Species Profiles for Pacific Island Agroforestry
www.traditionaltree.org

April 2006
ver. 2.1

Pometia pinnata (tava)

Sapindaceae (soapberry family)

***dawa*, *tawa* (Fiji); *kava* (French Polynesia); *kava*, *tava* (Samoa); *igi*, *ako*, *dawa*, *tauna* (Solomon Islands); *nandao* (Vanuatu); *lychee sauvage*, *le pomet* (*pometier*), *bois de pieu* (French); oceanic lychee, island lychee (English); *taun* (PNG); *tava* (Cook Islands, Niue, Tonga, 'Uvea and Futuna)**

Lex A. J. Thomson and Randolph R. Thaman

IN BRIEF

Distribution Has a wide natural distribution in the Asia-Pacific region.

Size Varies greatly, from a small to very large tree, typically 12–20 m (39–66 ft) tall with a canopy diameter of about 10–20 m (33–66 ft).

Habitat Grows naturally in warm to hot, humid subtropical and tropical zones, elevation 0–500 (–1700) m (0–1640 [–5580] ft) with annual rainfall of 1500–5000 mm (60–200 in).

Vegetation Occurs mainly in evergreen or shortly deciduous, lowland, closed forest and secondary forest.

Soils Grows on a wide range of soils with best growth on slightly acidic to neutral (pH 5–8), well drained, fertile loams and clays.

Growth rate Grows rapidly, typically 1–2 m (3.3–6.6 ft) per year.

Main agroforestry uses Mulch, improved fallows, homegardens.

Main products Timber, fruit.

Yields Timber: 5–10 m^3/ha/yr (72–144 ft^3/ac/yr). Fruit: 2–8 mt/ha/yr (0.9–3.6 t/ac/yr).

Intercropping Mixed food gardens.

Invasive potential Considered to have a low invasive potential.

PHOTO: C. ELEVITCH

Tava growing in a Tongan village.

INTRODUCTION

Tava (*Pometia pinnata*) is a small to very large tree up to 50 m (164 ft) in height. It is found occurring naturally from Sri Lanka and the Andaman Islands through Southeast Asia, with extensions into southern China, Vietnam, Malesia, and the South Pacific as far east as Samoa, Tonga, and Niue. It is possibly an aboriginal introduction into some of the more eastern parts of its range in Polynesia, and probably a post-European-contact introduction into the Cook Islands and French Polynesia. It occurs in a wide variety of habitats and soils and vegetation associations. In Papua New Guinea (PNG) and some parts of the Pacific islands it may become a dominant vegetation component, being the most abundant tree and sometimes with a canopy emergent over other forest tree species. In Fiji and Tonga it is rarely found in undisturbed primary forest and is considered mainly a planted or cultivated species, i.e., where naturalized it is found only in secondary forests. However, in Samoa, where the fruits are not traditionally eaten by humans, it is common in late successional and closed rainforests and is unlikely to have been introduced.

In some lowland parts of PNG it is planted to supply leaves that are dried and used as a nutrient-rich mulch for yam cultivation. It is also planted around villages and planted or protected in garden areas in other parts of the South Pacific, mainly for the purpose of providing fruit, medicine, and firewood. Tava is considered one of the most promising trees for replanting in Samoa, both for commercial and ecological reasons. It is also recommended for protection and replanting in Melanesia (Fiji, Papua New Guinea, Solomon Islands, and Vanuatu) and Tonga because of its wide cultural utility and amenability to pruning and pollarding. Families living in many Pacific island environments would benefit from having at least one planted tree of a selected form of tava to provide fruit and other products.

Selection and breeding work may be needed to identify and propagate trees combining desirable timber characteristics (good bole form and timber properties) and fruit quality, in order to encourage development and enhance the economic viability of larger-scale commercial plantings.

DISTRIBUTION

Native range

Tava has a wide natural distribution in the Asia-Pacific region mainly in lowland subtropical and tropical areas from about 14°N to 20°S. The species is native to:

Borneo Sarawak, Sabah, Brunei, and Kalimantan) (forma *acuminata*, f. *glabra*, and f. *alnifolia*, plus two other paramorphs)
Eastern Indonesia Sumbawa, Timor, Wetar (forma *cuspidata*), and Tanimbar Islands (f. *cuspidata* and f. *pinnata*)
India Andaman Islands (probably f. *glabra* and f. *tomentosa*)
Laos
Papua New Guinea (f. *pinnata*, f. *glabra*, and f. *repanda*)
Peninsula Malaysia/Indonesia Simalur and Sumatra (f. *glabra*, f. *alnifolia*, f. *macrocarpa*); Indonesia, Java (f. *glabra* and f. *tomentosa*)
Philippines/Indonesia Sulawesi and Moluccas, Aru Islands, Irian Jaya
South China Yunnan Province (probably f. *tomentosa*)
South Pacific Solomon Islands, Vanuatu, Fiji, Tonga, Wallis and Futuna, Samoa, and Niue (f. *pinnata*)
Southern Thailand (rare, probably f. *glabra* and f. *alnifolia*)
Sri Lanka (f. *tomentosa*)
Taiwan
Vietnam (f. *tomentosa*)

Current distribution

In addition to its native habitats, tava is present as a modern introduction into New Caledonia, the North Pacific (including Yap, Federated States of Micronesia, and Hawai'i) and eastern Polynesia, including French Polynesia (Marquesas and Tuamotus) and the Cook Islands.

BOTANICAL DESCRIPTION

Preferred scientific name

Pometia pinnata J. R. Forst. & G. Forst

Family

Sapindaceae (soapberry family)

Subfamily

Nephelieae (tribe)

Non-preferred scientific names

Aporetica pinnata DC.
Dabanus acuminatus Kuntze
Dabanus pinnatus Kuntze
Eccremanthus eximius Thwaites
Euphoria pinnata Poir.
Irina alnifolia Blume
Irina diplocardia Blume
Irina glabra Blume
Irina tomentosa Blume

Nephelium acuminatum Hook. f.
Nephelium diplocardia F. v. M.
Nephelium eximium Thw.
Nephelium pinnatum Cambess.
Pometia acuminata Hook. f.
Pometia alnifolia Blume
Pometia annamica Gagn.
Pometia coriacea Radlk.
Pometia glabra Blume
Pometia glabra Tesman & Binn.
Pometia gracilis King
Pometia macrocarpa Kurz.
Pometia tomentosa Blume

Common names

Pan-Pacific

oceanic lychee, island lychee (English)
lychee sauvage, *le pomet* (*pometier*), *bois de pieu* (French)

Papua New Guinea (PNG)

taun (PNG Standard trade name, Pidgin), *ohabu* (Vailala), *koiawo* (Buna), *dame* (Evara), *okamu* (Motu), *bas* (Waria), *cuhinh* (Yabim), *Tze* (Yalu)

Irian Jaya

kalasina, *kablauw*, i*wa* (Sentani language)

Solomon Islands

tauna, *igi*, *ako*, *dawa* (Kwara'ae language), *nyia tava* (Ayiwo), *tava* (Vaiakau), *nodae* (Graciosa Bay), *gema* (Roviana), *mede* (Marovo), *piraka taba* (Varisi), *taoa* (Nginia), *tao* (Lengu), *awa* (Santa Ana)

Vanuatu

nandao (Bislama language), *netowe*, *tewen*, *tien*, *wuten* (Banks Group), *ndalawa*, *n'dalaoa* (Maewo), *jaria*, *jariea*, *ah*, *jarie*, *ha*, *kao*, *nsai*, *n'seire*, *jarie*, *ndao* (Santo), *vujarie*, *vujaria* (Malo), *rao* (Ambrym), *nendre*, *dra*, *nendo*, *nendro* (Malekula), *burklata* (Epi), *dau* (Erromango), *nandem* (Tanna), *tava* (Aniwa), *tava*, *dava*, *ndava*, *netva* (Aneityum), with many folk varieties also given local names on different islands

Fiji

dawa, *tawa* (with folk varieties including *dawa dawa*, *dawa moli*, *dawa sere*)

PolynesiaTonga

t*ava* (varieties include *tava kula*, *tava moli*, *tava toua*) (Tonga)
kava, *tava* (Samoa)
tava (Niue and Cook Islands)
kava (French Polynesia)

Size

Tava is a small to large tree, typically 12–20 m (39–66 ft) in height and 10–20 m (33–66 ft) in canopy diameter. The largest specimens reach 50 m (165 ft) in height and 1.4 m (4.5 ft) in diameter above buttresses.

Form

Variable, from stout trees with short twisted or fluted boles

Large tree with huge buttresses, 'Upolu, Samoa. PHOTO: C. ELEVITCH

to slender, rather straight trees. Prominent buttresses are formed on older trees to about 1.5–3 (–5) m (5–10 [–16] ft).

Flowers

The floral inflorescences are highly variable. They include clusters of terminal, sub-terminal, or rarely axillary panicles, conspicuously projecting beyond the foliage, from stiff to hanging, 15–70 cm (6–28 in) long main branches, simple or with secondary branching. Panicle branches are sometimes subtended by auricle-like, densely to sparsely hairy or glabrescent leaflets. The species is monoecious, with unisexual male and female flowers on the same tree and within the same panicle. Female flowers may appear bisexual, but the anthers are reduced and sterile. Male flowers open first and greatly outnumber female flowers. The flowers are actinomorphic and 5-parted, calyx dish shaped to shallowly cup-shaped, 2–3 mm (ca. 0.1 in) in diameter with five short lobes and without any scent. Petals are small and regular, whitish to yellow-green, highly variable in shape, shorter or longer than calyx. Disk is annular, 1–1.5 mm (0.04–0.06 in) wide by 0.5 mm (0.02 in) high. Filaments are whitish, 3–6 mm (0.12–0.24 in), in the female flowers sometimes reduced to 0.5 mm (0.02 in), densely to sparsely hairy toward the base. Anthers are red or yellow, 0.7–1 mm (0.03–0.04 in) long, minutely hairy. Ovary in female flowers deeply 2-lobed (rudimentary in male flowers), densely brown-pubescent. Style is red, undivided, 1–2 mm (0.04–0.08 in) long, extending to 3–6 mm (0.12–0.24 in) after anthesis.

The age to first flowering and fruiting is not well documented and possibly varies among forms and genotypes. Fruits mature about 3–4 months after flowering.

The flowering times vary regionally and may occur more than once per year. In Fiji flowering occurs in December–March, while in Samoa flowering has been recorded in February–March, June–July, and October–November. In PNG flowering has been recorded throughout the year with peak flowering between January and April.

Leaves

The leaves are paripinnate, the rachis up to 1 m (3.3 ft) long, or rarely longer, with 4–8 (–13) sub-opposite pairs of sub-sessile leaflets. Leaflets are firmly herbaceous to coriaceous, asymmetrical to symmetrical, variably shaped (oblong/lanceolate/ovate), the first pair mostly suborbicular to elliptic, ≤ 3 cm (1.2 in) long, and often clasping the branch like stipules, leaflet tip subacuminate to acuminate with a tip up to 1.5 cm (0.6 in). The largest leaflets average 12–30 cm (5–12 in) long by 4–10 cm (1.6–4 in) wide. The midrib is flat above with a narrow keel that is triangular in section. Leaflet nervation is highly distinctive, comprising 11–25 pairs of parallel nerves at an angle of about 60° with the midrib, with every second nerve ending in a marginal tooth, and the in-between nerves bending upwards without reaching the margin. The leaflet margin is about 3 mm (0.12 in) deep, dentate or repand to subentire. Leaf surfaces are generally glabrous; however, juvenile leaves, including suckers, are densely covered in brownish hairs. The juvenile leaves are

Top: New leaf flush; Bottom: Fruits and leaves. PHOTOS: L. THOMSON

large, thin, and initially brightly colored (pink to red).

Fruit

The fruits are highly variable, indehiscent (not splitting), round to elliptical, sometimes paired, and often with one or more vestigial ovary lobes at the base, 1.5–5 cm (0.6–2 in) long by 1–4.5 cm (0.4–1.8 in) diameter, the skin or pericarp smooth and variously colored (greenish-yellow, yellow, red, purple, blackish or brown) with a gelatinous, sweet, white to slightly pinkish, translucent pulp (mesocarp) partially encasing a single large seed. Age to first flowering and fruiting is not well documented and possibly varies considerably. In Lae, PNG a large-fruiting form bore fruit only 5 years after planting, but usually the first fruit crops on well managed trees appear at an age of about 8–10 years. In the South Pacific the fruiting season varies by locality and from year to year, e.g., the main season in the Santa Cruz Islands of SE Solomon Islands is November–January (main season), while the main season in Fiji and Tonga is February–March (but fruiting may occur from January to April in Fiji). In Samoa fruiting has been recorded in the months of March, August, and November.

Seeds

The seeds are large, to 2.5 cm long by 1.5 cm across (1 x 0.6 in), flattened and rounded on the ends, and brown. There are 300–500 seeds/kg (140–230 seeds/lb). Fruits are mainly dispersed by fruit bats (*Pteropinae*), birds, including pigeons in Samoa, and humans. Water dispersal is also likely in riverine populations.

Rooting habit

The species appears to have a strong lateral rooting system, with large lateral roots extending out from buttress flanges.

Similar species

The most detailed and recent taxonomic review of *Pometia* (Jacobs 1962) recognizes only two species, *P. pinnata* Forst. and *P. ridleyi* King emend. Radlk. *P. ridleyi* exists as a small homogenous population in Sumatra (Indonesia) and Malaysia, whereas *P. pinnata* is a highly variable entity with a wide natural range in the Asia-Pacific region.

GENETICS

Variability of species

There is considerable variation in all plant parts of tava, with the most taxonomically useful characters being the leaves and inflorescences. Floral parts may vary in shape, size, and proportions on otherwise identical plants. Tava fruits show considerable variation, but there are insufficient specimens with mature fruits to properly evaluate its taxonomic utility. Furthermore, tava fruits have been subject to varying levels of human selection that complicates their utility for taxonomic purposes.

Known varieties

There has been considerable confusion concerning the taxonomy of tava due to its complex and seemingly bewildering variation patterns that cannot be satisfactorily accounted for by conventional taxonomic categories (Whitmore 1976). The taxonomic approach adopted by Jacobs (1962) recognized eight distinct forms, plus a number of less distinct "paramorphs," leaving a residue of polymorphic, unclassified material. According to Jacobs, tava exists in at least three distinctive forms in New Guinea namely, f. *pinnata*, f. *glabra*, and f. *repanda* (possibly representing different taxa). The type form *pinnata* is the most important for timber production, although this form has often been referred to in PNG as *P. tomentosa*, an entity that does not occur east of Java, Indonesia (and east of Wallace's line). In this treatment the focus will be on forma *pinnata*, the only form present in the Pacific islands, and the one with most potential for production of both fruit and timber.

On the basis of inflorescence and leaf characters, the eight forms that have been recognized by Jacobs (1962) are:

forma. *acuminata* (Hook. f.) Jacobs
f. *alnifolia* (Blume) Jacobs
f. *cuspidata* (Blume) Jacobs
f. *glabra* (Blume) Jacobs
f. *macrocarpa* (Kurz) Jacobs
f. *pinnata*
f. *repanda* Jacobs
f. *tomentosa* (Blume) Jacobs

Numerous traditional varieties within f. *pinnata* are recognized locally in the South Pacific mainly on the basis of fruit characters, especially size, shape, skin color, and taste/sweetness of fruits.

ASSOCIATED PLANT SPECIES

The species occurs mainly in evergreen or occasionally deciduous lowland closed forest and secondary forest associations. In most of its range it occurs at relatively low frequency in mixed forests, but it may also occur as a principal forest component; e.g., in PNG and Samoa. In New Guinea, tava is among the most common and important hardwoods of lowland and lower montane evergreen rainforest,

especially on ridges and spurs. In many parts of Melanesia tava's range and frequency has been increased by human influence both through planting around villages and protection of plants during garden development. In parts of Southeast Asia, including Malaysia and Java (Indonesia), its distribution is mainly associated with watercourses and swamp forest. In Fiji it is found almost exclusively in secondary forest, in shifting agricultural lands, and planted or protected around villages. Similarly in Tonga, where very little native forest remains, it is usually found planted or protected in semi-permanent shifting agricultural lands or planted in villages.

Associated species commonly found

Associated species in native habitats in the Asia-Pacific region include *Aglaia gigantea*, *Alstonia* spp., *Artocarpus altilis*, *Calophyllum* spp., *Celtis* spp., *Chisocheton lasiocarpus*, *Cinnamomum obtusifolium*, *Cryptocarya* spp., *Cynometra* spp., *Dillenia indica*, *Diospyros* spp., *Dracontomelon dao* and *D. vitiense*, *Duabanga sonneratioides*, *Elaeocarpus* spp., *Ficus* spp., *Homalium foetidum*, *Inocarpus fagifer, Intsia bijuga* and *I. palembanica, Ixora* spp., *Koordersiodendron*, *Mastixiodendron*, *Myristica subalata*, *Neonauclea* spp., *Octomeles sumatrana*, *Palaquium* spp., *Pimeleodendron* spp., *Planchonella* spp., *Podocarpus neriifolius*, *Pterocarpus indicus*, *Pterygota* spp., *Haplolobus* spp., *Radermachera* spp., *Saraca* spp., *Schoutenia* spp., *Terminalia* spp. including *T. richii* and *T. myriocarpa*, *Teysmanniodendron* spp., and *Tristania sumatrana.*

Species commonly associated as aboriginal introduction in Pacific islands

It is grown in gardens and associated with almost all aboriginal introductions in the South Pacific.

ENVIRONMENTAL PREFERENCES AND TOLERANCES

Climate

Tava grows naturally in the warm to hot, humid, subtropical and tropical zones.

Elevation range

0–500 (–1700) m (0–1640 [–5580] ft)

Mean annual rainfall

1500–5000 mm (60–200 in)

Rainfall pattern

Grows in climates with summer, bimodal, and uniform rainfall patterns.

Dry season duration (consecutive months with <40 mm [1.6 in] rainfall)

1–3 months

Mean annual temperature

22–28°C (72–82°F)

Mean maximum temperature of hottest month

25–32°C (77–90°F)

Mean minimum temperature of coldest month

18–24°C (64–75°F)

Minimum temperature tolerated

5–16°C (41–61°F)

Soils

Tava has a wide edaphic range but attains its best development on well drained, fertile loams and clays. In PNG the commercially important better timber tree forms of f. *pinnata* are found on better drained sites, whereas the poorer formed trees of f. *glabra* mainly occur on river flats and in low-lying areas.

Soil texture

It grows in medium and heavy texture soils (loams, sandy clay loams, clay loams, sandy clays, and clays).

Soil drainage

The tree grows in soils with both free and impeded drainage, as well as in seasonally waterlogged soils.

Soil acidity

Tava grows in acid to mildly alkaline soils (pH 4.0–8.0).

Tolerances

Drought

Examination of its natural distribution suggests that the tree is sensitive to an extended dry season, i.e., longer than 3–4 months.

Full sun

Mature trees grow best in full sunlight (or light shade up to about 25%), as do younger specimens (although specimens developing in open, sunny positions are likely to have short boles).

Shade

The tree tolerates 0–50% shade. Young seedlings and saplings are tolerant of high levels of shade. Planting under existing light to mid-density canopy (<50% shade) is a

suitable technique for establishing plantings of tava.

Fire

The tree is susceptible to fire.

Frost

It is likely to have little or no tolerance of frost as the entire native range is frost-free.

Waterlogging

Certain populations occur in swampy/riverine habitats and appear to have a moderately high tolerance of waterlogging.

Salt spray

It has little tolerance of saltwater spray or temporary saltwater inundation due to storm surge or tsunamis.

Wind

The species is tolerant of strong, steady winds and will develop a more stout form under such conditions. It is moderately resistant to cyclonic winds, with about 10% mortality from cyclones in the Solomon Islands in natural forest conditions.

Abilities

Regenerate rapidly

In rather undisturbed, closed forests, seedlings establish and persist with slow growth. The species regenerates by discontinuous recruitment, favored by small-scale disturbance, but not large gaps. Vine cutting is effective in liberating advanced growth of vine-smothered saplings; this has resulted in rapid regrowth and development of tava-rich forests in trials in Samoa.

Self-prune

In forest situations the species has a moderately good self-pruning ability, as frequently exhibited by the long, clear bole in mature trees. In open situations young trees tend to develop a coarse, low branching habit and often have poor self-pruning.

Coppice

Younger specimens may coppice, but coppicing of mature trees is unknown.

Pollard

Trees have been observed to regrow well following pollarding (and cyclone breakage of larger limbs). Regular cutting back or light pruning during fruit collection appears to stimulate subsequent fruiting.

GROWTH AND DEVELOPMENT

Early height growth is fast, about 2 m (6.6 ft) per year on sites with good soil fertility and moisture levels and intermediate to high light levels. After the first few years, growth rates are typically 1–2 m (3.3–6.6 ft) in height per year. In field trials in the Solomon Islands the annual stem diameter increment was in the range of 1.6–2.5 cm (0.6–1 in), with growth declining with age. The fastest growing trees attained a diameter a breast height (dbh) of 30 cm (12 in) in 13–16 years but had poor form and short boles to only 4–8 m (13–26 ft).

Reaction to competition

The species copes well with competition from other trees and crops, but growth will slow in more heavily shaded conditions.

PROPAGATION

Stands may be established either by direct sowing, seedling planting stock, or assisted natural regeneration (by removal of smothering vines). Vegetative propagation by stem cuttings is possible, and this may be a useful technique for mass propagation of selected material.

Seedlings

Seed collection

Fruit collection time varies among locations, and in some areas there may be more than one fruiting season per year. In PNG and the Solomon Islands the main fruiting season is November–March. In Fiji and Tonga the main fruiting season is February–March. For those countries in which the fruits are consumed, a good guide to collection time is when fruits become available in the market. A cost-effective collection method is to purchase good-quality fruits from different vendors; this technique is particularly appropriate when selecting germplasm for planting tava for fruit production. Seed can also be collected from the crown, which is the preferred option, or following natural shed. The seed is sensitive to moisture reduction and is readily damaged by insects or fungi. Seed collected from the ground must be harvested within a day of fruit fall to ensure that immature fruit is not collected. Collected fruits are placed in cloth bags in a cool location (out of the sun) and processed as soon as possible.

Seed processing

Removal of the flesh (pericarp and arillode) promotes seed germination. There are about 300–500 seeds/kg (136–227 seeds/lb).


Mature specimen showing straight trunk clear of branches to about 12 m (40 ft), 'Upolu, Samoa. PHOTOS: C. ELEVITCH

Seed storage

Seeds are recalcitrant and seed moisture content is about 35–55%. Under suitable conditions, including good air ventilation around fruits and cool temperatures (e.g., 10–15°C [50–59°F]), the seed can be stored for up to 6 weeks with the skin intact.

Seed pretreatment

Preferably the seed should be sown immediately after cleaning, and no treatments are necessary.

Growing area

Field Given the large seed, very rapid germination (commencing within 2–3 days), rapid initial seedling growth, and need to grow in large pots, direct sowing into the final field location is an effective and cost-efficient practice. With very fresh seed of high viability, only two seeds need be sown at each planting spot. Direct-sowing locations should be indicated and lightly shaded by living marker stakes of *Gliricidia sepium*, *Hibiscus tiliaceus, Polyscias* spp., or similar species.

Shade house If seeds are sown in a germination tray, transplanting is best done as soon as possible after the seed has germinated.

Germination

Most of the seeds will germinate within 7–10 days of sowing. Fresh seed has a high initial viability (e.g., >90%) but rapidly loses viability in storage.

Media

Seedlings can be grown in most standard potting media,

especially the more fertile, loamy types.

Time to outplanting

In the case of nursery-raised seedlings, the period in the nursery may be very short, as short as 6 weeks. Plants need to be grown in large pots if they are to be held in the nursery for more than 2 months.

Guidelines for outplanting

The approximate size at outplanting should be 25 cm (10 in) in height and approximately 4–6 mm (0.16–0.24 in) in diameter. Reasonable maintenance, including regular weeding on an as-needed basis, ensures high survival (e.g., >90%) and good early height growth.

Vegetative propagation

Experiments in PNG have shown that the species can be vegetatively propagated. Initial trials resulted in 50% rooting, but this was increased up to 100% by refining the technique using cutting material taken from older hedge plants (20 months). The most successful results were achieved by using shoot cutting material 3–5 cm (1.2–2 in) in length. The leaf area was reduced to about one third of its original size, and a rooting hormone gel (0.3% IBA) was used.

DISADVANTAGES

A general drawback is lack of availability of germplasm that combines both good fruit characteristics and good stem form for timber production. This reduces the utility of the species for multipurpose plantings. To reach tava's potential as a multipurpose timber/fruit tree will require a moderately intensive, medium-term (up to 10 years) improvement program.

Potential for invasiveness

The species is considered to have a low invasive potential, at least to spread rapidly. In forests remote from human habitation, the majority of the tava fruits/seeds fall near the parent tree. It is likely that dispersal by bats and birds will result in some medium-distance dispersal, i.e., up to several hundred meters away from the parent tree, and infrequently results in long-distance dispersal. In the South Pacific there is a good correlation between the distribution of fruit bats and tava. In areas where its fruits are consumed by humans, it is likely that tava seeds were distributed widely by humans, both inadvertently and deliberately.

Diseases and pests

In parts of the South Pacific, including Vanuatu and Fiji but not Samoa, saplings and mature trees suffer considerable defoliation, with almost all leaves having a heavily shot-holed appearance. Growth rates are reduced where leaf damage is severe, or over an extended period. Witches' brooms, presumed to be of viral origin, are reported to be common. These may develop as malformations of shoots, leaves and inflorescences and may develop into a dense mass of almost 1 m (3.3 ft) diameter before falling from the tree. However, witches broom, while recorded for New Guinea, appears to be infrequent or absent in the South Pacific region. Various galls may develop on the leaves or flowers. *Conopomorpha cramerella* (cocoa pod borer moth) is also listed as a pest.

BIODIVERSITY REHABILITATION

Tava may be used as a "framework" species to catalyze the return of biodiversity into degraded Pacific forest ecosystems because:

- in many countries there is an abundance of tava seed for direct-seeding programs
- in many areas there are already large trees that can be liberated through vine cutting
- it grows moderately rapidly
- the tree attracts bats and pigeons that carry and disperse seeds of other Pacific trees and shrubs.

Host to crop pests/pathogens

Tava is reported to be a common wild host for the beetle *Oxymagis horni*, the larvae of which are a very serious pest of *Eucalyptus deglupta* in the Solomon Islands.

AGROFORESTRY/ENVIRONMENTAL PRACTICES

Mulch/organic matter

In parts of PNG, the dried leaves, the residue of collected fruit-laden branches, are a major source of nutrient-rich mulch in yam cultivation.

Soil stabilization

Mature trees have fairly extensive surface and near-surface lateral roots that aid in soil stabilization.

Crop shade/overstory

The tree provides a moderately dense shade and would not be well suited for interplanting with crops that have a high light requirement.

Homegardens

Good fruiting types are well suited for inclusion in homegardens.

Improved fallows

In parts of PNG the trees are used as a planted fallow, assisting in more rapid return of soil fertility.

Boundary markers

The trees are occasionally planted or retained along property boundaries, serving as markers.

Windbreaks

Tava is infrequently planted specifically as a windbreak, but the trees have a moderately dense canopy and could be incorporated as the upper strata of a multi-tiered windbreak.

Silvopasture

In some parts of the Pacific, such as East Santo, Vanuatu, old trees are retained in pastoral systems to provide shade, fruit, and fuelwood.

Animal fodder

It has not been recorded as an animal fodder.

Woodlot

It is suitable for planting in woodlots, but long rotations and often variable bole form would discourage plantings solely for wood production.

Native animal/bird food

It is an important food tree for animals and birds. The fruits are consumed by fruit bats (*Pteropinae*) and birds, including pigeons.

Wildlife habitat

This tree makes an excellent habitat for wildlife, providing food and shelter and nesting sites (in the form of hollows).

Coastal protection

It is not especially useful for coastal protection, as the canopy is sensitive to salt spray.

Ornamental

Mature trees have a lot of character, with an attractive mottled to smooth bole and red flush of new growth. Most forms develop into large trees that should not be planted adjacent to buildings.

USES AND PRODUCTS

Tava produces a good general-purpose timber and is widely utilized locally throughout its range for a variety of end-uses. It is a commercially important export timber widely used for construction hardwood in PNG, and it is the most important native timber species in Samoa. In parts of the Solomon Islands the leaves are used for chewing with lime, and a canoe putty is extracted from the inner bark.

The fruits are edible, bearing some resemblance to the related lychee (*Litchi chinensis*).

Preparations from the leaves and bark are widely used in the South Pacific and elsewhere in traditional medicines to treat various ailments. Its timber is also considered an excellent firewood.

Fruit

Tava provides a very important seasonal fruit in many parts of the Pacific. The fruits are consumed fresh and sold in local markets and may be readily eaten fresh; the thin skin is removed simply by gripping the fruit around its circumference and twisting. Two shell-like halves come away from the fleshy aril that surrounds the seed. Fruits have a pleasant, sweet taste, reminiscent of a rather bland lychee.

In parts of its natural range it is highly regarded as a seasonal fruit, and its distribution has been expanded by people in Melanesia and Polynesia. In Tonga, the onset of its short fruiting season creates a hive of activity known as lulu tava (literally to "shake down the tava fruit"), before the bats or birds get at it. The greatest utilization of fruits occurs in New Guinea, the Solomon Islands, Vanuatu, and Fiji, which are associated with the selection and domestication of superior fruit types and the absence, until recently, of related Asian fruits trees such as rambutan and lychee. The areas where superior, large fruit types are reported from include the following.

Forma pinnata

PNG New Guinea Islands; Tanga (small island located east of New Ireland) has large, sweet-tasting fruits 3–4 times larger than those around Lae, with very thin, red skin.

Solomon Islands Tevai/Santa Cruz Group, Temotu Province.

Vanuatu Many localities including Banks Group, Santo, Malo, Epi, Aneityum.

Fiji Many localities, including SE Viti Levu, Gau, Kadavu.

Forma glabra

Irian Jaya Near Jayapura—vars. *kablauw* and *iwa* (Sentani language)—thick sweet flesh, tasting like rambutan.

Nut/seed

The seeds are barely edible and need to be roasted and baked prior to consumption. The cooked seeds resemble sour cheese in flavor and smell. The seeds may also be dried and stored.

Medicinal

In Papua New Guinea the masticated bark is applied to burns. In Fiji both leaf and bark extracts are used, either individually or in combination with other plants, to treat a wide range of ailments, including stomach complaints, diarrhea, dysentery, pain relief (bones, muscles, joints, chest, headache), colds, flu, diabetes, and mouth ulcers. In Tonga an infusion of the bark was used to treat diarrhea in children, stomach trouble, serious coughs accompanying fever and constipation, and the leaves were also used medicinally. The bark contains a saponin (an oleanolic acid glycoside), leucoanthocyanidins, and condensed tannins. In parts of Sarawak (Malaysia) it was used as a traditional treatment for chicken pox, with the patient being bathed in an infusion (hot water extract) of the bark. In the Solomon Islands an oral medicine is prepared from the bark to protect babies from the devil.

Near-ripe fruits, 'Upolu, Samoa. PHOTO: C. ELEVITCH

Masticant/stimulant

In parts of the Solomon Islands the leaves are used for chewing with lime.

Timber

The wood is a very good general purpose hardwood suitable for a wide range of uses. Its timber is particularly well suited to light construction, moldings, interior joinery and framing, non-impact tool handles, furniture, and veneers. The sapwood is pale pink or buff, 2.5–5 cm (1–2 in) wide, and not always well demarcated from the red or red-brown heartwood. The grain is usually straight or sometimes strongly interlocked. Wood texture is fine to coarse and uneven. Wood is slightly lustrous with an occasional ribbon or flame on back-sawn faces. It works easily with most machine and hand tools, but wood properties may vary depending on locality/site and taxonomic form.

Air-drying of 12 mm (0.5 in) boards may take 4 months and 40 mm (1.6 in) boards up to 6 months. Considerable degradation may occur during drying unless boards are handled with care. Mild kiln drying schedules will minimize surface checking and twisting of back-sawn material. Final steaming treatment reduces twist but could accentuate surface checking. Timber saws cleanly, producing fair to excellent surfaces. Peeling properties are variable. High-density or waterlogged zones may adversely affect peeling in some logs, with pre-heating advisable. Good quality stock is suitable for face veneer in plywood. The timber glues, screws, and nails well, takes a nice polish, and paints and stains satisfactorily. Shrinkage and density are variable (in the range 464–1025 kg/m^3 [28.9–64.0 lb/ft^3], typically averaging 690–750 kg/m^3 [43.0–46.8 lb/ft^3] at 12% MC), strength properties are intermediate/good, steam-bending properties are generally good, and moisture movement is low to medium. Durability is rather low, but the wood is suitable for outdoor uses not involving ground contact. The heartwood is impermeable, and the sapwood is moderately resistant to preservative impregnation. In service the wood is susceptible to pinhole and marine borer attack, and brown stain. Tava sawdust may cause irritation to nose and throat.

Fuelwood

The wood is an excellent, hot-burning fuel.

Craft wood/tools

In the Solomon Islands the wood is used for making axe handles.

LORE

In Ikutingting, Tanna (Vanuatu), the fruiting time of tava indicates that root crops in gardens are just beginning to store starch and that they are not ready for harvesting. Wild fruits offer alternative foods while allowing garden crops to complete the cycle to harvest.

Canoe/boat/raft making

In the Solomon Islands the wood is used for making canoes and paddles (although these are not especially durable). In Fiji and Tonga, the timber is used in boat building. A canoe putty is extracted from the inner bark.

Tannin/dye

In Fiji an extract of the leaves was formerly used to dye hair black.

COMMERCIAL CULTIVATION

The two main commercial products are timber and fruit.

Timber The species is an important general utility timber throughout much of its native range. It is the major timber species cut in native forests in Samoa and the most important construction timber in PNG.

Fruit Better fruiting types have been selected in Melanesia (southwest Pacific), where it is an important seasonal fruit.

Spacing

Timber

Open, sunny areas are unsuitable for timber plantations of tava, as young trees will break crown early, resulting in a short bole. In secondary or logged-over forest, tava may be planted in enrichment line plantings, with about 8–12 m (26–39 ft) between rows and 2 m (6.6 ft) within rows (for direct-seeding) and 4 m (13 ft) within rows (for seedlings). Tava may also be underplanted in taller forests where the canopy is not too dense (i.e., over 50% shade). The final crop density for timber production would be about 150–200 trees/ha (61–91 trees/ac). For block plantations a closer initial spacing of 3 x 4 m (10 x 13 ft) is recommended in order to reduce weeding. A thinning regime, involving three separate thinnings undertaken every few years and when crowns begin to touch and overlap, is recommended to achieve a final spacing as indicated above. The species is yet to be planted on any large commercial scale for timber. The area needed for timber production would range from 1–2 ha (2.5–5 ac) for local needs up to several hundred hectares to supply or supplement timber supply to a small sawmilling operation.

In parts of lowland Samoa there are large areas of secondary forest, opened due to a combination of cyclones and logging, and now smothered by vines. These forests are in a state of "arrested succession" (unable, or only very slowly able, to develop into lowland closed forest without human assistance); however, with several cycles of vine cutting a tava-rich forest may develop.

Fruit and timber

Closer spacing may be used for smaller-growing varieties, or in cases where fruit type is uncertain, such as for seedlings, and where thinning may be advantageous to produce an orchard of better-fruiting types.

Fruit

A suitable spacing for commercial production of fruit is likely to be 8–9 x 8–9 m (26–30 x 26–30 ft), i.e., 125–150 trees per ha (51–61 trees/ac). The area required for a fruit orchard will usually not be great, e.g., <0.5–1 ha (1.2–2.5 ac), as local markets could easily be over-supplied. With rigorous quality control over selected fruit, attractive packaging, and good marketing, it may be possible to develop a boutique industry supplying and exporting bottled tava fruits in syrup. In this case a larger area, of several to tens of hectares of good fruiting types, would need to be established.

Management objectives and design considerations

Timber

Periodic pruning of lower branches should be undertaken

Vines covering forest of tava trees arrests tree growth, Samoa. Trees can recover if vines are controlled over several years. PHOTO: C. ELEVITCH

to prevent them from developing into coarse branches which may even compete with the apical leading shoot. No more than one third of the crown should be removed at any one time.

Fruit and timber

For direct-seeded plantings, there is the option (if large quantities of seed are available) of establishing plantings at high densities and thinning out undesirable phenotypes, i.e., poorly formed stems in the case of timber plantations and trees that produce limited amounts of fruit or small fruits. Good weed control is essential, especially in the first 2–3 years, including regular removal of vines.

Fruit

Fertilizer application is not required, but tava fruit orchards may be kept more productive by periodic application of a complete fertilizer or interplanting with nitrogen-fixing trees and shrubs, such as *Calliandra, Casuarina*, *Gliricidia*, and *Flemingia*. Topping may be used to produce shorter, more spreading trees for fruit production.

Plantings for fruit production should be located near local markets (within 10–20 km [6–12 mi]) to keep transportation costs down and because fruits spoil easily during transport. Likewise, plantations for timber production should preferably be located near existing sawmilling facilities, e.g., within about 50 km (30 mi).

Yields

There is no documented information on timber and fruit yields. A monocultural plantation of better forms for timber production is likely to grow at about 5–10 m^3/ha/yr (72–144 ft^3/ac/yr) on fertile sites. Fruit yields for mature plantations of good fruiting types are estimated to be 2–8 mt/ha/yr (0.9–3.6 t/ac/yr).

Growing in polycultures

The species is very well suited to polyculture, growing together with other tree species to provide a wide range of products for local needs. An advantage of growing in polyculture is that trees develop better stem form for timber, compared to those grown under open conditions.

On-farm processing

It is important to sort and remove any damaged or rotting fruits, as these may cause more rapid spoilage of adjacent fruits.

Markets

Established local markets exist in many Pacific islands for both timber and fruits of tava, but the size of these markets is not well documented. There is potential to expand the local market for timber (and to provide timber for import replacement). Fruit markets are already mostly well supplied; varieties that produce larger, better-tasting fruits and/or those that extend the fruiting period will have better market potential.

Tava fruits bottled in syrup, a product developed by University of the South Pacific, Fiji. PHOTO: L. THOMSON

The University of the South Pacific (Institute of Applied Sciences and Food and Textiles Department) has developed a "dawa in syrup" product that appears to have export potential. A major UK retail chain has indicated they could market the product for about US$1 per fruit.

INTERPLANTING/FARM APPLICATIONS

Example system 1

Location

Lowlands of northwest Papua New Guinea.

Description

This traditional system consists of mixed food gardens, especially yam (*Dioscorea* spp.), banana, taro (*Colocasia esculenta*), and sugarcane. The cropping cycle is short, typically 18 months, followed by a fallow cycle of up to 30 years. During the cropping cycle, tava and breadfruit (*Artocarpus altilis*) are also planted and tended. Regular cutting back or light pruning during fruit collection from tava trees appears to stimulate subsequent fruiting.

The tava trees serve as both planted fallow, assisting in more rapid return of soil fertility, and in providing fruit. The dried leaves of tava, the residue of collection of fruit-laden branches, are heavily used as fertilizer mulch in yam cultivation.

Crop/tree interactions

There is minimal interaction between the trees and crops, as the trees are still small when crops are being grown. Planting seedlings among crops ensures good weed control during the establishment phase.

Spacing

Although there is no data available, the density of tava trees is estimated at 50 trees/ha (20 trees/ac).

Example system 2

Location

Tonga

Description

Tava is a very important component of the traditional agroforestry system in Tonga. The five most important trees in Tonga's rural allotments are coconut palm (*Cocos nucifera*), koka (*Bischofia javanica*), mango (*Mangifera indica*), citrus trees (*Citrus* spp.), and tava. In this system a lower stratum of root and other crops, characterized by mixed and staggered planting, is closely integrated with a dense mosaic of mixed tree species, including many different fruit trees and other useful multipurpose species, and fallow vegetation in various stages of regeneration.

Yields/benefits

Increased and more sustainable yield of a wide range of products, including food, wood, medicines, and cultural products.

Crop/tree interactions

Trees provide shelter and varying levels of shade for crops, and assist with cycling of soil nutrients that are below the crop root zone.

Eighteen-month-old tava sapling in rainforest regeneration plot, Falelima, Savai'i, Samoa. PHOTO: L. THOMSON

Spacing/density of species

Generally there are 1–3 trees per rural allotment (estimate).

PUBLIC ASSISTANCE AND AGROFORESTRY EXTENSION

Extension offices for agroforestry and forestry in the Pacific: http://www.traditionaltree.org/extension.html

INTERNET

CIRAD Forestry Department's wood quality page for tava: <http://www.cirad.fr/activites/bois/en/syst/asia/kasai.pdf>.

BIBLIOGRAPHY

(☛ indicates recommended reading)

Adema, F., P.W. Leenhouts, and P.C. van Welzen. 1996. Sapindaceae. In: Soepadmo, E., K.M. Wong, and L.G. Saw (eds.). Tree Flora of Sabah and Sarawak. Vol. 2. Sabah Forestry

Department/Sarawak Forestry Department/Forest Research Institute of Malaysia, Kepong, Malaysia.
Allen, B.J. 1985. Dynamics of fallow successions and introduction of robusta coffee in shifting cultivation areas in the lowlands of Papua New Guinea. Agroforestry Systems 3: 227–238.
Anon. 1959. Natural Regeneration. Extract from 1959/60 Report of the Department of Forestry of Papua & New Guinea, Port Moresby, Papua New Guinea.
Anon. 1976. Solomon Islands Timbers. Timber Booklet 1. Major species. Forestry Division, Ministry of Natural Resources, Honiara, Solomon Islands.
Anon. 1977. Taun. Information Service Sheet 10–13, CSIRO Division of Building Research, Highett, Victoria, Australia.
Anon. 1996. A guide to some indigenous Fijian trees. Fiji German Forestry Project and Fiji Department of Forestry, Suva, Fiji.
Anon. 1998. *Pometia pinnata* data sheet. CABI electronic forestry compendium. CAB International, Wallingford, UK.
Bengough, C.C. 1965. Local volume tables for *Pometia pinnata* growing on Baga Island. Technical Note 3/65 of the Foreign Department British Solomon Islands Protectorate, Honiara, Solomon Islands.
Bigger, M. 1980. *Oxymagis horni* on *Eucalyptus deglupta*. Forest Pests of the Solomon Islands 1. Forestry Division, Honiara, Solomon Islands.
Bose, T.K., P. Das, and G.G. Maiti. 1998. Trees of the World–Volume 1. Regional Plant Resource Centre, Orissa, India.
Brammall, B., J. Beko, and M. Nime Wilangue. 2000. Vegetative propagation at PNG FRI. Pacific Islands Forests and Trees Newsletter 4, December 2000.
Burslem, D.F.R.P., and T.C. Whitmore. 1996. Silvics and Wood Properties of the Common Timber Tree Species on Kolombangara. Oxford Forestry Institute Tropical Forestry Paper 34. Oxford, UK.
Cambie, R.C., and J. Ash. 1994. Fijian Medicinal Plants. Commonwealth Scientific and Industrial Research Organisation, Australia.
Chand, V.S., and K.D. Croft. 1980. Bark constituents of *Pometia pinnata*. Fiji Journal of Agriculture 42: 51.
Corner, E.J.H. 1952. Wayside Trees of Malaya. Vol. 1, 2nd ed. Govt. Printing Office, Singapore.
Croft, K.D., and R. Tu'ipulotu. 1980. A survey of Tongan medicinal plants. South Pacific Journal of Natural Sciences 1: 45–57.
d'Eispeissis, J.L. 1940. The chief characteristics and uses of six New Guinea timbers. Australian Forestry 5: 81–84.
de Graaf, N.R., J.W. Hildebrand, P.B. Laming, and J.M. Fundter. 1994. *Pometia* J.R. Forster & J.G. Forster. In: Lemmens, R.H.M.J., I. Soerianegara, and W.C. Wong (eds.). Timber trees: minor commercial timbers. Plant Resources of South-East Asia 5(1). PROSEA, Bogor, Indonesia and Backhuys Publishers, Leiden.
Damas, K. 1993. Variation within *Pometia* (Sapindaceae) in Papua New Guinea. Proceedings of the Biological Society 59–75. Wau Ecological Institute, Wau, Papua New Guinea.
Ha, C.O., V.E. Sands, E. Soepadmo, and K. Jong. 1988. Reproductive patterns of selected understorey trees in the Malaysian rain forest: the sexual species. Botanical Journal of the Linnean Society 97: 295–316.
Havel, J.J. 1975. Training Manual for the Forestry College, Vol. 3 Forest Botany, Part 2, Botanical Taxonomy. Department of Forests, Port Moresby, Papua New Guinea.
Henderson, C.P., and I.R. Hancock. 1988. A Guide to the Useful Plants of Solomon Islands. Solomon Islands Research Department/Ministry of Agriculture and Lands, Honiara, Solomon Islands.
☛ Jacobs, M. 1962. *Pometia* (Sapindaceae), a study in variability. Reinwardtia 6: 109–144.
Johns, R.J. 1976. Common Forest Trees of Papua New Guinea. Part 6 Angiospermae—Sapindales, Umbellales, Ericales. Training Manual for the Forestry College, Bulolo, Papua New Guinea.
Johns, R.J. 1985. The vegetation and flora of the south Naru area (Madang Province), Papua New Guinea. Klinkii 3: 70–83.
Kale, P. 1999. A Forest Tree Seed Manual of Plantation and Indigenous Timber Species of Papua New Guinea. Forest Management Division Seed Manual Series, Vol. 1. PNGFA, Lae, Papua New Guinea.
Keating, W.G., and E. Bolza. 1982. Characteristics, Properties and Uses of Timbers. Volume 1. South-east Asia, Northern Australia and the Pacific. Inkata Press, Melbourne.
Kebler, P.J.A., and K. Sidiyasa. 1994. Trees of the Balikpapan-Samarinda Area, East Kalimantan, Indonesia—a Manual to 280 Selected Species. The Tropenbos Foundation, Wageningen, The Netherlands.
Kininmonth, J.A. 1982. Properties and Uses of the Timbers of Western Samoa. Indigenous Hardwoods. Forestry Research Institute, Rotorua, New Zealand.
Koorders, S.H., and T. Valeton. 1913–1918. Atlas der Baumarten von Java (Atlas of tree species of Java.). Fa. P.W.M. Trap, Leiden, the Netherlands.
Kunzel, W. 1989. Agroforestry in Tonga: A Traditional Source of Development of Sustainable Farming Systems. Occasional Paper 12. South Pacific Smallholder Project, University of New England, Armidale, NSW, Australia.
Lane-Poole, C.E. 1925. The Forest Resources of the Territories of Papua and New Guinea. Report to the Parliament of the Commonwealth of Australia. Government printer for the State of Victoria, Australia.
Li, H.W., C.B. He, G.W. Chen, and J. Hu. 1999. A phytocoenological study of a *Dracontomelon macrocarpum* community in Xishuangbanna. Acta Botanica Yunnanica, 21: 333–345.
Martel, F. & Associates. 1998. Rapid Rural Assessment Surveys in Samoa. Final Report. SPRIG (South Pacific Regional Initiative on Forest Genetic Resources), CSIRO Forestry and Forest Products, Yarralumla, Australia.
Merrill, E.D. 1967 (reprint). Enumeration of Philippine flowering Plants. 4 Vols. Asher and Co., Amsterdam.
Chính, N.N, C.T. Chung, V.V. Cân, N.X. Dung, N.K. Dung, N.K. Dào, T. Hop, T.T. Oanh, N.B. Quynh, and N.N. Thìn. 1996. Vietnam Forest Trees. Forest Inventory and Planning Institute. Agricultural Publishing House, Hanoi, Vietnam.
Powell, J.M. 1976. Ethnobotany. In: K. Paijmans (ed.). New Guinea Vegetation. ANU Press, Canberra, Australia.

Sandom, J.H. 1978. The Performance of Exotic and Indigenous Species in the Solomon Islands. Silvicultural note S/1/78. Forestry Division/Ministry of Natural Resources, Honiara, Solomon Islands.

Saulei, S., and R. Kiapranis. 1996. Forest regeneration following selective logging operations in a lowland rain forest in Papua New Guinea. Science in New Guinea 22: 27–37.

Seeber, G., H.J. Weidelt, and V.S. Banaag. 1985. Dendrological characters of important forest trees from eastern Mindanao. 2nd edition. GTZ, Eschborn, Germany.

Seemann, B. 1865. Flora Vitiensis: A Description of the Plants of the Viti or Fiji Islands with an Account of Their History, Uses, and Properties. L. Reeve and Co., London.

Siwatibau, S., C. Bani, and J. Kaloptap. 1998. A Community Forestry Survey of Over Twenty Rural Communities in Vanuatu for Nineteen Selected Tree Species. Report by Island Consulting, FSPI (Vanuatu) to CSIRO Division of Forestry/SPRIG Project, Canberra, Australia.

Smith, A.C. 1985. Flora Vitiensis Nova. Vol 3. Pacific Tropical Botanical Garden, Lāwa'i, Kaua'i, Hawai'i.

Soetisna, U., D.E. Rantau, and E.S. Mulyaningsih. 1999. Desiccation and storage trial of recalcitrant seed: a case study of *Pometia pinnata* and *Shorea leprulosa*. In: M. Marzalina, et al. (eds.). IUFRO Seed Symposium 1998 "Recalcitrant Seeds," Proceedings of the Conference held in Kuala Lumpur, Malaysia, 12–15 October 1998.

Sykes, W.R. 1970. Contributions to the flora of Niue. New Zealand Department of Science and Industry Research Bulletin 200: 1–321.

Thaman, R.R. 1976. The Tongan Agricultural Systems: With Special Emphasis on Plant Assemblages. University of the South Pacific, Suva.

Thaman, R.R. 1982. Hurricane Isaac and Tonga: A natural or cultural disaster? Journal of the School of Social and Economic Development, University of the South Pacific 3(8): 22–34.

Thaman, R.R. 1989. Agrodeforestation and the neglect of trees: threat to the well being of Pacific societies. Ples: An Environmental Education Journal for the South Pacific Region 5: 48–64.

Thaman, R.R. 1989. Fijian agroforestry: trees, people and sustainable polycultural development. In: J. Overton (ed.). Rural Fiji. Institute of Pacific Studies, University of the South Pacific, Suva.

Thaman, R.R. 1993a. Tongatapu Island, Tonga. In: W.C. Clarke and R.R. Thaman (eds.). Pacific Island agroforestry: Systems for sustainability. United Nations University Press, Tokyo.

Thaman, R.R. 1993b. Rarotonga and Aitutaki, the Cook Islands. In: W.C. Clarke and R.R. Thaman (eds.). Pacific Island agroforestry: Systems for sustainability. United Nations University Press, Tokyo.

Thaman, R.R., and W.A. Whistler. 1996. A Review of Uses and Status of Trees and Forests in Land-Use Systems in Samoa, Tonga, Kiribati, and Tuvalu with recommendations for future action. Working Paper 5. South Pacific Forestry Development Programme. Suva, Fiji.

Thaman, R.R., L. Wilson, M. Tuiwawa, S. Vodonaivalu, and S.V. Tuisese. 2000. Trees, forest genetic resources and arboreal diversity in Fiji: Current status and prospects for conservation and sustainable use—a view from the village. South Pacific Regional Initiative on Forest Genetic Resources (SPRIG), Canberra and University of the South Pacific, Suva, Fiji.

☛ Thomson, L.A.J, K. Damas, and R.R. Thaman. 2000. *Pometia pinnata* J. R. Forst. & G. Forst. Taun. Species information sheet prepared for the Papua New Guinea Forest Domestication and Conservation Project. CSIRO Forestry and Forest Products, Canberra, ACT, Australia.

Uriarte, M.T. 1994. Air-pollution resistant species recommended for urban areas (A highly resistant species). Techno-Info Series, 4(1) Jan–March. ERDS-NCR-DENR, Quezon City, Philippines.

Uwamariya, A. 2003. *Pometia pinnata* J.R. Forster & J.G. Forster. In: Gunn, B.V., A. Agiwa, D. Bosimbi, B. Brammall, L. Jarua, and A. Uwamariya. Seed handling and propagation of Papua New Guinea's tree species. ACIAR/CSIRO/PNGFRI.

Van Royen, P. 1964. Manual of the Forest Trees of New Guinea. Part 2—Sapindaceae. Division of Botany, Department of Forests, Lae, Papua New Guinea.

Walter, A., C. Sam, and A. Mabonlala. 1995. Les arbres frutiers du Vanuatu (Fruit and nut trees of Vanuatu). ORSTOM Actualities 48: 23–27.

☛ Walter, A., and C. Sam. 2002. Fruits of Oceania. ACIAR Monograph 85. [trs. P. Ferrar from Fruits d'Océanie] Canberra, Australia.

Weiblen, G.D. 1998. Composition and structure of a one hectare forest plot in the Crater Mountain Wildlife Management Area, Papua New Guinea. Science in New Guinea 24: 23–32.

Weiner, M.A. 1971. Ethnomedicine in Tonga. Economic Botany 25: 423–450.

Whitmore, T.C. 1974. Change with Time and the Role of Cyclones in Tropical Rain Forest on Kolombangara, Solomon Islands. Commonwealth Forestry Institute Paper 46. University of Oxford, UK.

Whitmore, T.C. 1966. Guide to the Forests of the British Solomon Islands. British Solomon Islands Protectorate. Oxford University Press, UK.

Whitmore, T.C. 1975. Tropical Rain Forests of the Far East. Clarendon Press, Oxford, UK.

Whitmore, T.C. 1976. Natural variation and its taxonomic treatment within tropical tree species as seen in the Far East. In: Burley, J. and B.T. Styles (eds.). Tropical trees: Variation, Breeding and Conservation. Linnaean Society, London.

Whitmore, T.C., and I.G.M. Tantra. 1986. Tree flora of Indonesia. Checklist for Sumatra. Forest Research and Development Centre, Bogor, Indonesia.

Whitmore, T.C., I.G.M. Tantra, and U. Sutisna. 1986–1990. Tree Flora of Indonesia. Checklists for Sumatra, Sulawesi, Bali, Nusa Tengera & Timor, Maluku and Kalimantan. 6 vols. Agency for Forestry Research and Development, Forest Research and Development Centre, Bogor, Indonesia.

Womersley, J.S., and J.B. McAdam. 1957. The forests and forest conditions in the territories of Papua and New Guinea. Government Printer, Port Moresby, Papua New Guinea.

Yuncker, T.G. 1959. Plants of Tonga. B.P. Bishop Museum Bulletin 220.

Zhou, S.Q. 1993. Cultivation of *Amomum villosum* in tropical forests. Forest Ecology and Management 60: 157–162.

Pometia pinnata (tava)

Authors: Lex A.J. Thomson[1] and Randolph R. Thaman[2]

1. South Pacific Regional Initiative of Forest Genetic Resources (SPRIG) Project, SPC Forestry Program, Suva, Fiji (current contact info: IPGRI, Via dei Tre Denari 472/a, 00057 Maccarese (Fiumicino), Rome, Italy; E-mail: L.Thomson@cgiar.org).
2. Geography Department, School of Social and Economic Development, The University of the South Pacific, PO Box 1168, Suva, Fiji; E-mail: Thaman_R@usp.ac.fj.

Acknowledgments: The authors and publisher thank Dale Evans, Brian Gunn, Diane Ragone, and Art Whistler for their input.

Recommended citation: Thomson, L.A.J., and R.R. Thaman. 2006. *Pometia pinnata* (tava), ver. 2.1. In: Elevitch, C.R. (ed.). Species Profiles for Pacific Island Agroforestry. Permanent Agriculture Resources (PAR), Hōlualoa, Hawai'i. <http://www.traditionaltree.org>.

Sponsors: Publication was made possible by generous support of the United States Department of Agriculture Western Region Sustainable Agriculture Research and Education (USDA-WSARE) Program; SPC/GTZ Pacific-German Regional Forestry Project; USDA Natural Resources Conservation Service (USDA NRCS); State of Hawai'i Department of Land & Natural Resources Division of Forestry & Wildlife; and the USDA Forest Service Forest Lands Enhancement Program. This material is based upon work supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, and Agricultural Experiment Station, Utah State University, under Cooperative Agreement 2002-47001-01327.

Series editor: Craig R. Elevitch

Publisher: Permanent Agriculture Resources (PAR), PO Box 428, Hōlualoa, Hawai'i 96725, USA; Tel: 808-324-4427; Fax: 808-324-4129; E-mail: par@agroforestry.net; Web: <http://www.agroforestry.net>. This institution is an equal opportunity provider.