-Mahan cross developed in 1965 by the USDA. The nut has a dark golden brown appearance with symmetrical striping covering 65% of the nut surface. The shell is very thin, facilitating kernel removal which constitutes approximately 60% of the nut volume. Kernel eating quality is exceptional and the meat has a deep golden colour. Nut fall occurs in mid May.

CHEROKEE: One of the most precocious cultivars, again a true hermaphrodite. Parentage is Schley x Evers. Introduced in 1971 by the USDA. The nut is quite small (l30/kg), and ovate, with a sandy-brown appearance. Kernel volume constitutes 60% of nut volume. The tree is quite vigorous and has been observed to have a slight susceptibility to wind breakage of limbs.

KIOWA: One of the more ovate nuts with a precocious bearing pattern, developed in 1976 by the USDA. Parentage of the nut is Mahan x Odum. The variety has about 121 nuts/kg and a kernel percentage of 58 %. The nut sheds late in May and is mature for consumption in mid July. Cape Fear and/or Mahan is required as a pollinator species to obtain optimum kernel filling.

CAPE FEAR: A self-fertile variety whose importance is as a pollinator variety for Kiowa. The nut is ovate and comparable to Cherokee in size, with 134 nuts/kg. Developed in 1941 in North Carolina, the variety is a Schley seedling. Colouration of the shell is sandy to dark brown. The kernel constitutes 54% of the total nut volume. Shells are moderately thin, however it is difficult to remove the kernel in one piece.

WESTERN SCHLEY: A hermaphroditic cultivar which developed from a San Saba seedling. Nuts are elongated, with very thin shells facilitating easy kernel removal. Appearance is golden-brown with very little striping on the nut. Size is medium with 147 nuts/kg, and 58% kernel.

SHOSHONI: dichogamous cultivar which requires Cape Fear as a pollinator species. The variety is precocious and the tree is reasonably vigorous, but is slightly susceptible to limb breakage. It was released in 1972 by USDA and is the offspring of Odum X Evers. Nuts are ovoid and moderately small, comprising 148/kg. The shell is easily broken enhancing kernel removal. The nut has a sweet well balanced taste with a kernel volume of 54%.

WICHITA: A monogamous cultivar which is reasonably precocious. Released in 19S9 from the USDA, the cultivar is a result of a Halber x Mahan cross. The nut is elongated with a slight arch perpendicular to the suture line and a marked point at the calyx end. Golden brown in appearance, the nuts are of a good size but have a low kernel volume of 50%.

SIOUX: A monogamous cultivar which is a Schley x Carmichael cross released in 1962 by the USDA. The nut is a deep golden brown with an ovate shape and protruding tip point. The shell is moderately thin and kernel removal is reasonably easy. Nut size is quite small with 165/kg, but the percentage kernel is high at 61 %, making the effort in deshelling worthwhile. The tree is reasonably vigorous, naturally developing good crotch angles.

TEJAS: Mahan X Risien offspring which was released in 1973. The nuts are elongated with a sandy-brown colouring and very little striping. The shell is moderately thick but once again kernel removal is not too difficult. Nut size is moderate with 158/kg, however the kernel has a high volume as compared to that of the nut (56%). Tree growth is quite vigorous with large leaves and the branches form reasonable crotches.

The varieties described are the best ten from those being evaluated at Stoneville. In the selection of these cultivars, emphasis has been placed mainly on bearing precocity, nut size and shell cracking. As nut volumes increase then market appraisal will be sought to accurately tabulate the likely returns to growers.

Marketing

At the moment the marketing system for pecan nuts is very fragmented. This is because of two factors:

(1) lack of nuts that are currently being produced in WA, which doesn't allow for the establishment of a consolidated marketing force, and

(2) lack of market volume from W A and overseas limits the exposure of pecans to the public.

As pecans become promoted and in particular people become exposed to the several varieties available, then they will become accepted for their culinary value as well as fresh nut eating qualities.

There are three major outlets available for the marketing of nut crops. These are Natural Product Importers, Compass Trading and Roberts & Beck. According to personnel at Roberts & Beck, the market price to growers in W A is currently between $5.50 and $6.60 per kilogram for unshelled nuts.

They have indicated that the public prefer the shelled nuts which are currently imported from California and are being landed here in Perth for $7.75 per kilogram. It seems that the only way that W A producers could compete with these prices is to form a grower cooperative which would purchase the dehusking and shelling plant and contract itself to growers. Costings for such a plant are given in Table 4 .

Another by-product from pecan trees is the wood, for use in the meat smoking industry. As a member of the hickory family, pecan wood is a premium source of smoking material. Indications from MBL Australia are that there is a large demand for the wood chips, and they are prepared to pay a minimum of $1.00 per kilogram.

Table 4: Capital Items for establishing a Processing Plant

Item	*Cost ($)*	*Life (yr)*
Cleaner	20,000	20
Cracker	6,000 each	20
Sheller	25,000	20
Air Separator	30,000	20
Sundry elevators	6,000	20
Electricals	10,000	20
Packing Shed	25,000	20
Cool Room	15,000	20
Forklift	15,000	10

Conclusions

From the information available and our observations at Stoneville Research Station we have concluded that it is advisable to graft known scion material onto a known rootstock to ensure optimum tree performance. The most appropriate cultivars to use as scion material are Mahan, Mohawk, Cherokee, Kiowa, and Sioux. Of these Mohawk is best suited to those areas with short growing periods. This, as indicated by Appendix C, is because of it having a two week advantage in respect to fruit development period.

Another point to note when comparing cultivars from the USA is that the Australian climatic environment- such as that at Stoneville Research Station - can dramatically alter the plants' flowering habit. This problem has shown itself with several cultivars at Stoneville, one of these being Candy, which is classified as protogynous (female flowers first) in the USA, but is protandrous at Stoneville.

In summary, it may be said that pecan nuts do have a place in West Australian horticulture. However, anyone contemplating cultivating them should be aware of the fact that they have a bearing delay of 6 years, and don't reach maximum production until year 20.

Appendix A. Flower Characteristics of Pecan Varieties at Stoneville

Variety	Vigour	RS		RS		RS		RS	
		Female		Male		Female		Male	
		Burst	Receptive	Burst	Dispersing	Burst	Receptive	Burst	Dispersing
Burkett	2	4.11	17-21.11	30.10	16-18.11	-	-	18.10	16-18.11
Candy	3	10.11	17-21.11	10.11	21-23.11	29.10	18-23.11	20.10	17-19.11
Cape Fear	4	4.11	9-14.11	7.11	9-14.11	3.11	9-16.11	10.10	9-12.11
Caspiana	3	8.11	-	-	-	-	-	-	-
Cherokee	4	4.11	17-21.11	29.10	16-20.11	29.10	7-13.11	18.10	16-20.11
Cheyanne	4	29.10	16-18.11	20.10	9-17.11	30.10	9-21.11	15.10	7-16.11
Chickasaw	4	10.11	17-23.11	20.10	17-21.11	20.10	3-16.11	20.10	17-21.11
Desirable	3	29.10	14-16.11	29.10	16-18.11	7.11	7-13.11	18.10	16-18.11
Ideal	4	-	-	-	-	-	-	30.10	18-21.11
Kiowa	4	29.10	9-16.11	20.10	21-25.11	28.10	7-21.11	23.10	16-21.11
Mahan	3	4.11	17-21.11	9.11	21-25.11	4.11	14-19.11	20.10	15-20.11
Mohawk	4	4.11	17-23.11	15.10	16-21.11	7.11	17-23.11	15.11	23.11
Moore	3	10.11	-	-	16.11	3.11	16-24.11	15.10	16-21.11
Riverside	5	30.10	17-21.11	-	-	-	-	24.10	16-21.11
Shoshoni	5	4.11	9-13.11	20.10	21-23.11	25.10	7-12.11	18.10	21-23.11
Sioux	3	25.10	21-23.11	22.10	21-24.11	1.11	21-23.11	22.10	21.11
Stuart	2	10.11	21-27.11	29.10	16.11	7.11	14-16.11	20.10	14-16.11
Success	2	29.10	16-20.11	30.10	17-21.11	3.11	25-28.11	20.10	17-21.11
Sumner	3	4.11	-	29.10	-	-	-	26.10	-
Tejas	3	7.11	15-20.11	20.10	16-21.11	4.11	16-18.11	15.10	19-21.11
W. Schley	4	4.11	16-24.11	20.10	16-20.11	4.11	9-14.11	20.10	14-19.11
Wichita	3	4.11	17-21.11	15.10	17-21.11	29.10	21-23.11	15.10	17-23.11

Appendix B. Basic Fertilizer Regime

Tree Age (yr)	NPK Blue (Kg/tree)	DAP (Kg/tree)
1	0.6	0.3
2	0.8	0.7
3	0.8	0.7
4	1.8	1.0
5	1.8	1.0
6	2.0	1.5
7	2.2	1.8
8-10	2.5	2.0

Appendix C: Fruit Development Period (days) for various Varieties

Burkett	-	Chickasaw	160	Moore	171	Sumner	171
Candy	150	Desirable	184	Riverside	174	Tejas	171
Cape Fear	182	Ideal	182	Shoshoni	170	W. Schley	174
Cherokee	174	Kiowa	183	Sioux	174	Wichita	179
Cheyenne	171	Mohawk	156	Stuart	171		

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SOME HIMALAYAN WILD FRUITS
WORTH TRIAL ELSEWHERE

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There are thousands of wild growing plants all over the world bearing edible fruits of acceptable quality. The fruits of some of such plants like the lingonberry of Sweden, the quandong of Australia, and daru (a wild pomegranate) of India, are even marketed on a big scale like commercial fruits. In the case of some plants like wild amla (*Emblica officinalis* Gaertn.) of India, the demand is always more than the supply.

A strong need is being felt by fruit growers throughout the world for diversification into new crops as the traditional fruit crops are under severe pressure due to increasing production and declining profits. Wild fruits can be an excellent source for the choice of species for trial as new commercial crops. Kiwifruit is a good example of promotion of a wild fruit as a new commercial fruit crop.

The mid-Himalayan region of Pakistan, India, Nepal, and Bhutan has many wild growing plants bearing edible fruits. Parmar and Kaushal (1982) have studied the characteristics of26 such plants and have proposed the organized cultivation of a few of these wild plants as orchard plants or multipurpose tree species.

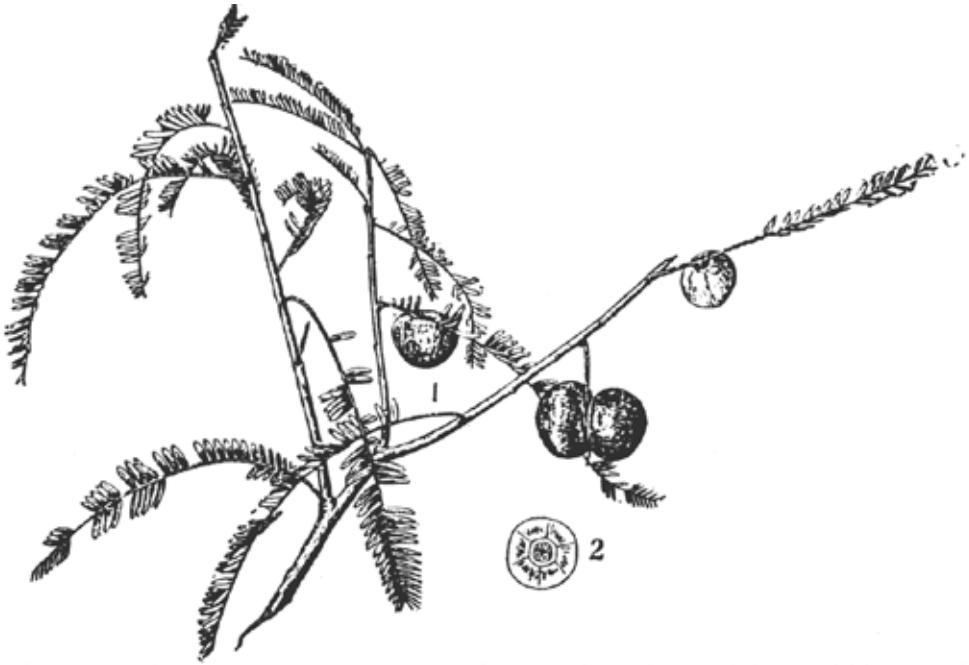
The region varies in altitude from 800 to 1800m and has a subtemperate climate resembling that of most countries in Southern Europe. The region is cold for mandarins and warm for Delicious apples. The usual fruit crops of the area are peach, apricot, plum, almond, Japanese persimmon, walnut etc.

It is felt by the author on the basis of his experience in some European countries that the following Himalayan wild fruits may be able to grow there. These fruits should therefore be introduced for trial as new fruit crops.

Kaphal (*Myrica nagi* Thunb.): This is an evergreen tree growing in the forests. It is found throughout the mid-Himalayas at altitudes ranging between 1300 and 2100m. It bears small seedy fruits, deep red to purple at maturity, which are very tasty. The fruits sell in retail at a price almost twice that of mango or apple.

Kaphal is a medium to large tree attaining a height up to 15m. This plant grows wild in the forests and wastelands only, and so far no attempt has been made to domesticate it. The population of kaphal trees is declining every year due to deforestation and reclamation of wastelands. The fruits are picked by the villagers during the season and sold in the markets of the neighbouring hill towns.

Kaphal is a slow growing tree and can only be propagated through seed. Attempts for its asexual propagation through cuttings, even under mist, have been futile.



Emblica officinalis [From: J J Ochse, Indische Vruchten]

Wild fig (*Ficus palmata* Forsk.): This is a very commonly occurring wild plant in the Himalayas up to an elevation of 1550m. Surprisingly, the trees of this wild plant are rarely seen in the forests. They mostly grow around the villages in the wastelands and in the cultivated fields.

Wild fig of the Himalayas has almost the same quality as the superior cultivated type of the mediterranean region. The fruits are, however, smaller in size. As the cultivated fig (Ficus carica L.) cannot be grown in all places due to its very exacting climatic requirements, the Himalayan wild fig may prove to be a suitable alternative to this fruit.

The wild fig tree can grow and bear fruits even in colder places experiencing high rainfall at the time of fruit ripening. It is a deciduous tree having a height of 6-10m. The new growth and flowering start in March, and the fruits start ripening from the second fortnight of June and continue to do so till the middle of July. There is a great variation among wild plants regarding yield and fruit quality but still a plant produces 20-25 kg of fruit during one season.

Besides the fruit, the newly emerging leaves and very young fruits are used as a vegetable in India. The fruits are about 2.5 cm in diameter and weigh about 6g each. Trees bearing even larger fruits are also met with. The fruits have an excellent taste .

The TSS (total soluble solids) content is 12.1 %. The ripe fruits are quite juicy. The juice can easily be extracted by hand pressing. One kg of fruit yields about 450 ml of juice. This wild fruit can be propagated both by seed and by cuttings.

Wild Himalayan Amla (*Emblica officinalis* Gaertn.): Amla is a fruit of Indian origin and grows mostly in tropical parts. It is cultivated for its fruits, which have a very high vitamin C content. This ranges between 1100 and 1700 mg per 100g. No other fruit except the Barbados cherry (*Malpighia glabra* L.) is known to have so much vitamin C.

The amla fruits are always in great demand. The wild amla is a form of the superior cultivated amla. It grows wild, mostly in the forests, in the mid-hill regions of the Himalayas which have a subtemperate climate. The cultivated amla cannot be grown in all places as it is highly susceptible to frost. The Himalayan wild amla, on the other hand, is a relatively cold hardy plant.

Some of the places where it is seen growing even experience light snowfall. This wild fruit can therefore be used for extending the cultivation of the tropical amla even to subtemperate regions.

The Himalayan wild amla is a small to medium sized tree attaining a height up to 5.5m. This is a very ornamental plant, especially when the branches are laden with fruits. The fruits are 2 to 2.5 cm in diameter and weigh about 6g each. There is, however, considerable variation in the fruit size of different trees and it is possible to select clones with relatively larger fruits. The fruits of the cultivated amla are larger in size, but except for the size, there is no other difference between the fruits of the Himalayan wild amla and the cultivated amla of the Indian plains.

The wild Himalayan amla can be propagated by seed. Asexual propagation is carried out by inarching. As this wild fruit tree is very ornamental, it is also ideally suited for planting as an avenue tree.

Ghain (*Elaeagnus umbellata* Thunb.): This is a deciduous shrub growing wild in the forests at altitudes ranging between 1200 and 2100m. It attains a height up to 3.5m. The young shoots and branches of this wild plant are clothed with white scales, imparting a very attractive silvery appearance. These scales, however, disappear later with the commencement of the rains.

The ghain bears small pink fruits which are very good to eat. The fruits are offered for sale at many places. These measure 3-9 mm in length and about 5 mm in diameter. They start ripening from the middle of July and continue to do so till the middle of August. Each fruit weighs around 135 mg. The fruits of ghain are a fine blend of sweet and sour and have a very good taste. Their TSS content is 14.5%. They contain 8.3% sugars and 1.5% acid. This fruit is very rich in protein, containing 4.47% of it.

This plant can be multiplied by seed. The shrub of ghain is quite attractive. It is thorny too. It can therefore also be utilized for planting as a protective hedge around fields or gardens.

Daru (*Punica* sp.): This is a kind of pomegranate which grows wild in very large numbers in the forests and wastelands throughout the mid- Himalayan region. Sharma, after a detailed comparison of this wild plant with the cultivated pomegranate, is of the view that this wild fruit should be designated as a separate species of the genus *Punica*. As the acid content of the fleshy seeds of wild pomegranate is quite high (5.5%), these taste sour even though they also contain 10.1 % sugars. The juice also contains 36 mg of vitamin C per 100 ml.

The fruits of daru are not consumed fresh like the cultivated pomegranate due to the excessive acid content. The fleshy seeds are taken out and then dried in the sun. The finished product is called anardana (*anar* (Hindi)=pomegranate, *dana*=grain). It is used in a number of ways as a souring agent for various food preparations throughout India.

Some Elaeagnus species. L:E. argentea; R: E. umbellata [From: N D Neterovich, Plody i Semena Listvennykh Drevesnykh Rastenii]

Every household buys a quantity of anardana during the season for meeting its annual requirements. It is reported to have a cooling effect on the body and a mixture of anardana, sugar and aniseed (*Pimpinella anisium* L.), ground together, is prescribed to those who lose appetite after long fevers or after taking a large dose of allopathic medicines, particularly the antibiotics.

The rind of daru yields a fast yellow dye, which is used for dyeing cloth and also for making hair dye. The rind is also used in the tanning of leather. The rind of this wild fruit is also a commercial commodity and traded like anardana.

Daru is a deciduous tree attaining a height up to 10m depending upon the soil. The new spring growth is pigmented, and the trees look quite ornamental due to this during the spring. The flowers start appearing after about four weeks and are also very attractive. The fruits of daru are about 80 grams each and are thus much smaller than the cultivated pomegranate. There, however, exists a large variation in fruit size and quality among the wild plants which offers scope for the selection of superior clones.

New plants of daru can be raised by seed as well as by cuttings. This is a very hardy plant and can grow even on very poor soils. Daru trees can also be planted on wastelands for afforestation. This plant can also act as a very good avenue tree because of the pigmented foliage in the early growing season and a long blooming season of attractive flowers.

In view of the utility and potential of these wild growing plants, a project is soon going to be taken up for the domestication of these fruits by our Department of Fruit Breeding & Genetic Resources.

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[Based on an article in *Chronica Horticulturae*, June 1991]

[Ed. note: see also http://www.fruitipedia.com/]

THE BUNYA - AN AUSTRALIAN NUT WITH OUTSTANDING POTENTIAL

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Introduction

The Bunya Pine, a native of Queensland, Australia, is one of the most interesting and prospective nut tree species in the world. This tall, stately tree in the southern-hemisphere Monkey-puzzle family, the Araucariaceae, is steeped in history at both the geological and human levels.

The bunya makes a striking landscape specimen, and produces excellent softwood timber. It is also the source of a useful resin. But its main present interest is in its valuable nuts.

Produced in a huge cone, weighing up to 20 kilograms, the large nuts have a leathery fawn outer skin, similar in texture to that of a chestnut. In flavour they have been described as a cross between a chestnut and a pine nut (from *Pinus pinea*, the Stone Pine of Europe).

Although most of the Araucarias apparently evolved under the high-rainfall conditions where they still do best, the Bunya had a rather harder time, and was subjected to occasional droughts. Because of this it has produced a range of germination and self-propagation mechanisms which are matched by no other tree known to me.

The Tree

The Bunya Pine grows into a very tall evergreen tree (45 metres), normally with a single straight central stem and a very characteristic symmetrical dome or beehive shape (Fig. 1). The foliage is clumped towards the ends of the branches. The foliage may be quite dense, although in harder conditions it tends to become more open and sparse, but the characteristic top profile is retained.

There is always a single stem unless the tree has been damaged in some way during growth, when twin, fairly parallel stems may grow up from the point of damage. Strong apical dominance will overcome minor damage, so that if the top of the growing stem is cut off, usually two new shoots will emerge but one will eventually take over.

The branches of the tree are hose-like and quite different in nature to the stem wood. As the tree matures, lower branches tend to be shed, and the tree may be left with a clear trunk to half its height or more.

The leaves are basically triangular. On very young trees the leaves are longer (5-7 cm) and more lance-shaped, on older and thicker branches they tend more towards triangular scales pressed against the wood. All the leaves are quite spiky. They do not usually fall singly, instead ends of branches, or whole branches, may be shed.

§ Member, WANATCA

The bark is notably thick, and in mature trees takes on a somewhat horizontally banded appearance which is also very characteristic of the Araucarias. The excellent timber, very similar to that of its relative the Hoop Pine (*Araucaria cunninghamii*), is used for flooring, linings, boxes, and some construction and cabinet work. A detailed description of the tree can be found in Francis [1970].

Fig. 1. Bunya Pine in a Perth Park

The Bunya has separate male and female flowers on the same tree. However, in common with many conifers, male and female flowers tend to appear at different stages of the tree's life. Usually male flowers appear fIrst. Then, in middle age, female flowers appear too, and the tree commences fruiting. In old age the tree will continue to fruit, but the number of male flowers produced will diminish.

The male flowers are rope-like pendulous catkins, up to 20 cm long, and the female flowers are the fruiting cones. The cones take three years to develop, and cross-pollination is not required. Male and female flowers also tend to appear on different parts of the tree, with female cones near the top, and males nearer the middle of the foliage.

The Fruit

Bunya nuts are contained in a giant fruiting body, the cone, which may weigh as much as 20 kilograms and be more than 30 cm long and 20 cm across. The cones are built on the typical pine-cone plan, but are quite rounded and each scale is very large (Fig. 2). The scales at the top and bottom of the cone tend to be empty, with only a flattened or vestigial seed, but most of the central scales will contain a single large nut, 5-7 cm long.

The nuts can be 'popped' easily out of their scales, like a tablet from a medicine pack. They have a buff to fawn coloured leathery skin which is quite tough, but can be cut with a sharp knife. Inside is the large starchy kernel, the same shape as the shell, and a loose thin red papery cover which usually adheres to the inside of the shell.

If cut across with a knife, the cream-coloured kernel flesh is seen to include a light greenish yellow section at the centre, which is the embryo. The kernels can be eaten raw; they are quite pleasant, with a flavour somewhere between that of a chestnut and a European pine nut.

However, as is typical of starchy nuts, flavour is improved by cooking. The easiest way is to slit the skin of the nuts and boil them. They can also be roasted like chestnuts, and are excellent if deep-fried like small potatoes. If microwaved without adequate water, they will blacken and char - they have appreciable sugar content.

Bunya nuts could certainly be used as stuffing, and some Australian cookery books include recipes for bunya sauces or soups (e.g. Evans [1986]). A particularly good book in this regard is Jan Sked's Wild Food Cookbook [1985], which has a wealth of bunya recipes of every sort.

A most interesting gourmet product which I feel has real commercial possibilities is the bunya equivalent of marron glacé, made from high-quality chestnuts. In 1988 a Perth student [Morcombe, 1988] carried out a research project on bunya glacé, which established the possibility of producing an acceptable product.

Bunya nuts have a limited storage life of 4-8 weeks, like chestnuts, unless kept under refrigeration. As the kernels break down, the meat changes to a greyish white colour, and a consistency similar to crumbly dry putty.

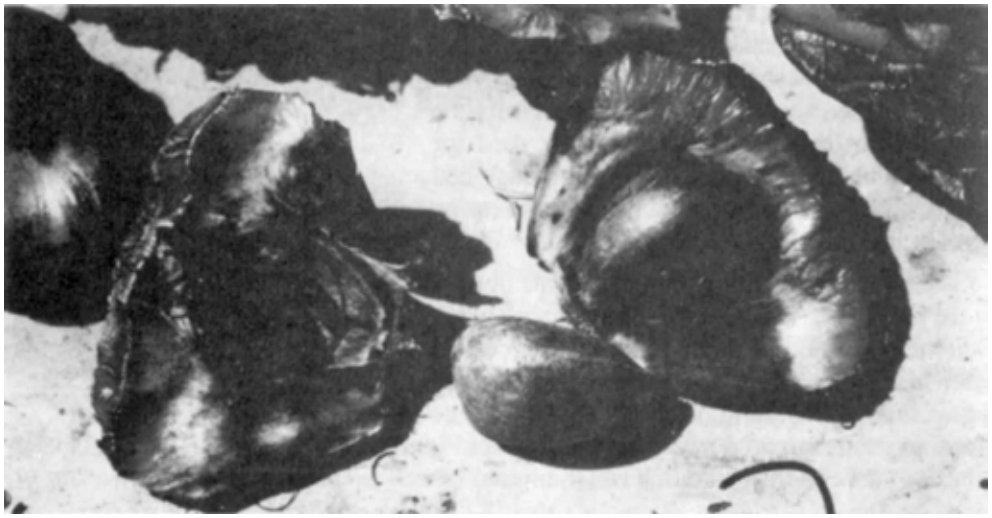

Fig. 2. Bunya nuts and cone scales

Distribution and Botany

The Bunya Pine, *Araucaria* bidwillii, is one of about 19 species in the genus *Araucaria*, which is one of the two genera in the family *Araucaria*ceae (the other is *Agathis*, as in the New Zealand Kauri Pine). Distribution of the genus and the family is confined within a South Pacific 'circle' which has South America and eastern Australia as its east-west limits, and the Philippines as its northern boundary.

The *Araucaria* species fall clearly into three sections. All except 3 species are in sections where the members have narrow or needle-like leaves and small seeds (too small to be of edible interest), with the seeds on winged cone-scales. Perhaps the best-known member is the Norfolk Island Pine, *Araucaria heterophylla*, widely used as a landscape and tub tree in warmer climates. All these species, and their *Agathis* relatives, are confined to the western Pacific part of the distribution.

The remaining 3 species are the ones which interest us. All have good large edible nuts, all have wide leaves with prickly points. Young trees of the three species are difficult to tell apart. However, the mature growth habits differ.

The characteristic beehive shape of the Bunya has already been mentioned. Its two very close relatives are found in South America. In central-south Chile the Monkey Puzzle or Chile Pine, *Araucaria araucana*, is native. Both parts of the botanical name come from that of a Chilean tribe of Indians.

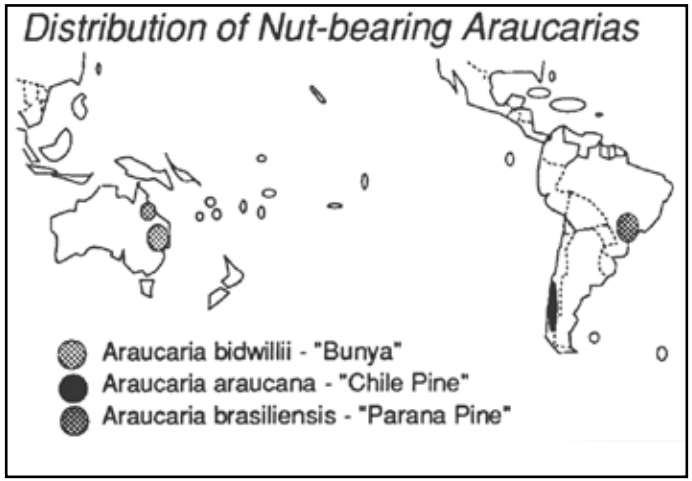

Fig. 3. Distributions of the nut-bearing Araucarias

The Monkey Puzzle is also a common European landscape specimen, much favoured in Victorian Britain. It is easily the most cold-hardy of the Araucarias, quite able to withstand prolonged snow. Specimens, are to be found growing in Aberdeen and on the island of Skye, both in northern Scotland.

The Monkey Puzzle is similar to the Bunya in mature growth habit, however the ropy limbs are much more contorted and intertwined (supposedly, enough to 'puzzle a monkey'), and the shape is often not as symmetrical. Nuts of *A. araucana* are narrower and a little shorter than those of the Bunya, but are otherwise similar in flavour and use, being a staple item in the local Chilean native diet.

The last species, the Paraná Pine or Candelabra Tree of southern Brazil and adjacent Argentina, is also the source of edible nuts used by the local native and European populations. These nuts are usually narrower than the Bunya nuts but are almost as long. Botanically *Araucaria angustifolia* (or *A. brasiliensis*), the tree is native to the Paraná Mountains south of São Paulo (see Fig.3).The mature growth habit of this species is very distinctive. Typically, all lower branches are shed as the tree matures, leaving a single 'whorl' of branches and the growing tip, very much like an umbrella - hence the alternative common name.

Both South American species have fine timber. That of the Paraná Pine is particularly notable for the brilliant red veins which often extend through the yellowish-white wood.

The Bunya Pine itself is found in the Bunya Mountains of southern Queensland. Most of the trees are now within the Bunya Mountains National Park. Visitors are allowed to collect nuts on payment of a small fee per cone. In a surprising event in 1947, a second tiny and isolated native occurrence of this tree was found on Mount Molloy, near Cairns in northern Queensland - over 1000 km away.

Geological History

The three nut-bearing Araucarias are clearly closely related, but are currently widely separated on opposite sides of the Pacific, almost a third of the way around the Earth. As close relatives, they must, in the geological past, have had common ancestors in a single area. The question arises as to how the modern distributions of these species have become so distantly separated. All three species are typical of inland mountains, with heavy seeds which could not be carried thousands of kilometres by birds, or withstand months of drifting in ocean currents.

In fact these distributions are one of the keys to an important realization, that the Earth is expanding over geological time, and that it is this expansion which has opened up the Pacific and spread apart the previously continuous distribution of the Araucaria ancestors. This concept, which is dealt with in my book *Nuteeriat* [Noël, 1989], is in fact confirmed by a host of plant family distributions across the Pacific and other areas, but the Araucaria example is a particularly clear one.

Of course the expansion involved is quite small - only around 20 cm or so per year over the whole 40,000 km circumference of the Earth - but it has been going on a long time. It appears that the Pacific Ocean itself was created by expansion during the last 200 million years, as all the rocks on the bed of the Pacific are younger than this.

Human History

As in South America, in Australia the Araucaria nuts were a very important part of the native diet before the advent of European settlers. More than just a food, the Bunya nuts were one of main factors in trade and social customs of the tribes of eastern Australia.

Maiden [1975] gives a good description of the relationship of the Australian aboriginals with the Bunya. Here is his quote from Hill:

"The cones shed their seeds, which are two to two and a-half inches long by three-quarters of an inch broad; they are sweet before being perfectly ripe, and after that resemble roasted chestnuts in taste. They are plentiful once in three years, and when the ripening season arrives, which is generally in the month of January, the aboriginals assemble in large numbers from a great distance around, and feast on them.

"Each tribe has its own particular set of trees, and of these each family has a certain number allotted, which are handed down from generation to generation with great exactness. The bunya is remarkable as being the only hereditary property which any of the aborigines are known to possess, and it is therefore protected by law.

"The food seems to have a fattening effect on the aborigines, and they eat large quantities of it after roasting it at the fire. Contrary to their usual habits, they sometimes store up the bunya nuts, hiding them in a water-hole for a month or two. Here they germinate, and become offensive to a white man's palate, but they are considered by the blacks to have acquired an improved flavour".

Maiden also quotes a Dr Bennett as saying that after the aboriginals' indulgence in this exclusively vegetable diet, they had an irresistible longing for flesh, and in order to satisfy that craving, cannibalism used to be frequent among the tribes visiting the bunya grounds!

This does, however, conflict with other writers, who have said that a truce was declared in all tribal wars and disputes during the bunya harvest. Certainly the tribes would come in from hundreds of kilometres away, and not just to eat, but for all sorts of festivities - a sort of Aboriginal Olympics.

Germination of the Bunya

When the bunya cones fall from the tree, they are usually slightly soft and may break into two or more pieces when they strike the ground. Under normal conditions the cone scales are quite fleshy and moist, and the cone soon falls apart completely, leaving the nuts, still inside their scale coverings, to be scattered around in the undergrowth by investigating animals and people.

The nuts soon germinate, but in a remarkable way. Out of the point of each nut, a shoot grows, which dives down through any leaf litter and enters the ground. Under the surface of the soil, a second oval 'nut' forms (Fig. A), with a brown skin and a thin tail.

This 'after-nut' is a very unusual formation, and I am not sure of its true botanical term. It has been called a lignotuber, but that term implies it is a woody formation, which the after nut is not. Instead, it is a crisp and edible structure, with a good flavour resembling coconut.

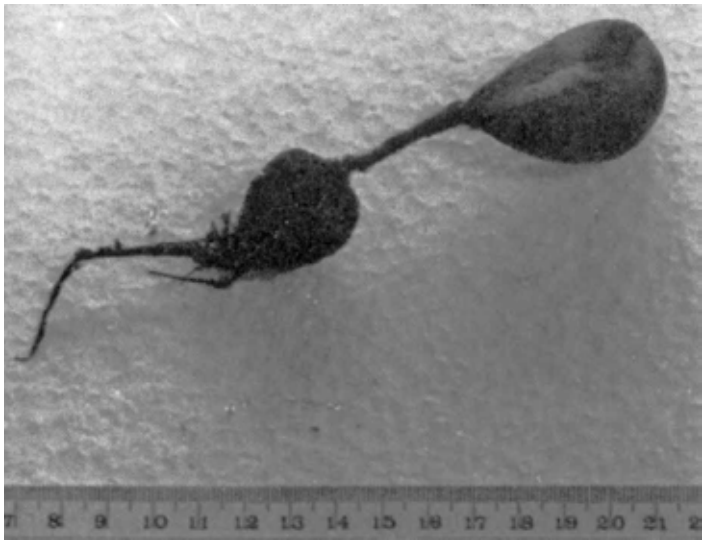

Fig. 4. Germinating Bunya nut and after nut.

I suspect that this 'after-nut' is the origin of the aboriginal practice of burying bunya nuts in mud for later retrieval, as described by Maiden above. The normal nut does not stay wholesome long, but breaks down within a few weeks to the dried-putty state and a disagreeable flavour which would certainly be described as "offensive to a white man's palate".

What happens to the after-nut, once it has been formed from the original nut's frantic dive, depends entirely on the weather and soil conditions at the time. If the conditions are dry, or very cold, the after-nut will just sit there, month after month. It retains viability and edibility for a long time. As well as thus being suitable for aboriginal food reserves, this also makes it a good modem distribution medium, as the after-nuts can be surface-mailed around the world and still arrive with a good chance of germinating.

If the conditions for growth are good, the after-nut will germinate immediately, sending up the first true stalk from its apex. If conditions are bad, the after-nut will wait until they improve. By this time, the original nut may have rotted away completely, or have dried up and blown away.

The Bunya has yet another mechanism for coping with hard conditions at the time of fruit drop. As the cones take three years to mature, the tree cannot 'plan ahead' that long, and must do its best with what happens closer to the time. If it happens that fruit drop will occur in a time of drought, another intricate mechanism comes into play.

What happens then is that the outer skin of the whole cone becomes dry and all the outer scale surfaces are more or less fused together. The cone falls and is hard enough to stay completely whole on the ground. Within the cone, there is still considerable moisture, and this is enough to set germination of the nuts into motion (Fig. 5).

Fig. 5. In-cone germination of bunya nuts

Out of each of these nuts, the usual shoot forms, and on this appears the usual after-nut but in this case, in the inner core of the cone, which has by then become soft and pulpy. In this case, the whole dry cone can sit on the ground until the rains come, when it will fall apart, releasing the after-nuts to germinate and grow. Such a sophisticated and complex set of germination mechanisms is probably unmatched anywhere else in the plant kingdom.

Commercial Propagation

Almost all propagation of bunya pine to date has been from seed. A typical method is to deep-sow the seeds under a mixture of soil and pine sawdust, and pot on individual plants when the emerging shoot has reached around 15 cm in height. This emergence has been described as "slow and erratic" [Queco, 1975], and we can see the reason for its erratic nature in the complex sequence of action needed for true shoot development.

Nuts can also be germinated in a bin of damp sawdust, or any other similar medium. I once mislaid a large plastic bag which I had filled with bunya cones, and did not come across

it, in a comer of a shed, until two years later. Many of the nuts had formed after-nuts, and some had also formed true shoots up to 30 cm long, snaking through the cone debris and around in the bag. All these, surviving for two years without any water or soil, were planted out without difficulty.

Propagation by budding and grafting is also possible, and is obviously the route to improved and early - bearing varieties. However, again there is an unusual feature of the bunya family, shared with the Abies family of northern-hemisphere firs, which must always be kept in mind.

Basically, dormant buds on the bunya bark are of two quite distinct types, called orthotropic and plagiotropic. Orthotropic buds appear only on the main, central stem, and it is only these which can give rise to upright stem growth. Plagiotropic buds appear on the branches, and these can only give rise to branch extensions. A good description of this matter and of some grafting techniques used appears in Queco [1975].

For this reason, it is essential to choose propagating material from the correct part of the plant. For example, cuttings of bunya can be rooted, but if the original cutting material was from a branch, the resulting 'tree' will only be a long, sprawling branch.

On the other hand, this feature has been used in Hoop Pine to provide an early pollen source. Female flowers appear on the new-growth branches, around two years old, normally at the top of the tree, while male flowers appear on older branches, from six years old. A graft from a 'male-condition' branch has been placed on the top of a relatively young seedling, and has produced pollen in one year rather than six.

Patch budding, whip and tongue grafting, wedge grafting, and a special terminal side graft technique [Queco, 1975] have all been used successfully. However, both stock and scion should still contain chlorophyll - but in this species the wood may be several years old and still green.

To propagate normal specimens from a mature tree, the only suitable material usually available is from the current central leader, which may be 40 metres up at the very top of a prickly tree. Innovative Australian foresters have sometimes been able to collect such material with accurate rifle shots from the ground. Occasionally, on a huge mature tree, nodules develop on old lenticels near the base of the tree, and these may give rise to orthotropic shoots which would be suitable. It may be possible to purposely induce such nodules and shoots through suitable hormone applications .

It is also possible to graft other Araucaria species onto bunya. About a year ago I got a propagator friend to graft pieces of Paraná Pine (*A. angustifolia*) onto some bunya stocks [Noël, 1991]. Both have grown strongly and developed normally (see Fig. 6).

Culture

Only in its native area in Queensland has the Bunya been commercially propagated, and then only as a timber tree forming part of general forestry stock. In other parts of the world, the trees have generally been grown as specimens, often in public parks. Experience in growing the trees commercially for nuts has therefore been almost negligible.

Generally speaking, the bunya is a hardy tree which is not hard to grow. It certainly responds well to fertilizer and water, grows in sand or in heavy soils, and under good conditions can grow at a metre a year. While not an arid-country tree, once established it can withstand quite long droughts with equanimity. At a bush property in the hills south of Perth, where a summer of several months with no effective rain is quite common, I have a lot of bunyas well

established. They were watered once at planting and not since.

Bunyas do not normally fruit until they are around 15 years old, again a common feature for a tree which has never been selected for fruiting. Undoubtedly early-bearing, faster growing varieties could be selected. Many people are reluctant to plant bunyas in their gardens because of the potentially large tree size, perceived danger from falling cones, and the nuisance of the prickly leaves. Personally, I do not see the hazard as much different from that in living among coconuts, as so many do in the tropics. In Perth, bunyas in public parks are harvested just before their natural fall in late summer.

Fig. 6. Paraná Pine grafted onto Bunya. The arrow indicates the grafting tape.

Again, almost nothing is known about nutritional requirements. I remember reading somewhere that the trees have a need for manganese, but cannot trace this reference.

In contrast to the bunya, I have found that seedlings of Paraná and Monkey Puzzle are more tricky to raise. Both these species are subject to sudden death while still only 20-60 cm tall, for a reason I have not been able to discover. The problem seems worse in warmer climates, and may be due either to a pathogen, or to a lack of something they are used to in their native soil. The answer, from the nut production viewpoint, may be to graft these trees onto hardy bunya rootstock.

Potential Production Areas Experience from specimen plantings shows that bunyas will grow over a wide range of climatic conditions. They are native to both north and south Queensland, in typical tropical and sub-tropical conditions. In Singapore Botanic Gardens, right in the low land tropics, there is a fine bunya growing, though I understand it has not fruited

Yet bunyas grow well in the coldest parts of W A, in typical apple country - near Manjimup, inland in Southwest W A, trees approaching 100 years old can be seen. In my bush planting, also in typical apple country, no signs at all of any frost damage have been seen on the bunyas, or on my two paraná pines. Even in much colder conditions, where snow is common, it may be possible to establish commercial plantings, based on monkey puzzle rootstock - as mentioned, some Araucarias seem to be better under colder conditions.

Conclusions

I know of no tree with the same inherent interest, extending over botany, geological history, and human history, as the bunya. At the same time, it and its close relatives among the Araucarias have outstanding potential in the development of commercial nut crops. While it is true that such development is only at its earliest beginnings, there is no basic sales barrier to overcome, as nuts from unselected trees are eagerly bought whenever available, by those who know them.

This potential, together with the existing established market for the valuable timber, must make the bunya a candidate to be considered as the second native Australian plant to fill a place in the world's food supply.

Video Presentation

This paper follows on a 20-minute video presentation on the bunya which I made for the 1990 Annual Meeting of the Northern Nut Growers Association in Lincoln, Nebraska. Copies [Noel, 1990] are available from the Tree Crops Centre.

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THE DESERT WALNUT - *OWENIA RETICULATA*

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Up in the Pilbara area of Western Australia there grows a native nut tree which is one of the traditional food sources of the aboriginals. This is the TURTUJARTI tree, sometimes known as the Desert Walnut. Its botanical name is *Owenia reticulata* .

This unique tree, with many uses and a special language of its own, grows up to 9 metres with a spread of 3 metres; it is twisted and scaly with a large canopy. The spot where one is growing is ideal for a campsite, especially if you are thirsty, because the trees grow where they can find water, be it rain or underground.

The Desert Walnut's large purple globular fruits are covered by an outer skin that, when shed, reveals the nut inside. Unripe, this is called *Ngijirrimpil*; ripe, *Karnka*. The large kernel is known as *Makaly* and the small, *Kurripita*. These can be roasted in the hot coals of a big fire (*Yakun*), stirred continuously with a wooden spade (*Marralal*).

The Desert Walnut of the Pilbara

While the nuts are roasting they appear to talk, as the shells crack, making many different sounds. Rocks found near camp sites have a hollow appearance from continuous beating to crack open the nuts. When cracked the nuts reveal, in most cases, two peanut-sized kernels inside.

Cutting the bark reveals a sap-like liquid not unlike golden syrup, known as *Marnta*, which, upon crystallizing, takes on a salty taste.

Dead trees make excellent firewood but check them beforehand for an edible grub called *Pirrapirra* which lives under the bark.

If you happen to get cut or burnt, a rub with fresh seeds of the Owenia helps ease the pain. Although I've had limited luck in propagation, this may be because my seeds were too fresh. I tried many different methods - cracking them in a vice, soaking in gibberellic acid - without success. Perhaps they are best left until they are much older and the termites have had a go!

WANATCA member Sarah Burton (who took the photos) has looked out a reference to the Desert Walnut in John Brock's book. Here is a summary on what it says:

Family: Meliaceae. A tree to 10 m high with open spreading crown; semi-deciduous; male and female trees. Bark rough, dark grey. Leaves crowded towards ends of branchlets, smooth and pinnate, 15-32 cm long, with 5-16 mostly paired leaflets. Can be confused with its relative, *Owenia vernicosa*, but the latter has much narrower and more numerous leaflets.

Fruits of the Desert Walnut

Small yellowish-white flowers, male and female on separate trees. Fruits are smooth globular drupes, 2.5-4 cm across, in pendulous clusters on thick central stalk up to 35 cm long. Fruits are reddish-brown when ripe, with tough flesh enclosing a hard, pitted, stony-shelled seed.

Flowers appear October-December, fruit ripens March-May (in the Pilbara, fruiting is July-September). The tree grows in open forest and woodland on well-drained sites, extending to sparse savanna woodlands in dry regions. Its distribution extends from Western Australia across the Northern Territory to Queensland.

Propagation is difficult, by seed (another source suggests cuttings, also).

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MEDICINAL USES OF THE KIWIFRUIT FAMILY (*ACTINIDIA*)

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INTRODUCTION

In recent years, kiwifruit (genus *Actinidia*, species *deliciosa*) have become exceedingly well known throughout the world. From seed of Chinese origin, New Zealand growers have developed many named varieties of kiwifruit (most notably, the Hayward variety).

Other species of Actinidia are becoming known to plant growers under the name 'hardy kiwifruit'. It is relatively easy to learn how to grow kiwifruit, how to process the fruit into products, or to cook with the fruit, from the many papers or books written on the subject.

However, information on the medicinal uses of kiwifruit and other Actinidias is rarely encountered except in Chinese articles and books. This article deals with the treatment and therapy of some diseases using Actinidia plants and fruits, as discussed in Chinese publications and in modern scientific and clinical literature. It should be remembered that in China, there is no sharp distinction between traditional and 'professional' methods as there is in the West.

The Actinidia species are dealt with alphabetically, using the scientific name of each.

ARGUTA *Actinidia arguta* (Sieb. et Zucc.) Planch (Fig. 1.).

Arguta is a large vine plant, up to 30 m in height. It is found twining around forest trees. Young growth is grey-white and spotted, mature branches are brilliant and smooth, with a paper-like bark. Leaves are 6-13 cm long, 5-9 cm wide. The flowers are white. The fruit is round to rectangular-round, and it ripens in August-September. The fruit is slightly astringent yet sweet.

Arguta is found in northerly glens along major rivers, such as the Yangtze Chiang, in China. Fruit is collected during summer for eating as well as medicinals. Roots are dug in autumn and winter. Small twigs are also collected for medicinal use.

The plant parts used medicinally are the roots, leaves, fruit and twigs. The biochemically active component in the plant is Actinidine (Gross et al, 1972).

§ Member, WANATCA

Traditional uses

Its traditional uses and major treatments are to relieve stomach disorders, reduce fever, increase urination, treat indigestion, stop nausea, and treat jaundice and rheumatoid arthritis.

An example of treatment is to concentrate, by boiling, 50-200 g arguta roots or leaves and take orally. Cancer treatment by using roots only as a folk medicine is also known.

Fig. 1. Actinidia arguta

Clinical uses

Arguta has been used clinically as a treatment for stomach cancer. In one trial of 18 patients, 3 showed reduction of cancers by over one half (by weight), general condition was significantly improved, and X-ray observations showed reduced cancer size. Seven patients showed effective results, but not to the same degree, and 8 patients showed no real improvement with the cancers themselves.

CALLOSA *Actinidia callosa* Lindl. var. *henryi* Maxim (Fig. 2.).

Callosa is a vine plant, with a round, columnar stem, black-brown in colour.

The leaves are 7-10 cm long, 3-4 cm wide. The fruit is elliptical, young berries are green and many seeded. The plant flowers in June-July, fruit matures in July. The fruit is cooling and astringent, edible.

Callosa is found in central and eastern China, in the shaded areas of mountain valleys. The plant part used medicinally is the root skin.

Traditional uses

Used to reduce fever, reduce edema (anti-inflammatory), cure swelling and pain of appendicitis.

Fig. 2. Actinidia callosa var. henryi

CHINENSIS *Actinidia chinensis* Planch (Fig. 3.).

Note: the botanical name "*chinensis*" has recently been changed to "*deliciosa*".

A large twining plant. Young branches and petioles are densely covered with brown, prickly hairs. Older branches are pink -brown, polished, and hairless. Leaves are 6-17 cm long, 5-13 cm wide.

Chinensis is dioecious (individual plants only produce unisexual flowers). The flowers are fragrant, starting off as opaline in colour and gradually changing to orange-yellow. The flowering period is April-June.

The fruit is egg-shaped to nearly round. Some varieties may be cylindrical. The skin has brown-yellow, long, stiff hairs. Fruit flesh is yellowish, brown-green, the fruit has many small black seeds. Fruit ripens October to November.

Actinidia chinensis grows on mountain slopes of the forest or bush. Distribution: River valleys of the Yangtze Chiang (Henan, Jiangsu, Anhui, Zhejiang, Hunan, Hubei, Shaanxi, Sichuan, Ningxia, Yunnan, Guizhou, Fujian, Guangdong, Jiangxi). Chinensis grows in cool moist places. Plants prefer sandy soils with rich leaf mold present.

Chinensis is widely cultivated in China. Propagation may be by seed or layering. Layering is very popular in China.

In winter, a parent branch is chosen which had many large berries the previous autumn. The branch is pulled down and stuck in the ground while still attached to the mother plant. A couple of years later, in winter after all the vine's leaves have fallen, dig up the new plant. Cut and separate each new vine, and check new vines and their roots. Transplant the good new vines.

Young plants are transplanted in December to January.

Give first fertilizer after bud emergence in the second spring. Each summer and winter, fertilize twice after cultivating the soil by hoe. In winter, prune the unnecessary branches which grow on lower parts of young plants and encourage a single main stem.

Chinensis fruit is very nutritious, containing sugars, vitamins, and organic acids (Table 1.) (Randoin et al., 1945; Acrus, 1959). Additionally, the components of a related species, *Actinidia kolomikta*, are shown in Table 1. (Ivanov, 1940)

Fig. 3. Actinidia chinensis. 1. Flower branch; 2. Fruit

Several different Chinensis plant parts are used extensively for medicinal purposes - fruits, roots, branches, leaves, and stem sap. Here they will be treated separately.

Fruit

The berry is a tart-sweet, acid fruit.

Traditional uses

Chinensis fruit is used in lowering fever, and in treatment of diabetes mellitus, jaundice, and cystolithiasis (stones). It improves liver function.

It is effective for treating rheumatoid arthritis, hemiplegia, and piles. Recorded uses include treatment of anorexia and dyspepsia, and chronic inflamed testicles.

Root

Chinensis root is available in all seasons. The roots and root skins are washed thoroughly and dried in the sun, or the raw root (root skin) is used as medicine. The root is bitter/sour, faintly sweet, and refreshing. It is slightly poisonous.

Traditional uses

Chinensis root has antipyretic analgesic action, diuretic action, and improves the blood circulation. It also reduces edema (swellings).

Another source records use of the root in treating hepatitis, water blisters, contusions, rheumatoid arthritis, gonorrhea, leukorrhea, small cutaneous ulcers, and swellings. It improves urination (diuretic action), stops diarrhea (anti-diarrheic), and is used in treating ascites. Also, its roots are used for the treatment of bonesetting wounds for external use.

Table 1. Components (%) of 100 g edible portion of 2 fresh kiwifruits, *Actinidia chinensis* and *Actinidia kolomikta*.

Compound	*Actinidia chinensis* [1] (%)	*Actinidia kolomikta* (%)
Sugar	11.00 g	
Protein	1.60 g	
Lipoid	0.30 g	
Vitamin		
vitamin Bl	0.007 mg	
vitamin C[2]	300.00 mg (ripe)	461-521 mg (young); 532-930 mg (ripe)
Minerals		
sulfur (S)	25.50 mg	
phosphor (P)	42.20 mg	
chlorine (CI)	26.10 mg	
sodium (Na)	3.30 mg	
potassium (K)	320.00 mg	
magnesium (Mg)	19.70 mg	
calcium (Ca)	56.10 mg	
iron	1.60 mg	
Carotenoid	0.035 mg	

1) *A. chinensis* contains actinidine. 2) Ascorbic Acid.

It regulates the stomach, improves blood-circulation, and assists in production of mother's milk after birth (lactation action) It cures inflammation (anti-inflammatory action).

It eases fever (antipyretic action). In poisonings, chinensis roots help the body to excrete, neutralize, or decompose the poison. Chinensis root is said to have anti-cancer activity. It is used for small cutaneous ulcers and swelling.

It is cautioned that pregnant women should not take the treatment

Other sources record its use for treatment of acute hepatitis, edema (for instance, kidney and cardiac edema, edemas of acute renal insufficiency and ascites), dyspepsia and vomiting, contusion, rheumatoid arthritis, gonorrhea and fluor albus, anal prolapse, gastrointestinal cancer and breast cancer.

Leaves and Twigs

Chinensis twigs and leaves are effective as insecticides or pesticides.

Medicinal uses recorded include treatment of purulent mastitis of women, and treatment of a burn.

Stem Sap

Chinensis sap contains some amino acids. The main amino acids are arginine, lysine, leucine, alanine, and asparagine (Hirsch, 1970). Also, pulped stem sap contains (+)-abscisin II (Davison et al., 1973).

According to Li Shih-chen (1596), the sap has a sweet and refreshing taste. It is not poisonous.

Traditional Uses

Chinensis sap is effective for treating stones of the urinary bladder. Oral administration of the juice and ginger juice together is useful for the problems of chronic vomiting, stomach cancer, and other diseases.

CORIACEA *Actinidia coriacea* (Finet et Gagn.) Dunn (Fig. 4.).

A. coriacea is a vine which twines around other trees. The vine stems grows sometimes to 10 m in length. Branches are red-brown, almost round, glossy, and hairless.

Leaves are 4-13 cm long, 2-4 cm wide. The flowers are red in colour, and hermaphrodite.

The fruit is egg-shaped or round, and brown in colour. Its length is 1.5-2.0 cm, and its width is 0.7 cm. It changes in colour to yellow on ripening. The ripe berry is yellow and hairless, and matures August to September. Fruits are sun-dried in the autumn.

A. coriacea grows around canals, in forests, or shrubs. Its distribution extends to Sichuan, Guizhou, Yunnan, Guangdong, Hunan, Jiangxi, Anhui, and Hubei.

Fruit

The fruit has a sour and astringent taste. Its main use is in the treatment of cancers.

Root

A. coriacea root also is used in medicine. The root (Dunn's root) has a pleasant taste although sometimes bitter. Its main value is that it improves blood circulation, and is used in treatment for hematemesis (contusions or bruises) and lumbago.

ERIANTHA *Actinidia eriantha* Benth. (Fig. 5.).

Eriantha is a twining plant up to 10 m in height. Young, small branches and petioles are densely covered with white, soft hairs. On growing, they change to a polished and smooth look, and have elliptical lenticels.

Leaves are 7 -15 cm long, 4-12 cm wide. Flowers are large and pale pink, diameter around 2.5 cm. Fruit is cocoon-like and densely covered with grey-white long soft hairs. It matures in August-September.

Eriantha's distribution is on the slopes of mountain valleys, glens along mountain streams, and shrubs around forests. Its districts of occurrence are Zhejiang, Fujian, Jiangxi, Hunan, Guangdong, and Guangxi.

Fig. 4. Actinidia coriacea. 1. Flower branch; 2. Fruit branch; 3. Flower.

The plant parts used medicinally are the roots and leaves. Roots are collected in all seasons. Leaves are collected in the summer and fall. The root is somewhat astringent and the leaf is bitter.

Its main uses are to reduce fever, increase urination, improve blood circulation, and cure pneumonia, gonorrhea, leukorrhea, acne, adenolymphitis, dermatitis, and carbuncles. It is also used to reduce fever (antipyretic) and improve blood circulation and to relax muscles (muscle relaxing effect).

Among other recorded uses are to cure general wounds, dermatitis, swelling, groin adenolymphitis, reduce fever of pneumonia, cure St. Francis's disease, fluor albus, stones of the urinary bladder, gonorrhea, suppurative mastitis, stomach cancer, nasopharynx cancer, and mammary cancer.

It has been used in the treatment of vocal chords wounded by pneumonia, leukorrhea and fever of leukorrhea, cystolithiasis, gonorrhea, erysipelas perstans faciei, suppurative mastitis, ill-defined cancer, groin adenolymphitis, hernia, general wounds and dermatitis.

Fig. 5. Actinidia eriantha. 1. Leaf branch; 2. Flower branch; 3. Fruit branch.

POLYGAMA *Actinidia polygama* (Sieb. et Zucc.) Miq. (Fig. 6.).

Polygama is a deciduous twining plant up to 5 m in height. Old branches are hairless, leaves are 6-13 cm long and 4-9 cm wide. The leaf is similar to wild mulberry.

The plant is dioecious. The flowers are large, white (2.5 cm diameter), and have an aromatic smell. The immature fruit is yellow, and ripe fruit is egg-shaped and yellow-red, 3 cm long and around 1.3 cm wide. The fruits have many pale-brown seeds, and ripen in September to October. The inside of the fruit is similar to an eggplant.

Its habitat is in areas around high mountains, in forests and shrubs on the slopes of mountains, and in river valleys. Its distribution is in the eastern and northern areas of China, in Shandong, Shaanxi, Hunan, Hubei, Sichuan, Zhejiang, and Anhui.

The main Polygama plant parts used are the branches and leaves, but the root, and insect galls which the plant is subject to, are also used in medicines.

A large number of complex biochemicals have been isolated from Polygama. The leaf and fruit contain various cyclopentanes (terpenoids). Other natural-product chemicals found include alkaloids (Sakan, 1959), matatabilactones (Fujino, 1960; Murai, 1960; Sakan et al., 1960a-d, 1965), alcohols (Sakan et al., 1968), and matatabiethers (Sakan et al., 1968).

The leaf also contains beta-phenylethylalcohol, 3,4-dimethylbenzonitrile, and 3,4-dimethylbenzoic acid (Fujino, 1960; Murai, 1960; Sakan et al., 1960a-d). Fruits with insect galls contain more matatabistic acid and iridodiols.

Pharmacological action

Polygama extracts show action on the central nervous system. For example, actinidine,

beta-phenylethyl alcohol, matatabilactones show catnip reaction in the Feloidea family of cats and lions, characteristics which include actions like salivating, staring and abnormal licking.

Actinidine and matatabilactone increase both the sedative and hypnotic actions of barbital , an analgesic and anti-epileptic. Actinidine, beta-phenylethyl alcohol, and matatabilactone increase salivation in dogs and cats (Hano, 1967).

Fig. 6. Actinidia polygama. 1. Flower branch; 2. Fruit

Circulation of blood and respiration may be affected by actinidine, beta-phenylethyl alcohol, and matatabilactone. Beta-phenylethyl alcohol influences the actions of smooth muscles of guinea pigs, rats and rabbits. Actinidine affects sexual glands in animals.

According to older literature, polygamol, which is contained in Polygama, has stimulatory action on the hearts of frogs and rabbit blood vessels, small intestine and urinary bladder. Polygamol has a significant diuretic action.

Polygama has a bitter taste, similar to ginger and pepper. Its toxicity is low or almost nil.

Traditional uses

Polygama extracts have ben used to treat Hansen's disease (leprosy), reduce indigestion in children, and treat infectious diarrhea. Also used to treat gonorrhea, lepra alba, exhaustion and colds.

It is said that a person who is administered too much polygama will have a shortened lifetime. Polygama extract can stop a cold, but in so doing may induce depression.

PURPUREA *Actinidia purpurea* Rehd. (Fig. 7.).

Purpurea is a deciduous vine up to around 3 m in height. The leaves are 5-8 cm long, 2- 4 cm wide, with rough star-like hairs on their backs. The flowers are hermaphrodite and white, although sometimes a plant has only unisexual flowers.

The fruit is egg-shaped or elliptical, 2-2.5 cm long. Inside, the ripe fruit is violet. The fruit is sour and bitter, although the taste refreshes the mouth.

Purpurea is found in mountain chasms and steep Valleys. Its distribution covers Guizhou, Sichuan, Yunnan, Hubei, and Jiangxi.

Fig. 7. Actinidia purpurea

The plant parts used medicinally are the roots and fruits. Its main uses are to reduce fever, increase urination, improve weakened condition and help to cure a disease. Also used as a treatment for hematemesis, menstrual disorder, chronic hepatitis, and rheumatoid arthritis.

VALVATA *Actinidia valvata* Dunn (Fig. 8.).

Valvata is a deciduous vine, with small variable-shaped leaves and white flowers. The fruit is rectangular to round, 4 cm long and 3 cm wide, yellow when ripe (October).

The plant grows in low mountains or in scrub in Valleys. Its distribution extends to Jiangsu, Zhejiang, Anhui, and Jiangxi.

The plant part used is the root. These are collected in the summer and fall, washed, cut in pieces, and dried under the sun.

Main medicinal uses are to reduce fever and as an antitoxic treatment for a carbuncles or swellings. Also used to treat fluor albus.

Clinically, Valvata has been used as a treatment for leprosy. In a trial on 65 patients, excellent effects were obtained with 21 patients, some improvement with 37 patients, while with 7 patients treatment was ineffective. In a treatment where Valvata extract was used in combination with sulfones, excellent, effective, or improved patients were seen in 90.7 % of the cases. With clinical applications, it is important to choose the valvata drug according to the type of leprosy involved.

Fig. 8. Actinidia valvata. 1. Leaf branch; 2. Root; 3. Fruit branch.

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[Editor's Note. Professor Motohashi's article above has been greatly condensed from the original, which had considerable detail on botanical structures of the plants, recipes and methods of preparing medicines, sources of the traditional treatments quoted, and clinical effects of extracts. The author should be contacted concerning availability of the full version.]

PROPAGATION OF MANGOS

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The mango, a tropical fruit of distinctive flavour, is becoming increasingly popular in Western Australia. The fruit is now seen on shop shelves for a longer period each year, due partly to production in the Kimberleys, Carnarvon and Perth, and partly to overseas imports. Western Australia's Asian migrants have contributed to the mango's popularity.

Many new cultivars (varieties), have been imported in recent years, potentially spreading the Carnarvon mango season from 6 weeks to 12 or 14 weeks.

However, most of the new cultivars (many of which were developed in Florida, USA) do not produce seedlings true-to-type. Grafting or budding is necessary to overcome this problem and thus get uniform yields, fruit size and quality.

Seedling mangos may be either monoembryonic (single embryo) or polyembryonic (many embryos). Only one shoot develops from a monoembryonic seed, which has originated from a fertilized egg cell.

Polyembryonic seeds produce a number of shoots, only one of which originates from fertilization. The remainder will have been derived from the nucellus (mother tissue) without fertilization. These will produce seedlings true-to-type and resemble the mother tree in every way. The fertilized seedling is often weak, and stunted.

Polyembryonic mango seed, showing seed with and without surrounding husk.

Propagation by seed

This is only practised for polyembryonic types, because monoembryonic types do not run true-to-type.

Mango seed loses its viability very rapidly after it is removed from the fruit. Even one or two weeks delay in planting will lead to poor germination. Therefore it is essential to clean the seed as soon as possible after it is removed from the fruit, then allow it to dry in the shade for only one or two days.

Before planting, the outer husk is removed by carefully snipping around the edges with secateurs.

The seeds, which are kidney shaped, are planted on edge with the convex edge on the top and the concave edge to the bottom. The top of the seed should be level with, or just below, the surface of the potting mixture.

Seedling rootstocks ready for whip and tongue grafting.

For the best results a potting mixture containing slow-release fertilizers, 50% coarse river sand, 25% vermiculite, and 25% sphagnum peat moss should be used. Fumigation with methyl bromide is recommended if there is any chance of contamination from harmful fungi or if old potting mix is re-used.

At Carnarvon, seeds are germinated under 50% shade, in black polythene bags 13 cm in diameter and 41 cm deep. These are ideal as they allow unrestricted development of the tap root. If large quantities of seed are to be planted, germination in small 'starter bags' 9 cm in diameter and 16 cm deep may be more economic in time and material costs. This may make better use of available nursery area and potting mixture. Seeds that do not germinate would not create a nursery space problem.

Germination can be expected in 10 to 14 days. Polyembryonic varieties such as Kensington, Banana, Nam Dokmai, Carabao, Strawberry, Sabre, and Turpentine may produce a number of shoots from each seed. The first and most vigorous shoots to emerge should be retained and the remainder removed with secateurs. Using this method of selection ensures that nucellar seedlings true-to-type will develop.

Propagation by grafting

This method is recommended where the variety to be reproduced is monoembryonic. Many researchers say it also can be used with polyembryonic varieties to produce smaller

trees and bring the trees into earlier production. Grafting is the process by which part of the parent tree to be reproduced (called the scion) is joined with part of a rooted plant (called a rootstock).

Grafting is the only method of vegetative propagation described in this farmnote. Plants also may be vegetatively propagated by inarching, layering and cuttings. These methods are practised successfully in many parts of the world, but they are mainly of academic interest. They are not practical for producing a large number of plants.

Selection and planting of rootstocks

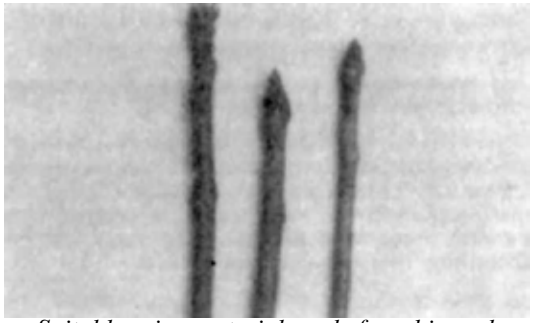
Seedlings from monoembryonic varieties are usually more vigorous than polyembryonic types. However, as these are open-pollinated the genetic variation in the seedlings is greater. Seedlings from polyembryonic varieties are genetically uniform, so they are preferred. It is most important to have rootstocks of similar characteristics.

Seeds are planted during the December to January period. By August to September they will have reached a stem diameter of 8 to 10 mm at a point 10 to 15 cm above soil level. If they have not achieved enough growth by this time, grafting could be delayed until October to December or alternatively March to April the following year. Grafting is not recommended during the winter months of May, June, and July or the summer months of January and February.

Preparation of scion material

The best scion material is obtained from the tips of mature (rounded) shoots with prominent buds (called tip wood) immediately before the August growth flush. Tip wood is prepared two or three weeks before use by removal of leaves from the scion, leaving 1 cm of petiole (leaf stem) remaining.

The graft stick is cut from the mother tree when required and should be about 6-8 cm long. If not used immediately scions can be stored, wrapped in a moist towelette and plastic bag, in a cool, dark position for periods up to seven days.



Suitable scion material ready for whip and tongue or side grafting.

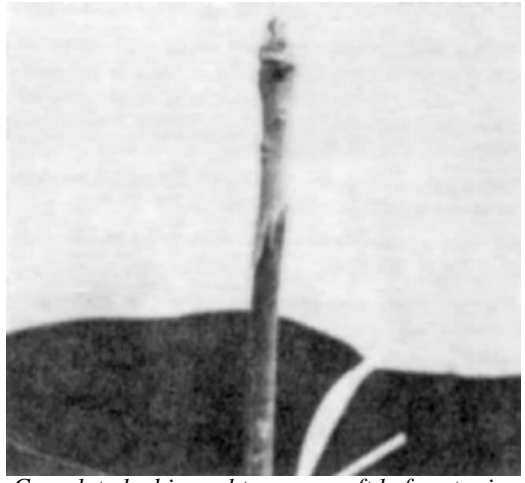
Equipment

All grafting enthusiasts should have the basic equipment to do the job. This includes: sharp grafting knife, secateurs, pocket-size sharpening stone (carborundum), PVC grafting tape, grafting mastic, sterilizing agent (alcohol or methylated spirits), and, if reworking large trees, a pruning saw.

Whip and tongue graft

The whip and tongue graft is used when the stock and scion material are of the same diameter. This graft is the easiest to do as the tongue helps hold the stock and scion together while the union or join is covered with PVC tape.

With a clean, sharp grafting knife, make a smooth sloping cut about 25 mm long on the stock. At a point a third of the way down the sloping cut, a further cut about 5 mm long is made in the opposite direction slightly across the grain. This is the tongue. Leave as many leaves as possible below the cut on the stock as this will encourage sap flow.



Completed whip and tongue graft before taping of union and scion. Note interlocking tongues and matching diameter of stock and scion.

The scion is selected and similarly prepared, with cuts that exactly match those on the stock. If the scion material is of the same diameter there will be a perfect union with tongues interlocking and matching of cambium layers (the area of actively-growing cells between the wood and bark).

The union is then bound with 10 mm wide PVC tape as quickly as possible to prevent oxidation of the cut surfaces. Taping should be carried out from well below to well above the union. Each preceding layer should be overlapped by at least half the width of the tape. The union can be firmly covered twice to ensure a good seal.

After taping is completed the remainder of the scion is also lightly wrapped with tape so that none is left uncovered. This helps prevent the scion drying out and builds up humidity.

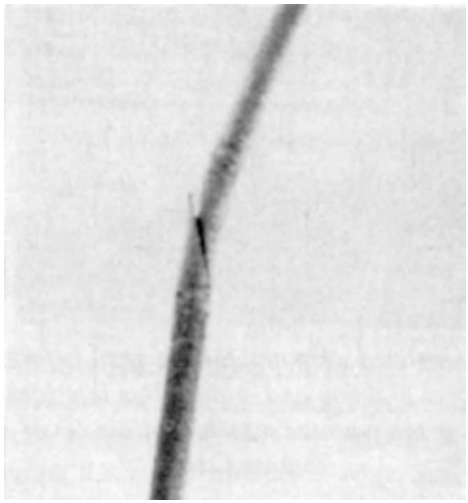
Alternatively, or in addition, the whole graft may be covered with a small plastic bag and lightly tied.

About three to four week after grafting, a bud (usually the terminal bud) should be observed swelling. When this occurs the tape in this area should be cut or loosened to allow the new shoot to emerge. If more than one bud swells the tape is similarly treated. It may be removed progressively, but only after enough growth has occurred.

Suckers from the rootstock must be removed as they appear because they tend to prevent proper scion growth, and may cause loss of the graft.

Side graft

This graft is used when the stocks are much larger than the scion material, making whip and tongue grafting impossible. This graft is more difficult to perform and greater expertise is required.



Sloping cut 25-30 mm long in rootstock ready for insertion of scion.

Firstly, a long sloping cut (25-30 mm long) is made at virtually any point on the stock, although preferably 10-20 cm above soil level. This cut should not sever the stock completely. The top portion is temporarily retained.

The scion (of similar size and type as detailed above) is cut in a wedge fashion with one side of the wedge being slightly longer than the other. The length of the wedge should match the cut in the stock.

By exerting slight pressure on the stock above the proposed union, the first cut will open and allow the scion to be inserted. The operator should make sure the cambium layers correspond. The top portion of the stock is then removed with secateurs at the point immediately above the union.

The graft is then bound with PVC tape in the same fashion as the whip and tongue graft, to cover all cut surfaces and take the ends well past the union.

Grafting mastic (Colgraft®) can be applied lightly over the whole union (to prevent entry of fungi or water) and the scion taped as already described.

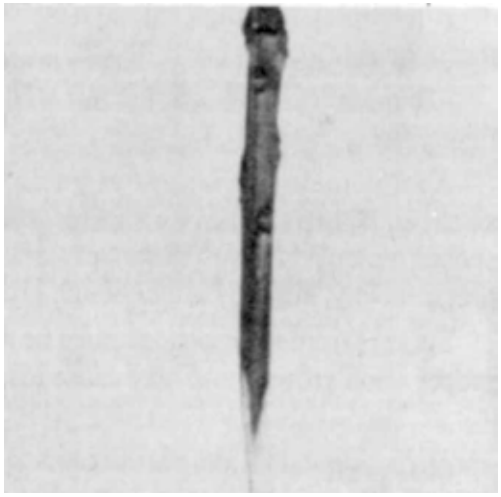
Reworking

Many of the common or Turpentine mangoes already established in the north-west of Western Australia could be reworked to named varieties. This is more successful if the tree is in good condition and shows no sign of dead wood or stunting.

Firstly, the old trunk is cut off at a point 40 to 80 cm above ground level, and the cut surface coated with Colgraft® or similar material. Shoots will develop from around the trunk.

When these have reached ideal size (7 to 10 mm) three or four can be grafted as described already. However, as grafting takes place in a field situation, it is necessary to shade the graft to prevent the scion being sunburned and dried

A brown paper bag is ideal for this purpose. It can be removed when enough new growth has taken place.



Scion cut in a wedge fashion ready for inserting in rootstock.

Reworking has the added advantage of bringing old trees with inferior quality fruit into early production (two years after working), making use of the extensive root system already established.

The only disadvantage is the possibility of a weak union, which may lead to some branches being lost when heavy production starts.

Care of grafts

Newly grafted potted plants should be placed under 50% shade. They should not be overwatered as the roots have a reduced leaf area to service and are easily damaged by overwatering.

As the new shoots develop the PVC tape on the scion is loosened and progressively removed.

Two month old side graft.

All tapes should be removed within six weeks depending on the scion growth.

The side graft needs extra protection once the tape over the union has been removed. A coating of Colgraft® is necessary to prevent water and fungi entering the partially-callused union.

Any shoots developing below the union must be removed, as they will affect scion growth. Depending on growth and vigour of the plants, grafted trees may be planted out within six months of grafting. Planting out in the field when the trees are making flush growth should be avoided.

[Based on Western Australian Department of Agriculture Farmnote No. 66/87]

PISTACHIO POTENTIAL IN WEST TEXAS

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Pistachios for nut production were introduced for evaluation in the early 1920's at Chico, California. The nuts have been cultivated in the Middle East for thousands of years. United States pistachio acreage increased during the 1970's in California and Arizona. Much interest has developed in planting pistachio trees in Texas as a commercial nut crop.

Pistachio production has become well established in central California, but only recently have production areas extended to Arizona, New Mexico and far west Texas. Incentives to produce pistachios include high income potential and consumer demand, limited need for frost protection (as needed in other tree crops), relatively low water requirement and high tolerance to saline conditions, adaptability to mechanical harvest, and long nut storage life. California pistachio area is currently more than 18,000 ha, and Arizona plantings exceed 1000 ha. Northern Mexico plantings are also being made.

Because the trees are native to areas of the world similar to the southwestern United States and because of continued publicity, many Texans have expressed an interest in the crop. Good general consumer acceptance of the nuts has also added to potential producer inquiries. There are less than 80 ha of planted pistachios in the state of Texas. No Texas plantings are currently bearing commercially mature crop yields.

The edible pistachio, *Pistacia vera* L., is a member of the Anacardiaceae family, which also includes mango, cashew, poison ivy, poison oak and sumac. *Pistacia vera* is the only pistachio species with a nut large enough to eat, in addition to the only one with a shell that splits at maturity.

All other species produce small, hard seed nuts. *Pistacia texana*, a native pistachio of north America, occurs along the Rio Grande River near Comstock, Texas. Chinese pistache, *Pistacia chinensis*, is widely used as a landscape tree. Several other species are used as commercial rootstocks. As many as eleven species belonging to the genus Pistacia have been recognized. Most are native to middle eastern countries.

Pistachio orchards are long term investments. Potential growers should carefully study all production and marketing aspects of pistachios before planting trees. Because pistachios are a perennial crop, site selection and water quantity and quality are of utmost importance. Pistachios have not received the benefits of an extensive long term research program in the state of Texas. The information presented here is based primarily on publications, research articles, interviews and grower-related experiences from California, Arizona and Mexico. As such, the intent of this guideline is to answer general questions about pistachio culture. It is not possible to make specific cultural recommendations for Texas pistachios because there are no research or production data available for the state.

* Deceased

The pistachio tree grows and produces nuts best in areas having long, hot and dry growing seasons. Pistachios will not tolerate high humidity or prolonged periods of rain during this time. Many sources indicate pistachios are ideally suited to commercial olive producing regions. Adverse growing conditions, such as strong winds and cold or damp weather interfere with pollination, causing a reduction in crop set. Also, areas that experience frosts after the first week in April should be avoided, since blossoms and newly developing vegetative tissue are susceptible at this time.

Texas Pistache (Pistachio texana) [from Vines, 1960]

Winters should be moderately cold. Pistachio trees in California have easily survived winter temperatures of -10oC. In Persia, temperatures as low as -18°C have not caused serious injury. It is possible to experience tree growth in such areas, but nut crops would not be satisfactory. Northern parts of the state where early April frosts are common likewise are poor areas for cultivation. Presently, commercial plantings of pistachio are being established in the Pecos and El Paso areas. They are also being planted below the Rio Grande river near Paras and Torreon, Coahuila, Mexico.

Pistachios have a winter chilling requirement of 800-1000 hours (Dale, 1984; Joley, 1979). This means that the trees must receive at least that many winter hours of temperatures above the freezing point but below 7°C. Pistachios would not receive sufficient chilling hours, in south and south central areas of Texas, to grow and flower properly. Winter temperatures below -12°C may damage bearing age trees.

Pistacia atlantica rootstocks have exhibited severe freeze damage 3 out of 5 years in the Fort Stockton area of West Texas. Damage occurred during 1984 and 1985 winter temperatures below -15°C. The same rootstocks were also damaged during March 1987 lows of -7°C when shoots were 10-15cm in length. Pistachio rootstocks in West Texas appear to become active in the spring about the same time that peaches begin to bloom. Orchard sites conducive to the collection of cold air pockets in the early spring should be avoided.

Pistachios require a well drained soil. A 1.2m minimum of sandy loam top soil is considered ideal. Pistachios will grow on heavier soils that are more shallow, but yields will likely be reduced. The extent of yield reduction is dependent on the degree of soil limitations and may significantly alter economic potential of the orchard. Pistachio orchards are not prime candidates for poor quality soils.

Soils with a history of verticillium or cotton root rot should be avoided. Some pistachio rootstocks are susceptible to these pathogens. Once the tree is infected, implied both diseases, there is no cure.

SPACING AND POLLINATION: Pistachio orchards have been established on 5.1 x 5.1m, 3.6 x 7.2m, 4.5 x 6.0m, and 6.0 x 7.2m spacings. Because the pistachio is slow growing and full canopy spread is not reached for 10 to 15 years, it is common practice to increase productivity in early years. Tree thinning can also be practiced 10 to 15 years later when crowding and shading occur. For example, depending on soil depth and fertility, initial spacing can vary between rows. Under good soil conditions, it is generally advised to allow no less than 7.2m between trees, since their canopy width will approach this value at maturity. This is to allow enough space for adequate spread and production at full potential and to eliminate crowding and shading. Optimum tree density and male- female ratio have not been determined in Texas.

VARIETIES AND ROOTSTOCKS: Commercial pistachio nut production in the U.S. is largely based on the variety 'Kerman'. It is the seedling result of nut samples collected during the 1920's in Iran. 'Kerman' was selected because of high yield potential, large nuts, good kernel quality and a relatively high percentage of split shells (Herkert,1983). Most pistachio nuts are sold in-shell so the split shell characteristic is important for hand to mouth consumption. The variety 'Kerman' may be prone to canker-like discoloured areas (epicarp lesions) that penetrate hull, shell and kernel under certain conditions.

Improved and selected varieties of pistachios are budded to Pistacia species under stocks. 'Kerman' is an edible varietal selection from the *Pistacia vera* species. Rootstock species are necessary because *P. vera* seedlings are weak and not well adapted to nursery operations. *P. vera* is also susceptible to nematodes. *Pistacia atlantica*, *P. terebinthus*. *P. integerrima* and *P. atlantica x integerrima* (hybrid) have all served as commercial rootstocks. *Pistacia atlantica* has been recommended for sandy soils, *P. terebinthus* for heavy soils and *P. integerrima* x *P. atlantica* and hybrids for soils where verticillium root rot may be a problem (Herkert, 1983).

Two other Pistacia species, *P. chinensis* (widely cultivated as a shade tree) and *P. texana* (a relatively rare native Texas tree), have not proven suitable as understocks for *P. vera*. Scion overgrowth and lack of cold tolerance are the major problems with these species used as understocks. Pistachio understocks have not been widely evaluated for long periods of time in Texas. It is not currently possible to recommend specific understocks for individual orchard situations in Texas based on research data or accumulated grower experience.

PROPAGATION & GRAFTING: Pistachio has a history of being difficult to propagate and transplant. In California and Arizona a high percentage of the trees are grown as seedlings in containers and the trees are "T" budded after the seedlings are established in the field. Special budding crews which have experience in pistachio propagation are then used to "T" bud the trees. The rootstock should be growing strong and at least 1/2 inch in diameter for a high percent bud take. Fall budded trees usually have a higher percent takes than spring buds.

In Mexico, the pecan patch bud graft is used with very good success in later summer, using fresh cut bud wood. As soon as these buds take, the seedling top is cut off above the graft to force growth from the patch bud. Some 30-90cm of scion variety growth can occur before growth stops in October. This could be very dangerous in higher latitudes such as Texas. There are some nursery-grown containerized budded rootstock trees available to the industry; however, many consider the cost of these trees prohibitive, as the price is usually more than US$12 per tree.

Rootstocks are usually budded after planting in the field. In California, the T-bud is the most common procedure and can be done only when bark slips. The diameter of the rootstock should be at least 9-12mm at the point of insertion. Buds should be made at a uniform height above or below the point where the mechanical shaker would contact the trunk. Buds can be forced into growth by cutting back the tops two to three weeks after insertion. There are differing opinions as to the best time for budding, but bud take is known to drop when the air temperature rises above 32°C or during periods of cool, damp, cloudy or rainy weather. Budding too early in the fall may result in growth that is susceptible to freeze injury.

In Mexico, orchard rootstocks seedlings are planted and grown in place for one year exactly as in pecans, with budding one or two years later in May, June or July using fresh bud wood. As soon as the buds take, the seedling tops are cut off immediately above the bud to force the patch bud.

IRRIGATION: Pistachios are considered drought tolerant trees. The trees will survive under moisture stress situations. Trees in California reportedly do not grow and produce sufficient numbers of new shoots to remain productive from a crop standpoint under moisture stress. Irrigation deficits have also contributed to alternate bearing and light crop years. Although the drought-tolerant trees survive moisture stress they do not produce economical high quality yields (Gibson, 1987).

San Joaquin Valley mature pistachios use 200 litres of water per day when clean cultivated and planted on a 5.1 x 5.1m spacing. Seasonal crop water use was given as 1000mm for a normal growing year.

Good pistachio tree growth has been maintained in Arizona with high total soluble salts irrigation water. Water within the 2-3,000 parts per million (ppm) range was considered suitable. Water with 2 ppm boron content was also considered acceptable (Mielke, 1980). Both water quality parameters are considered unacceptable for Texas pecan production. There is no pistachio consumptive water use or salt tolerance data for Texas production areas.

PROPAGATION: Presently, there are not satisfactory techniques for rooting pistachio cuttings. However, current investigations are emphasizing vegetative propagation, including tissue culture, in the production of vigorous rootstocks with uniform characteristics.

For commercial planting, pistachios are sold as container -grown rootstock trees, which are usually planted in the field in early winter or spring while dormant. Rootstocks are grown from seed of vigorous, healthy trees. *P. atlantica*, *P. terebinthus* and *P. integerrima* are the three most common commercial rootstock species, as they are more resistant to the root-knot nematode. Both *P. terebinthus* and *P. atlantica* are susceptible to the Verticillium wilt and are not recommended for areas previously planted to cotton. *P. integerrima* resists Verticillium wilt in California. *P. terebinthus* is the most tolerant of low temperatures and is recommended over *P. atlantica*, which can be sensitive to temperatures below -7° or -9°C in colder climates.

TREE TRAINING: Pistachio rootstocks are staked (50 x 50mm x 1.5m wooden stakes) at planting time. The fall placed bud is forced into growth the following spring. As the shoot

grows it is repeatedly tied to the stake to prevent wind breakage. Understock suckers and shoots must be continually removed during the first 3 years after orchard planting (Mielke, 1980).

Pistachio trees are trained with summer and winter pruning during the first 5 years. Training objectives are to produce strong, well spaced primary branches at a height compatible with mechanical shakers and equipment operations in the orchard (Opitz, 1977).

FERTILIZATION: Young pistachio trees respond to nitrogen. They are not considered heavy users in California. Nitrogen fertilization rates for non-bearing trees in training in Arizona range from 30-60g of 21-0-0 for trees the first year after budding to 3.3kg of 21-0- 0 for 5th year trees (Mielke, 1980). Frequent small applications of 21-0-0 from April to June will give best results without over-fertilization.

It is very important to stop fertilizing if the trees are not growing. Also do not fertilize after the month of June, because this could stimulate late season growth which is very freeze susceptible. Optimum nitrogen fertilization rates for non-bearing and bearing Texas pistachios have not been established. Also, minor element have not been identified, but deficiencies, especially zinc or iron, may develop as acreage increases. Some California pistachio orchards have apparently benefited from copper (Cu) and boron (B) micronutrient foliar sprays (Cavanaugh, 1987).

PESTS AND DISEASES: Insect related problems are not considered major or production-limiting in other areas of the nation. Thrips, darkling beetles, naval orange worms, cicadas, stink bugs, brown scale, aphids and mites have all been mentioned as minor problems (Cavanaugh, 1987; Joley, 1979; Mielke, 1980).

Above ground diseases are apparently not as big a problem as the previously mentioned root rots. Alternaria species, leaf spot and brown rot are considered controllable problems in some orchards (Cavanaugh, 1987; Joley, 1979).

YIELDS: Pistachio yields are biennial in nature with heavy production on alternate years. Off-year production ranges from 30-50% of heavy production years. Trees may begin to bear light crops (0.5-2kg per tree) during years 4 and 5 after budding. Mature orchard bearing yields can be expected sometime after the 10th year from budding. California estimates indicate 'Kerman' yields to be 2.05-2.25 t/ha after orchard maturity. Production yields are not available for Texas.

HARVESTING AND DRYING: Pistachios mature during September. When the crop is ripe the nuts may be threshed from the trees or removed with mechanical shakers. Catching frames aid the harvest. The nuts are then collected in bins or boxes and moved to the processing plant. Precleaning equipment removes sticks and leaves. Pistachios must be dehulled within 24 hours of harvest to prevent shell and kernel discolouration. Dry hullers and wet hullers remove the soft outer hull. Blank or unfilled nuts are separated from well-filled nuts during a water bath. Nuts with good meat sink. Pistachio nuts are then dried in predryers, rotary dryers and large tank silos.

The nuts are then separated into split shell nuts and those with intact shells. The higher the percentage of split shells the better. The nuts are screened for loose meats and broken

shells. Trained hand sorters are also used for final checks. The nuts are packaged and marketed after roasting and salting. High quality pistachio nuts have split shells that are easily removed with large, green, good flavoured, crunchy kernels inside. Early fall rains in Central, East, and South Texas could complicate pistachio harvests; consequently, commercial planting is being confined to the irrigated west.

ECONOMICS AND MARKETING CONSIDERATIONS: Pistachio orchard establishment costs will be more than for pecans because there are more trees per hectare and each tree is more expensive. Drip or microsprinkler irrigated Texas pistachio orchards will likely cost US$3750-5000/ha through the fifth year. This figure is exclusive of land costs and may inaccurately reflect water costs for certain areas suitable for pistachio production.

Prices paid to domestic Arizona growers in 1980 were US$5.06-5.72/kg for hulled, dried, in-shell split nuts. Casual observations of nut prices since 1980 have indicated a range of US$3.08-5.72 to be reasonable gross returns.

Sufficient equipment for processing the nuts after harvest should be budgeted at US$15,000+. Grower cooperatives or large acreage orchards are necessary to justify harvesting and equipment capital investments.

It has been variously estimated that only 10-20% of the U.S. population has ever tasted a high quality pistachio nut. The California and Arizona pistachio industries are currently expanding to meet the national market which is currently about 30,000,000 pounds. Iran and Turkey are the largest producers in the world. Mexico and Australia are developing new pistachio industries. The potential for pistachio production in West Texas is yet to be realized.

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SAPUCAIA NUTS -
THE GENUS *LECYTHIS*

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Sapucaias, paradise nuts, monkey pots. The most delicious nuts in the Western Hemisphere. Take it from a reformed nut hater!

The Sapucaias are in the family Lecythidaceae, which also includes *Bertholletia excelsa*, the famous Brazil Nut. Among its relatives and rivals are the *Lecythis* species or Sapucaias, which many people think include the tastiest nuts in the world. They certainly deserve to be experimented with in subtropical climates everywhere.

Common names: Many names are used when talking about the 50 or so nut bearing tree species comprising the genus *Lecythis*. Though each has a colloquial name, sapucaia and monkey pot are used interchangeably for several species. Paradise nut refers specifically to *Lecythis zabucajo*. The nuts are borne inside urn-shaped, woody fruits or capsules.

The origin of the name 'monkey pot' is uncertain, but it's a fact that monkeys relish the nuts and, unless checked, can decimate a crop. Empty capsules are used by rural folk to capture the monkeys. The empty fruits are baited with corn and sugar and when a monkey puts his head or hand through the fruit opening, he cannot withdraw it and is caught.

Distribution: Most *Lecythis* species are native to northeastern South America. Nonetheless, some occur naturally as far north as Costa Rica and as far south as Sao Paulo, Brazil. These trees are close relatives of the well-known Brazil nut, *Bertholletia excelsa*.

Ecology: *Lecythis* species thrive in humid tropical lowlands and require at least 1700 mm of rain annUally. However, they will not prosper under conditions of regular or prolonged flooding.

Data on cold hardiness is hard to come by, but it bears noting that *L. pisonis* does perfectly well in the Sao Paulo area located roughly 24 ° south of the equator (Miami is almost 26° north). Average daily low temperature for Sao Paulo in July, the coldest month, is 9°C.

Another factor to consider is the partially deciduous character of most *Lecythis* species. They can stay leafless for up to two months, sometimes coinciding with a brief dry spell in parts of their natural range. One author reports that *L. ollaria* trees show "... signs of wintering at certain times of the year." From this it might be inferred that sapucaia trees might be slightly cold hardy, but only experimentation with the different species will tell.

§ Member, WANATCA

Lecythis minor flowers [Photo: Author]

Botany: Trees range from the 30 metre tall *L. zabucajo*, the most commercial species, to the smaller *L. elliptica*, which grows to a height of 14-16 metres and is said to bear a crop when only 2 metres tall. The trunks are a light grey colour with many darker vertical fissures. The 15-17 cm long elliptical leaves occur in very copious clusters. The flowers are generally white, yellow or reddish pink, fleshy, 5-7 cm in diameter and very attractive.

Fruits and flowers coexist on the tree for several months. The flowering lasts four months or more, while fruits from the past season are still reaching maturity. The trees will fruit through out their canopy, often in clusters of 2-5 capsules, which are borne only on branch tips. The dense clusters of leaves sometimes make it difficult to spot the capsules.

Pod of Lecythis usitata [From: Prance, 1979]

The capsules usually ripen in 8-10 months, depending on the species. The quantity of nuts per fruit is highly variable. A Guyana native, *L. davisii*, reputedly may produce 50- 70 nuts in each fruit! *L. pisonis* bears 40-50 nuts per capsule as compared to *L. ollaria*, which produces between 10 and 30. On the low end is *L. elliptica*, which has an average of 8 nuts per fruit. Statistics for *L. zabucajo* trees growing in the Amazon show a yield of 30-40 nuts per fruit and 80 kg of nuts per tree yearly.

Size and shape of both nuts and fruits vary with the species. The largest fruits, those of *L. zabucajo*, can measure 25 cm across and 20 cm deep, with 5 cm nuts. At the other extreme is *L. elliptica*, whose fruits measure about 7.5 cm both long and deep and whose nuts are only 2.5 cm long. The shape and colour of the nuts also vary. *L. ollaria* and *L. zabucajo* are generally elongated, rounded at their ends and somewhat corrugated. *L. elliptica* nuts are shiny, chocolate brown, with yellowish lines running parallel to their longest axis.

Propagation: Propagation is by seed only. Brazilian researchers have succeeded in grafting the Brazil nut, *B. excelsa*, which halves these nuts' first bearing age to six years, and even to 42 months in exceptional cases. No instances of *Lecythis* grafts are recorded, however.

Various authors state that bearing commences at 7-10 years after planting. Malaysian experience with *L. ollaria* indicates seed germination is slow, with specimens growing very slowly to maturity.

Harvesting: While Brazil nuts fall intact to the ground and must be hacked open, the monkey pots have a lid which is only shed upon maturity.

Thus, even though the capsules hang upside down, the nuts do not fall out immediately. They are fastened to the interior of the capsule by a rubbery piece of plant tissue called a funiculum. As the funiculi dry on exposure to air, the nuts fall one by one to the jungle floor.

Nuts of Lecythis minor [Photo: David Noël]

Once the nuts have dropped, they are difficult to find amongst the heavy tropical undergrowth. Also, rodents, monkeys, wild pigs and birds avidly seek the tidbits, which explains why these nuts are almost never seen outside their native habitats.

The few paradise nuts that reach the international trade are used in the making of fine chocolates and other sweet confections. The nuts are collected from wild trees, since no large commercial plantations exist at the moment. This is the reason the nuts are very expensive. Only a few experimental plantings have been established in Brazil, the Guianas, Malaysia, and the West Indies.

For the home grower, an easy way to collect the nuts might be to clip the capsules from the trees once the lids have fallen off. Admittedly, this could be difficult to do with tall specimens. The author has observed that apparently mature *L. elliptica* fruits picked before shedding their lids will open by themselves in a few days, albeit with lighter colored nuts than usual.

The capsules remain on the tree for quite some time after dropping their nuts. They, too, eventually fall off, and are suitable for floral arrangements or in crafts projects. They are as hard as wood and can be sanded or varnished if desired.

Composition, flavour and use: *Lecythis* nuts are easier to crack than Brazil nuts and they are definitely sweeter. Creamy, delectable ivory-while kernels await inside. Their oil content is high and ranges from about 51 % for *L. pisonis* to more than 60% for some of the other

species. Paradise nuts are very nutritious, containing 61 % edible fat and 20% protein. This compares favourably with the Brazil nut, which contains 67% edible fat and 14% protein.

The high fat content of these nuts makes rancidity a problem. Freshness is prolonged by keeping the nuts out of light and air and storing them at less than 20°C. In their natural range, kernels are often used to make cakes and candies. A pale yellow edible oil can be extracted from the nuts and it is sometimes made into soap and illuminants.

Some Venezuelans and Brazilians shun the scrumptious nuts, thinking they are somehow toxic. There is a persistent belief in some South American localities that ingesting *L. ollaria* nuts will cause hair loss and other maladies. This belief is not wholly unfounded, but toxicity occurs only under very specific soil conditions. That the nuts are not toxic per se is evidenced by the fact that they are grown and relished in Malaysia.

Summing up, *Lecythis* species combine beautiful trees with pretty flowers, useful fruits and exquisite nuts. What more could you ask?

Germination of Lecythis tuyrana, showing 'macropodial embryo' [Prance, 1979]

AUTHOR'S NOTES:

1. *Lecythis* nomenclature is somewhat imprecise, since not all botanists agree on specific scientific names. Cavalcante says fruit size and shape may vary substantially within a single tree. This may be the reason why there is some confusion in the naming of different species.

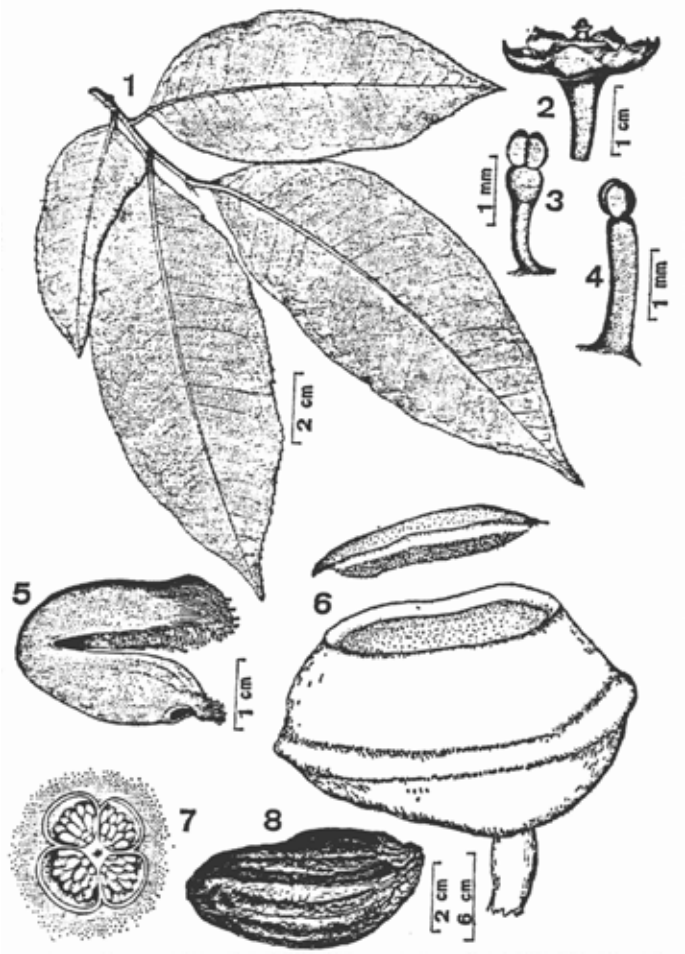
Martin lists *L. usitata* as a synonym for *L. zabucajo*, while Rosengarten declares the same nut to be " ... *L. usitata*, formerly *L. zabucajo*". Cavalcante declares that *L. usitata*, *L. paraensis*, *L. amapaensis* and *Pachylecythis egleri* are all synonyms for what he calls *Lecythis pisonis* subsp. *usitata*.

To complicate things further, I was told on a recent visit to the USDA's Tropical Agricultural Research Station in Mayaguez, Puerto Rico, that *L. elliptica* is now called *L. minor*. I have not yet found literature to substantiate this but note that *L. minor* is listed by Martin as a species native to Colombia.

2. It seems that the soils of certain plains in northeastern South America contain an abnormal amount of the element selenium. *L. ollaria*, and perhaps other *Lecythis* species, absorb selenium and store it in different plant parts, including the nuts (other crops such as corn and tomatoes also store this element and are thus rendered inedible).

A Venezuelan physician has found that when selenium is ingested in large quantities by humans and animals, it replaces sulphur atoms in the amino-acid cystathionine. This amino acid is essential in the formation of hair and nails. When it is altered by selenium replacing sulphur, hair production ceases and nails split lengthwise.

Eating tainted nuts causes these symptoms plus nausea, vomiting and headaches. Symptoms vary with the amount of nuts eaten, but will fade away as the selenium is eliminated from the body. This rather uncommon phenomenon should not dissuade the backyard grower from trying these delicious nuts. If in any doubt, have your soil tested for its selenium content before planting.



Lecythis usitata: leaves. pod and lid, nut. and flower parts [From Cavalcante, 1988]

3. Apparently, *Lecythis* specimens will not produce fruit unless planted in pairs.

A GERMINATION EXPERIMENT

The author ran a simple experiment with a growth promoting substance to see if germination and growth could be hastened.

Thirty *L. elliptica* nuts were carefully cracked with pliers. The kernels were extracted from their shells and soaked in 2,000 ppm gibberellic acid solution for 24 hours. The kernels were then patted dry and sown in moist peat moss at a temperature of about 25°C.

Germination started the second week, though some kernels took up to six weeks to sprout. Total germination was 57%. The rest of the kernels rotted or were eaten by ants.

The fIrst kernels to sprout are now, two months later, nearly 35 cm tall, with taproots extending some 11 cm underground (the kernels were sown in large plastic cups in order to observe their roots).

Only further study of subsequent speed of growth and replication of results will confirm that my results were not due to factors other than gibberellic acid. No control group was established to compare results (I had too few nuts). Perhaps, too, *L. elliptica* exhibits greater precocity than *L. ollaria*. Success might have been due to merely cracking the nuts or soaking in liquids prior to sowing.

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[The cover illustration on the 1991 WANATCA Yearbook is of *Lecythis usitata*, from Prance (1979)]

[Expanded from an article in *Tropical Fruit News*. July 1990]

JAK FRUIT - WHAT TO LOOK FOR

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PO Box 153, Mourilyan, Qld 4858

In the late 1960s, at the Brisbane R.N.A. Exhibition, I saw a very large green 'fruit' with small spikes all over the skin.

Upon asking about the fruit and listening to what others said, I was left with the impression that one could eat parts of the fruit, but more often it was fed to pigs.

Well, many jakfruits later, the impression of size is still with me but the uses of the fruit are far greater.

With the recent plantings of many thousands of jakfruit trees, there will be a good supply (possibly over -suppy) within a few years. Most people I have talked to, consider the jakfruit tree a good windbreak tree that will possibly produce some saleable fruit. They have not given much thought to selection; usually planting the seeds of any fruit they found.

I mentioned earler that there were many uses for the jakfruit, but there are also many different types. The characteristics of some fruits make them unsuitable for some recipes. Ammy Setu, a Fiji-Indian friend of mine, often refemed to various trees as good for curry and others not so.

After eating a few curries, I became interested and compared a few fruits from different trees. What a surprise, some fruits made a very good full-body curry, while others were bitter; very bitter, only good for chook* food.

Jakfruits are eye catchers at any fruit display. Steven holds a Fitzroy Nursery selection at a Field Day at the Nursery.

§ Member, WANATCA

* Australian for 'chicken'

Aril characteristics of ripe jakfruit also vary considerably. Very soft arils are good for milk shakes, while the crisp type are more useful stuffed with dates and nuts or similar.

Before you plant jakfruit trees, consider where you intend selling the fruit, then select your trees carefully.

Windbreak

Select light cropping trees with good tap roots. Remember that a root-bound tree full of jakfruit in a strong wind, with soft wet soil, is not much of a windbreak - they tend to fall over.

Vegetable

Size of fruit is not as important, as fruit picked for use as a vegetable is at a very immature age and also it is often cut and sold in pieces like pumpkin. Jakfruits for vegetable must not be of a bitter type and should preferably have a small core. The seeds of the jakfruit are a useful vegetable; they resemble large beans when cooked. Considerably more promotional work needs to be done on how to use the seeds, otherwise they will be treated as waste (like most seeds).

It is advisable to keep a bottle of household kerosene handy when preparing green jakfruit, as kero is very effective in cleaning the sticky sap off hands, knives and mum's kitchen table. Cooking oil and many sheets of newsapaper also help.

Dave Dickson poses with an early bearing Jakfruit tree of Cliff Groves - Yeppoon

Fruit

There are two basic flesh types -

A. Soft Flesh B. Crisp flesh

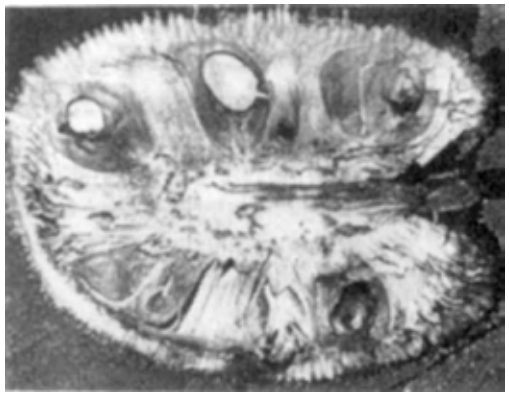
Between these extremes there is a range of flesh types. The soft flesh is easily blended with dairy products etc, like ripe mango, whereas the crisp flesh breaks up into small pieces in the blender which may be useful in yoghurt and ice cream, but the flavour is not evenly distributed. Crisp types are easy to eat fresh and can be filled or cut up. The rags or underdeveloped arils are the stringy, usually bland, filler between the arils.

Although this may be used from ripe fruit, its use in jams etc is very restricted and it is mostly considered with the skin and core as waste. In some jakfruit types, the rags are quite soft and full of flavour. This may be a desirable feature to look for.

General Characteristics

I purchased a number of jakfruit from a roadside stall. The shop owner didn't know much about the fruit except that when it was soft, it was ripe. All the fruit turned out to be some of the worst I have seen: it was probably these fruits that first prompted me to write this article.

The fruits were small and bumpy, that was okay. When I opened them up they were all much the same, very big core, thick skin, only 8-12 seeds, all very large and hardly any aril. With a recovery of about 1 % the $3/kg price became quite expensive.



Few large seeds, thick crisp aril. The cross section of this Jakfruit also shows a medium sized core and a thick skin.

Unconfirmed reports of pinks disease and root rot affecting trees may indicate that selection or management may be needed to reduce tree losses. Time to first fruiting varies widely. Thirty months from seed to ripe fruit is the best I have heard of, while some trees are over six years old without setting a fruit. I consider growing conditions to be very important here.

With grafted jakfruit trees becoming available, it is important that as many characteristics of the parent tree as possible be recorded and made available.

There are some very good jakfruit trees available. Small round fruit, thin skin, small core, many small seeds covered in thick bright coloured aril with a strong fruity flavour. These characteristics are not the only ones that make up a good fruit, but they are a guide.

Comparison of some characteristics of various small jakfruits

Supplier	Total Weight	No.of Seeds	Ave Seed Wt.	Weight of Arils	% of Aril	Remarks
Sing	1900g	140	3.6g	500g	26%	Round brown fruit, soft yellow aril
Cummings	2500g	14+11 aborted	3.6g	900g	36%	Oval green fruit, semi-soft yellow aril
Adelaide Park	5600g	180	7.8g	1400g	25%	Oval green fruit, semi soft yellow aril
Bosworth	3200g	140	3.3g	1100g	34%	Round brown fruit, semi soft yellow aril
Mackay seminar	2600g	19	6.3g	700g	27%	Bumpy green fruit, soft yellow aril
Cummins	1200g	6+6 aborted	3.3g	260g	22%	Oval green fruit, semi soft yellow aril
Musumeci	4300g	288	5.6g	600g	14%	Oval green fruit, crisp yellow aril
Musumeci	3200g	74	6.8g	1500g	47%	Oval green fruit, semi soft bright yellow aril
Spear	4000g	184	4.3g	1800g	45%	Oval green fruit, semi soft pale yellow aril

[Based on an article in Rare Fruit Council of Australia Newsletter, May 1988]

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.

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