



Broussonetia papyrifera (paper mulberry)

Moraceae (fig family)

ai masi (Fiji); *aute* (Societies, Cooks, Australs, New Zealand); *hiapo* (Tonga, Niue); *hiapo, tutu* ('Uvea); *lafi* (Futuna); paper mulberry (English); *u'a* (Samoa); *ute* (Marquesas); *wauke* (Hawai'i)

W. Arthur Whistler and Craig R. Elevitch

IN BRIEF

Distribution Native to Japan and Taiwan; an ancient introduction to many Pacific islands as far east as Hawai'i.

Size Small tree up to 12 m (40 ft).

Habitat Humid tropical, subhumid tropical, and temperate climates; 0–1500 m (5000 ft).

Vegetation Associated with numerous plants in cultivation.

Soils In the Pacific, moist volcanic soils are preferred.

Growth rate Growth rate is fast, usually 12–18 months to reach harvest size of 3–4 m (10–13 ft).

Main agroforestry uses Soil stabilization, homegarden.

Main products Bark for cloth and traditional medicine.

Yields No information for Pacific islands.

Intercropping Commonly planted with a wide variety of other species in fields and homegardens.

Invasive potential In the Pacific islands, only male clones were introduced. Because both male and female plants are required for viable seeds to be produced, paper mulberry is not invasive in the Pacific. In many places where both the male and female plants are present, such as the eastern U.S., the species is considered an invasive pest.



Paper mulberry cultivated in a mixed agricultural system in Tonga.

INTRODUCTION

Paper mulberry is native to Japan and Taiwan and is an ancient introduction across the Pacific as far east as Hawai'i. Although the tree is fertile in its native range, the plants carried into the Pacific were all male clones, transported and planted as rootstock or stems. Thus, the female plants with flowers and consequently fruit are absent.

The tree reaches a height of 12 m (40 ft) or more if allowed to grow, but in practice it is usually harvested at a much shorter height when the stems are about 2.5 cm (1 in) in diameter and 3–4 m (10–13 ft) tall. The tree was very important in traditional Polynesian culture, as its bark supplied one of the most important materials in ancient Polynesia—tapa cloth.

To make tapa, the bark is peeled from the cut stems to obtain a single long strip. The inner bark or bast is then separated from the outer bark, and after being scraped and washed, the strips are pounded to flatten them. The resulting sheets were felted together to form tapa, which could then be bleached in the sun and printed with native dyes to produce the finished traditional tapa cloth.

Today, the tree has disappeared from most of its traditional range and is cultivated to any extent only in Tonga, Fiji, and Samoa. It is important in these places because it is a major source of handicraft income in the form of finished tapa cloth. Although it is no longer used in Polynesia for clothing, in Tonga and Samoa tapa cloth is still worn during ceremonial occasions such as festivals or dances. It does not last very long when worn as everyday clothing.

The tree is grown in plantations and homegardens on islands where tapa cloth is still made. It can tolerate a wide range of environmental extremes, and even does well in temperate climates (its native habitat). Since only the male clones are present in Polynesia, the tree has no potential for becoming invasive.

DISTRIBUTION

Native range

The tree is native to Japan and Taiwan, where it is now mostly restricted to cultivation.

Current distribution

Paper mulberry was an ancient introduction eastward across the Pacific to Hawai'i. It was commonly grown throughout the high islands of Polynesia and Melanesia. In Micronesia it was recorded only from Pohnpei and Yap (modern introductions), but is virtually unknown there now. It is also virtually unknown and usually not recog-

nized on islands and archipelagoes where its bark is no longer fashioned into tapa cloth (i.e., in most of Polynesia except Tonga, Samoa, and Fiji). It is now recognized as a culturally significant plant in Hawai'i, however, which has led to a renewed interest in its cultivation. On the U.S. mainland, where both fertile male and female trees have been introduced, it is found from Illinois to Massachusetts, south to Florida and west to Texas. The tree is reportedly naturalized in Burma and Thailand.



The traditional art of tapa making is being rediscovered in Hawai'i, as at this cultural demonstration at Pu'uhonua o Hōnaunau, Kona, Hawai'i. PHOTO: C. ELEVITCH

BOTANICAL DESCRIPTION

Preferred scientific name

Broussonetia papyrifera (L.) Vent.

Family

Moraceae (fig family)

Non-preferred scientific names

Morus papyrifera L.

Common names

paper mulberry (English)

ai masi (Fiji)

aute (Societies, Cooks, Australs, New Zealand)

hiapo (Tonga, Niue)

hiapo, tutu ('Uvea)

lafi (Futuna)

mûrier à papier (French)

u'a (Samoa)

ute (Marquesas)

wauke (Hawai'i)

Size

Small tree up to 12 m (40 ft) in height, but it is often not allowed to get that tall in cultivation.

Flowers

Flowers occur in elongate, male spikes up to 8 cm (3.2 in) long and female axillary globose heads up to 2.5 cm (1 in) long, on separate male and female trees (although all trees in the tropical Pacific islands are apparently male). Female flowers have a two- to four-lobed perianth and a superior ovary with a filiform style. Male flowers have four valvate tepals and four free stamens with filaments inflexed in the bud. Flowering is unknown or infrequent over most of the tree's distribution in the Pacific.

Leaves

Leaves are simple, alternate, blade ovate to three- to five-lobed, 8–20 cm (3.2–8 in) long; lower surface densely tomentose, upper surface scabrous; margins serrate; petiole nearly as long as the blade.

Fruit

The fruit is a globose to club-shaped syncarp 1–2.5 cm (0.4–1 in) in diameter comprised of numerous red to yellow drupes (but not reported from the tropical Pacific islands).

Seeds

Not known to set seed in the Pacific islands, where the traditional population present belongs to a sterile clone.

Similar species

Since the tree rarely flowers, it may be hard to distinguish from other trees in a sterile state. However, the fuzzy, alternate, ovate, and often three-lobed leaves and the milky sap are the most characteristic indicators. Its habit of producing root suckers is one distinguishing feature. Also, the plant is always found in cultivation or in formerly cultivated sites. Some leaf forms can be confused with common mulberry; however, paper mulberry leaves have a rough, sand paper-like upper surface, whereas mulberry leaves are smooth.

GENETICS

Variability of species

The leaves are the most variable part, from slightly to deeply lobed, but this variation is not recognized taxonomically.

Known varieties

No varieties are reported. However, the ancient Polynesian plants are all male clones of the species, and it has been noted that Hawaiians used at least three terms to describe cultivars or forms of the plant (Meilleur et al. 1997).



Paper mulberry leaves. PHOTO: C. ELEVITCH

Culturally important related species in the genus

One other species of the genus, *Broussonetia luzonica*, is native to the Philippines; its wood is used for timber. It was reportedly introduced to Polynesia, but if so, it has not become established.

Genetic resources where collections exist

The trees used traditionally in the Pacific islands are sterile, while those grown on the U.S. mainland were introduced from where the tree is fertile (i.e., from its native range). The best genetic resources for the traditional clone are probably found in Tonga and Fiji, where the tree is still commonly grown.

ASSOCIATED PLANT SPECIES

The flora of its native habitat is secondary temperate forest. In the Pacific islands, the flora most often associated with the tree is comprised of introduced plants, both weeds and cultigens, which vary from island to island. The tree has virtually disappeared from much of its Pacific island range, but where it does occur, it is either cultivated or persists in moist valleys where it has survived after cultivation has ceased. The tree is found mostly in lowland plantations and homegardens, where it is associated with other cultivated plants, such as dryland taro, breadfruit, etc.

Species commonly associated as aboriginal introduction in Pacific islands

The tree is cultivated in plantations in Tonga and Fiji, and to a lesser extent Samoa, although elsewhere in the Pacific the tree has all but disappeared. It has traditionally been associated with trees like coconut and breadfruit, which are also grown in plantations and homegardens. Today, the same species are often associated with it as were in the past, with the addition of modern introductions, such as papaya, mango, and weeds of more recent introduction.

ENVIRONMENTAL PREFERENCES AND TOLERANCES

Climate

The tree has a wide ecological tolerance and can be grown in humid tropical, subhumid tropical, and temperate climates (since it is originally native to Japan and Taiwan). It is grown on the U.S. mainland as far north as Illinois, but farther northward it cannot survive the colder winters. It was originally cultivated in northern New Zealand, presumably limited southward by the colder winters there.

Sufficiently moist, warm to cool climates are suitable for its cultivation. It is not found on Pacific atolls, presumably because of the soil and maritime conditions.

Elevation range

Lower Near sea level.

Upper Up to 1500 m (5000 ft), but usually limited to the lower elevations by human factors (plantations rarely go high into the montane forest in the Pacific islands).

Mean annual rainfall

No data available, but it prefers wet climates.

Rainfall pattern

Grows under any rainfall pattern that keeps the soil moist most of the year. The tree also frequently grows along streams.

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

It can survive a 3–4 month dry period.

Mean annual temperature

Lower Below freezing, but the tree will not tolerate bitterly cold winters.

Upper This is not a limiting factor.

Soils

In the Pacific, moist volcanic soils are preferred. The tree is not cultivated on atolls, presumably because of the coral substrate.

Soil texture

Prefers light and medium texture soils (sands, sandy loams, loams, and sandy clay loams).

Soil drainage

Grows in soils with free drainage as well as seasonally and continually waterlogged soils.

Soil acidity

No data available.

Special soil tolerances

It can grow along streams.

Tolerances

Drought

It is able to tolerate long dry spells if properly situated. For example, it has been growing for years at Manukā State

Park in Ka‘u, Hawai‘i, where it has survived many years with 6–8 months of drought.

Full sun

The tree does best in sunny places.

Shade

It does not grow well in heavy shade.

Fire

The tree probably would survive fire, as it sprouts from its root base when the stems are harvested.

Frost

The tree is tolerant of frost but not bitterly cold winters.

Waterlogging

It is somewhat tolerant of waterlogged soils, as populations in Hawai‘i that have persisted long after being actively cultivated are often found along streams.

Salt spray

The tree is probably intolerant of salt spray.

Wind

It does not tolerate wind well.

ABILITIES

Regenerate rapidly

It can regenerate rapidly, as it readily forms new stems from the rootstocks after the stems have been harvested.

Self-prune

The buds that form lateral branches are usually removed so that they do not form side branches that leave holes in the inner bark, which would appear in the tapa cloth.

Coppice

The tree coppices well, and in fact, it is the main means of production of new stem shoots from the root system.

GROWTH AND DEVELOPMENT

The tree does not produce seed in the Pacific islands (since the trees are all male clones), thus there are no seedlings. The means of propagation is vegetative, either from root or stem cuttings. The tree grows rapidly, and when the stems are harvested, the rootstock rapidly forms new, fast-growing stems.

HAWAIIAN LORE

A Hawaiian legend tells of Hina and her tapa-making. Formerly, the sun always hurried across the sky. It went so rapidly that Hina’s tapas did not have time to dry. So her son, Maui, went to the place of sunrise, caught the sun’s first ray, and broke it off. Ever since, the sun has traveled more slowly (Neal 1965).

Growth rate

Under ideal conditions, harvest time can be reached in as little as 6 months. However, the time to reach harvest size of 3–4 m (10–13 ft) is usually 12–18 months. The side branches are usually removed from the stems to assure a clean, straight stalk free of side branches and, consequently, tapa cloth without major holes. Normally side branch buds are removed weekly, although during ideal growing conditions of sunlight, nutrients, and moisture, bud removal must be done twice weekly.

Yields

In Indonesia 2-year-old trees 2–3 m (6.6–10 ft) tall with stem diameter of 2 cm (0.8 in) yielded about 300 g (0.7 lb) of fresh bark per tree, equivalent to 90 g (0.2 lb) dry bark (Berg 2003).

Rooting habit

Paper mulberry generally grows with matted surface roots and a taproot. The surface roots frequently produce suckers. Mulch is beneficial to growth.

Reaction to competition

The tree can tolerate some competition, because the rootstock rapidly forms dense thickets of stems. It does not do well in the shade, however, which may be why in Hawai‘i relic stands are often found along streams, which are sunnier than deep forest.

Cultivation

Forster (1778) noted that the Tahitians “lop off the leaves and branches that are sprouting out, which operation increases the main shoot, and invigorates its straight growth.” When the plants are 3–4 m (10–13 ft) high (less than 2 years old) and usually less than 4 cm (1.6 in) in diameter, the stems are harvested leaving the rootstock, which is allowed to regenerate new stems. The methods of cultivation and production of tapa were very similar all across Polynesia. In Tahiti, Forster noted the plants are cultivated in fenced plots and that the Tahitians “plant the young shoots of the



Left: Side branches should be removed when they are very small, as woody branches such as these will cause holes in the main stem bark. **Right:** Thinned stand of paper mulberry with side branches removed. PHOTOS: C. ELEVITCH

aouta [aute], in regular rows, at the distance of about 18 inches, or two feet..." In Fiji, Seemann (1865) noted the tree is "propagated by cuttings, and grown 60–90 cm (2–3 ft) apart, in plantations resembling nurseries. For the purposes of making cloth it is not allowed to become higher than about 4 m [13 ft] and about 4 cm [1.6 in] in diameter." In Hawai'i, plantations of paper mulberry were often surrounded by enclosures of dry banana leaves to protect the plants while they were young, and plantings of it were often surrounded by stone walls in the Marquesas.

PROPAGATION

Root shoots (suckers), cut matted roots, stem cuttings, or sections of "second growth" stems are used for propagation.

Propagation by root shoots

Transplanting root shoots is reportedly the easiest method. These are best harvested when 30–45 cm (12–18 in) in

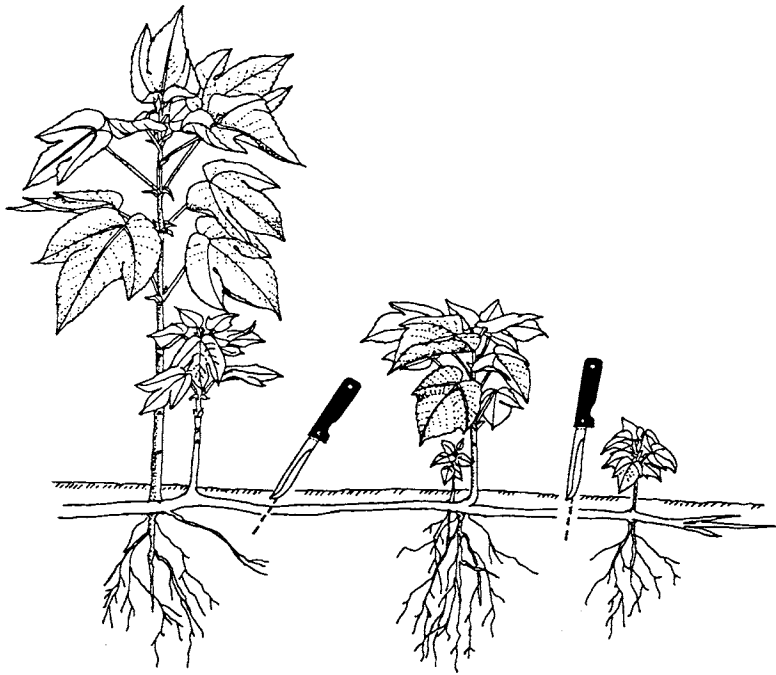
height. They are best cut from the mother plant by means of a sharp knife, and are then left to "harden" in place for a month before they are transplanted into a pot or directly into the field. When the shoots are gathered, care should be taken not to break the taproot. If this happens, the plant will dry up. The prepared shoots are placed in holes 80 cm (2.7 ft) apart in rows 1.2–1.8 m (4–6 ft) apart. In old Hawai'i, the land where the shoots were to be planted was cleared and mulched (Krauss 1974).

Shoot collection

Shoots about 2 m (6.6 ft) in length were used in Hawai'i (Krauss 1974). Shoots were cut from plants that had already started resprouting.

Shoot processing

All the leaves are removed from the shoots except for the terminal bud. As the plants grow, the lateral branches are plucked off to produce a clean, straight surface suitable for use in making tapa cloth.



Propagating paper mulberry from root shoots. ILLUSTRATION: JOAN YOSHIOKA, COURTESY HAWAII STATE OFFICE OF ENVIRONMENTAL QUALITY CONTROL

Shoot storage

There is usually no need for storage of the slips, because these can be harvested from live plants at nearly any time.

Planting

Special treatments, such as growth hormones or fungicides, are usually not needed.

Growing area

The plants are taken from the source plant and planted directly where they are to be grown, with no need of potting and replanting. They are usually planted in sunny places.

Starting vegetative material

The plants are put into the ground the day after they are cut from the source plant. In Hawai'i, cuttings kept overnight before being planted the next day were wrapped in ti or banana leaves to keep them moist. The cuttings are planted directly in the ground and covered with loose soil to promote drainage, then mulched.

Propagation by stem cutting

The stem cuttings are typically planted directly into the ground rather than needing to be first put in a nursery for later transplanting. Nagata (1992), however, recommends that the cuttings be put into a light potting medium such as perlite and covered with a clear plastic bag supported by a wire frame. The medium should be kept moist by adding water once or twice a week. All leaves (but not the termi-

nal bud) are removed from the cutting. Once the plants have rooted and are sprouting, they are planted in a weed-free area, then heavily mulched.

DISADVANTAGES

The plant was formerly important as a source of clothing. This use quickly disappeared throughout most of Polynesia after Western contact. The only modern use is as ceremonial dress and as handicraft. The methods of tapa making are largely forgotten on most of the islands where the plant was formerly cultivated. The process is very labor intensive.

Potential for invasiveness

The tree is not invasive in the Pacific islands, as all of the trees traditionally grown are male clones (hence, no seeds). Consequently, it can only spread slowly by root sucker and is easy to control. However, in temperate areas where fertile trees have been introduced, paper mul-

berry may become a pest since it fruits and produces seeds. As long as the male clone is used (which is the usual and useful type in the Pacific islands), there is no threat of invasiveness. Therefore, female plants should not be introduced in the Pacific.

Susceptibility to pests/pathogens

No information is available regarding pests and diseases of paper mulberry in the Pacific islands. In Japan the bacterial blight *Pseudomonas syringae* pv. *broussonetiae* affects paper mulberry. The fungi *Phytophthora boehmeriae* and *Dendryphiella broussonetiae* are known to attack the plant (Berg 2003).

Host to crop pests/pathogens

In China the plant is known to host crown gall (*Agrobacterium tumefaciens*), which causes tumor-like growths on the plant.

AGROFORESTRY/ENVIRONMENTAL PRACTICES

Soil stabilization

Due to the dense root mat and ability to grow on stream banks, it appears that some soil stabilization is provided by the growing plants.



Tapa making remains a very important part of Tongan culture. Pieces of tapa are much valued as gifts to be given by Tongans on special occasions. Nuku'alofa, Tonga. PHOTO: C. ELEVITCH

Homegardens

The plants are grown in homegardens and plantations in Tonga, Fiji, and Samoa. They are also sometimes grown in homegardens in Hawai'i, especially with the increased interest in this important traditional plant.

USES AND PRODUCTS

The most significant part of the paper mulberry is its strong, fibrous bark used in making native bark cloth commonly known as tapa cloth or tapa. The plant has other less important uses including medicinal ones.

Fruit

The sweetish fruits are edible, although where only male clones are present, such as in the Pacific Basin, no fruit is formed.

Leaf vegetable

In Indonesia, the steamed young leaves are eaten.

Medicinal

In Hawai'i, the slimy sap was used as a laxative and the ash of burnt tapa was used for treating thrush. In Samoa,

an infusion of the crushed leaves is sometimes taken as a potion for treating stomach pains and ill-defined abdominal pains. The leaf, bark, and fruit are used medicinally in Indochina.

Animal fodder

The leaves are fed to pigs in Indochina and to silkworms in China.

Fuelwood

After removing bark for tapa, the stems can be used for kindling.

Fiber/clothing

The inner bark has been used for centuries in Southeast Asia for paper and textiles. The bark is traditionally used in Polynesia to make bark cloth known as tapa. The bark is stripped from the cut stems by making a lengthwise incision across the stem and pulling it off intact to obtain a single long strip. The inner bark, or bast, is then separated from the outer bark, and any green matter remaining on the bast is removed using scrapers; the bast is then washed to remove the slimy sap. The strips are pounded on a wooden anvil by using a square, billyclub-like beater made of a hard wood. Two or three of the strips are then

felted together by the pounding, helped by the stickiness of the bark. Several of the resulting sheets are often pounded together in layers to increase the thickness or to cover over thin spots or holes in the individual sheets. A bit of paste in the sprinkling water is usually used at this point. These white tapas are then painted, or as in Hawai'i, printed with decorative designs. The finest and most delicate tapa in Polynesia was made in Hawai'i. Nowadays, however, tapa making in the Pacific is limited to Tonga and Fiji, and to a lesser extent, Samoa, and the tree and the art are nearly forgotten everywhere else.

Rope/cordage/string

The bark fiber can be used to make rough cordage, as can the roots.

Ceremonial/religious importance

The bark cloth is used ceremonially in Tonga, Fiji, and Samoa. In Hawai'i, tapa was important in burial wrapping and other funerary customs (Meilleur et al. 1997).

URBAN AND COMMUNITY FORESTRY

Paper mulberry is primarily of cultural rather than ornamental value. The tree can be grown in homegardens, but its tendency to produce root suckers requires constant maintenance. This maintenance is a normal part of cultivating the plant for tapa but may present an overwhelming burden to a homeowner or public works department. The tree can also be allowed to grow out to its full size as a shade tree, although a large tree still produces root suckers.

Size in an urban environment

The tree can grow to 12 m (40 ft), but in cultivation the stems are usually cut off at the base when they reach 4 m (13 ft). New stems quickly sprout back.

Rate of growth in a landscape

In a landscape, especially where weeds are controlled and irrigation used when necessary, the new growth is expected to reach 4 m (13 ft) annually.

Root system

Paper mulberry forms a dense surface root mat. Since these readily produce suckers every few

feet, the tree can interfere with lawns and other landscaping features if not given plenty of space for growth.

Products commonly used in a Pacific island household

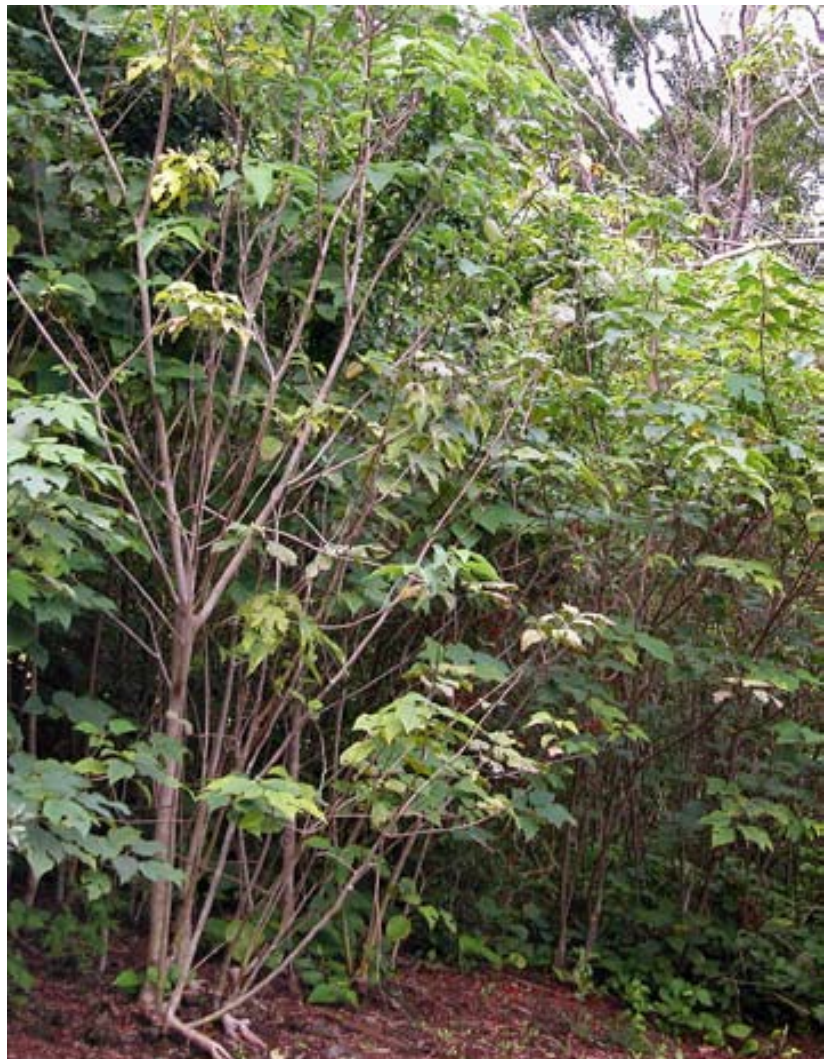
The most common use is for making tapa cloth. The cultural value of tapa artwork is enjoying a revival in some areas, such as in Hawai'i.

Light requirements

The plant requires full sun for vigorous growth. However, light shade from surrounding plants will not substantially reduce growth rates.

Water/soil requirements

It prefers light and medium soils, although it tolerates pe-



This planting has survived for decades at Manukā State Park, Ka'u, Hawai'i, with little care and long droughts. PHOTO: C. ELEVITCH



Paper mulberry stems are sold at the central market in Nuku'alofa, Tonga.

PHOTO: C. ELEVITCH

riodic waterlogging. The plant grows best with continuous soil moisture.

Life span

By all indications, the plant will grow for many decades, even when stems are cut off every 12–18 months.

Varieties favored for use in homegardens

There are no known varieties in the Pacific, although the Hawaiians recognized three forms of paper mulberry. It is best to propagate a plant that is known to grow well in the area.

Seasonality of leaf flush, flowering, fruiting

Paper mulberry grows continuously as long as there is sufficient soil moisture. During drought, active growth ceases. The traditional paper mulberry plants of the Pacific islands

do not usually flower and never set fruit (since all of the individuals are male).

Exceptional ornamental values

The light to dark green foliage is attractive. However, the plant is usually grown for its cultural values rather than as an ornamental.

Use as living fence, hedge or visual/ noise barrier

A dense thicket of paper mulberry consisting of numerous plants or suckers spaced on a grid of about 0.75–1.5 m (2–4 ft) could serve as a visual barrier. Visual protection would require preserving the lower branches, which excludes use of the stems for making tapa.

Bird/bee/wildlife

In cultivation, the plant has little wildlife value, and due to the absence of flowers and fruit, it is of little importance to bees or birds.

Maintenance requirements

The tree can grow well without fertilizer, although in poor soils light applications of balanced fertilizer would be beneficial. Mulching is highly beneficial to the plant. Pruning side branches is necessary for tapa production, as is continual harvesting of the stems at a height of about 4 m (13 ft) and stem diameter of no more than 2.5–4 cm (1–1.5 in).

Nuisance issues

The plant tends to spread outward from the main plant by means of root suckering, which can easily become a nuisance, especially in small garden areas. The root suckers will come up in neighboring areas, and when cut off at the base, new sprouts often quickly arise. Since the root suckers are connected to the main plant, herbicide cannot be used to control suckers. The only means of control is continual cutting at the base.

Common pest problems

The plant is relatively free of pests. An occasional white fly infestation has been reported (Deگو 2004).

Other comments about this species in homegardens

The tree is most suitable for those wanting to produce tapa cloth, which is still commonly made in Tonga and Fiji, and

is having a revival in other places, such as Hawai'i and Samoa.

COMMERCIAL PRODUCTS

The only commercial product of the paper mulberry is tapa cloth. Originally this was used for mostly ceremonial clothing. Nowadays it is used ceremonially in Tonga, Samoa, and Fiji, and is an important handicraft as well. Much time is spent by women in Tongan villages making tapa cloth. This is sold for export or local use. The dried strips of bark and the white, unpainted tapa cloth are also sold locally (e.g., in the Nuku'alofa marketplace in Tonga) to women who want to make the finished product.

Spacing for commercial production

A spacing of 45–60 cm (18–24 in) has been noted by various sources.

Polycultures

Paper mulberry grows well with many other crops as long as it is not heavily shaded.

Estimated yield

No information is available for the Pacific islands. In Thailand, plants grown with a spacing of 1 x 1 m (3.3 x 3.3 ft) harvested 6–12 months after planting yielded 2400–2800 kg/ha (440–520 lb/ac) of bark.

Markets

Strips of the inner bark, raw (uncolored) tapa cloth, and finished tapa cloth are sold in local markets in Tonga. Elsewhere, the finished tapa cloth is the most common product, and this is imported as a handicraft in many curio shops in tourist areas in the Pacific. Otherwise nearly all of these products are used by the people who grow the plants (i.e., the handicraft makers grow their own trees).

INTERPLANTING/FARM APPLICATIONS

Paper mulberry is very flexible in its growth requirements, and was, consequently, grown in a variety of systems. It was described in Hawai'i in 1793 growing with other traditional crops such as breadfruit and sweetpotato. The plantings were typically surrounded by fences made from dry banana leaves to shield them from the wind, according to Krauss (1993)

Example system (Johansen 2004)

Location

Manukā State Park, island of Hawai'i

Description

Planted 20 years ago at base of a slope of established plumeria and pothos vine (*Scindapsus pictus*). The area has received minimal care for past 15 years.

Crop/tree interactions

Paper mulberry groves persist growing in and among plumeria trees and pothos plantings, despite little care and periodic extended droughts.

Spacing

The plant survives in sparse populations over a much wider area than the original planting.

PUBLIC ASSISTANCE AND AGROFORESTRY EXTENSION

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

INTERNET

Canoe Plants of Ancient Hawai'i: <<http://www.canoeplants.com/wauke.html>>.

Kapi'olani Community College: <<http://apdl.kcc.hawaii.edu/~ahupuaa/botany/fiber/wauke.htm>>.

BIBLIOGRAPHY

(☛ indicates recommended reading)

- ☛ Abbot, I.A. 1992. Lā'au Hawai'i: Traditional Hawaiian Uses of Plants. Bishop Museum Press, Honolulu.
- Berg, C.C. 2003. *Broussonetia papyrifera* (L.) L'Hér. ex Vent. In: Brin, M. and R.P. Escobin (eds.). Plant Resources of South-East Asia No. 17. Fibre Plants. pp. 91–95. Prosea Foundation, Bogor, Indonesia.
- Boer, E., and M.S.M. Sosef. 1998. *Broussonetia* L'Hér. ex Vent. In: Sosef, M.S.M., L.T. Hong, and S. Prawirohatmodjo. (eds). Plant Resources of South-East Asia No. 5(3). Timber trees: Lesser-known Timbers. pp. 119–120. Backhuys Publisher, Leiden, The Netherlands.
- Brown, F.B.H. 1931, 1935. Flora of southeastern Polynesia. III. Dicotyledons. Bishop Museum Bulletin 130: 33–34.
- Dego, M. Amy Greenwell Ethnobotanical Garden, Kealahou, Hawai'i. Personal comm., September, 2004.

- Elevitch, C.R., and K.M. Wilkinson (eds.). 2000. Agroforestry Guides for Pacific Islands. Permanent Agriculture Resources, Holualoa, Hawai'i.
- Forster, J.R. 1778. Observations Made During a Voyage around the World in Physical Geography, Natural History, and Ethic Philosophy. G. Robinson, London.
- Fosberg, F.R., M.-H. Sachet, and R. Oliver. A geographical checklist of the Micronesian Dicotyledonae. *Micronesica* 14(1-2): 41-295.
- Handy, E.S.C., and E.G. Handy. 1972. Native Planters in Old Hawaii. Bishop Museum Press Bulletin 233: 1-641.
- Johansen, H. Horticulturist, Native Planters, Honomalino, Ka'u, Hawai'i. Personal comm., August, 2004.
- Kooijman, S. 1972. Tapa in Polynesia. Bishop Museum Press, Honolulu.
- ☛ Krauss, B.H. 1974. Ethnobotany of Hawaii. Unpublished manuscript, prepared for University of Hawai'i Department of Botany, Honolulu.
- Krauss, B.H. 1993. Plants in Hawaiian Culture. University of Hawai'i Press, Honolulu.
- ☛ Nagata, K.M. 1992. How to plant a native Hawaiian garden. State of Hawai'i, Office of Environmental Quality Control. <<http://www.state.hi.us/health/oeqc/garden/eioegpic.htm>>.
- ☛ Meilleur, B.A., M.B. Maigret, and R. Manshardt. 1997. Hala and Wauke in Hawai'i. Bishop Museum Bulletin in Anthropology 7: 1-55.
- Neal, M. 1965. In Gardens of Hawaii. Bishop Museum Press, Honolulu.
- Smith, A.C. 1985. Flora Vitiensis Nova 2. Pacific Tropical Botanical Garden, Lāwa'i, Kaua'i.
- Te Rangi Hiroa. 1930. Samoan Material Culture. Bishop Museum Bulletin 75: 1-724.
- Thaman, R.R., and W.A. Whistler. 1996. A Review of Uses and Status of Trees and Forest in Land-Use Systems in Samoa, Tonga, Kiribati and Tuvalu with Recommendations for Future Action. South Pacific Forestry Development Programme, Suva, Fiji.
- ☛ Whistler, W.A. 2001. Plants in Samoan Culture. Isle Botanica, Honolulu.



Traditional Tree Initiative—Species Profiles for Pacific Island Agroforestry (www.traditionaltree.org)

Broussonetia papyrifera (paper mulberry)

Authors: W. Arthur Whistler¹ and Craig Elevitch²

1. Isle Botanica, 2814 Kalawao St. Honolulu, Hawaii 96822 USA; Web: <<http://www.Islebotanica.com>>.

2. Permanent Agriculture Resources, PO Box 428, Hōlualoa, Hawaii 96725 USA; Web: <<http://www.agroforestry.net>>.

Acknowledgments: The authors and publisher thank Dale Evans, Heidi Johansen, Manuel Rego, and Peter van Dyke for their input.

Recommended citation: Whistler, W.A., and C.R. Elevitch. 2006. *Broussonetia papyrifera* (paper mulberry), 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); Kaulunani, an Urban Forestry Program of the DLNR Division of Forestry and Wildlife and the USDA Forest Service; State of Hawai'i Department of Land & Natural Resources Division of Forestry & Wildlife; USDA Forest Service Forest Lands Enhancement Program; and Muriel and Kent Lighter. 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), P.O. 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.

Reproduction: Copies of this publication can be downloaded from <<http://www.traditionaltree.org>>. This publication may be reproduced for noncommercial educational purposes only, with credit given to the source. © 2006 Permanent Agriculture Resources. All rights reserved.

