



## *Artocarpus mariannensis* (dugdug)

Moraceae (mulberry family)

*chebiei*, *ebiei meduuliou*, *mai* (Palau); *dugdug*, *dokdok* (Guam: Chamorro); *maiya* (Puluwat, Yap); Marianas breadfruit, seeded breadfruit (English); *mei chocho* (Chuuk); *mei kole* (Pohnpei); *mejwaan* (Marshall Islands); *mos en kosrae* (Kosrae); *te mai* (Kiribati); *ulu elibe*, *ulu elise* (Tokelau)

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### IN BRIEF

**Distribution** Palau, Mariana Islands, FS Micronesia, Kiribati, Marshall Islands, Tokelau, Tuvalu, Nauru, Banaba, and Rabi Island, Fiji.

**Size** Large tree 20 m (66 ft) or more at maturity.

**Habitat** Tropical regions, usually found sea level to 150 m (490 ft) with rainfall of 1300–3800 mm (50–150 in).

**Vegetation** Associated with remnants of tall native-canopy forest and secondary forest.

**Soils** Associated with raised coral or elevated limestone.

**Growth rate** Moderately fast growing in favorable conditions, growing 0.5–1.5 m (1.5–5 ft) per year.

**Main agroforestry uses** Soil stabilization, overstory, homegardens.

**Main products** Staple food, medicinal, wood for crafts and timber.

**Yields** 50 kg (110 lb) or more fruit per tree per year.

**Intercropping** Interplanted with small fruit trees or short-term fruit and vegetable crops.

**Invasive potential** It has little potential to become invasive.



PHOTO: D. RAGONE

Dugdug tree.

## INTRODUCTION

*Artocarpus mariannensis* (dugdug) is native to the Mariana Islands and Palau and is closely related to breadfruit (*A. altilis*), with which it has naturally hybridized. It is recognized on those islands as being distinct from breadfruit. However, this species and the numerous interspecific hybrids in Micronesia are considered to be “breadfruit,” whether they are seeded or seedless. Micronesian navigators spread it throughout the region and it is now widely cultivated, mostly in coastal areas and on atolls. In Kosrae it is believed to generally occur in the long-abandoned interior of the island, although some trees are found in lowland areas. It has been distributed as far south as Tuvalu, Tokelau, and Rabi Island, Fiji, and a few trees have been introduced to Hawai‘i. It is not grown elsewhere in the Pacific or in other tropical regions. This species, its close relative, *Artocarpus altilis*, and the many hybrid varieties are a major staple food tree in the Micronesian region. It tolerates salinity better than seedless breadfruit, but is usually cultivated in the interior of the atolls’ islets (motus) in close proximity to the taro swamps, where damage from salinity is less. The fruit is high in carbohydrates and is a good source of minerals and vitamins, especially vitamin A. The high-protein, relatively low-fat seeds are roasted and eaten. The large evergreen trees can reach heights of 20 m (66 ft) or more with buttressed trunks more than 2 m (6.6 ft) in diameter at the base. Trees of dugdug and hybrid varieties tend to be more massive than *A. altilis*, often not branching below 5 m (16 ft) from the ground. The straight trunks are very desirable for canoes, although the wood needs to be protected from direct sunlight. The sticky white latex is used as caulking and glue. Wild populations in Guam and the Northern Marianas are seriously declining due to typhoon damage and the disappearance of its important natural disperser, flying foxes.

## DISTRIBUTION

### Native range

This wild seeded relative of breadfruit (*Artocarpus altilis*) is native to the Mariana Islands, in limestone and ravine forests from coastal to lower mountain slopes. In Palau, it is common in the Rock Islands, in Peleliu, Angaur, and Kayangel, and in the Southwest Islands of Sonsorol, Fana, Pulo, Ana, Merir, and Tobi. It also found in calcareous soils along the northeast coast and on the volcanic island of Babeldaob. It is distributed through its natural range by flying foxes (fruit bats).

### Current distribution

Dugdug and hybrid varieties (*A. mariannensis* × *A. altilis*) are cultivated throughout the Republic of Palau, Federated States of Micronesia, Kiribati, Republic of the Marshall Islands, Tokelau, Tuvalu, Nauru, Banaba, and Rabi Island, Fiji. A few dugdug trees can be found in Hawai‘i. It has not been distributed elsewhere in the Pacific or to other tropical regions.

## BOTANICAL DESCRIPTION

### Preferred scientific name

*Artocarpus mariannensis* Trécul

### Family

Moraceae

### Non-preferred scientific names

*Artocarpus altilis*

*A. camansi*

*A. communis*

*A. incisa*

### Common names

*chebiei, ebiei, meduuliou, mai* (Palau)

*dugdug, dokdok* (Guam: Chamorro)

*maiyah* (Puluwat, Yap)

Marianas breadfruit, seeded breadfruit (English)

*mei chocho* (Chuuk)

*mei kole* (Pohnpei)

*mejwaan* (Marshall Islands)

*mos en kosrae* (Kosrae)

*te mai* (Kiribati)

*ulu elibe, ulu elise* (Tokelau)

### Size

It can reach heights of 20 m (66 ft) or more at maturity. The trunk may be 2 m (6.6 ft) or larger in diameter, often growing to a height of 5 m (16 ft) or more before branching. A sticky white latex is present in all parts of the tree. The bark is smooth, brownish-gray, with new shoots purplish-green.

### Form

Single-trunked tree with rounded, spreading evergreen canopy and typically forms buttresses at the base of the trunk.

### Flowering

Monoecious with male and female flowers on the same tree at ends of branches, with the male inflorescence appearing first. Male flowers are club-shaped, up to 3 cm (1.2

in) in diameter and 8–12 cm (3.1–4.7 in) long. Thousands of tiny flowers with two anthers each are attached to a central spongy core. Female inflorescences consist of 1500–2000 reduced flowers attached to a spongy core. The flowers fuse together and develop into the fleshy, edible portion of the fruit. Cross pollinated but pollination is not required for a fruit to form.

### Leaves

Leaves are alternate, 15–30 cm (5.9–11.8 in) long, broadly obovate to broadly elliptic, typically entire or shallowly 1–3-lobed on the upper third of leaf. Blade is smooth, glossy, flexible, dark green with greenish-yellow veins and few hairs on upper veins. Few to many appressed reddish hairs are found on veins on the leaf underside. Two large green stipules enclose the bud and turn yellow before dehiscing.

### Fruit

The fruit is a small fleshy syncarp, cylindrical, kidney-shaped or asymmetrical, about 15 cm (5.9 in) long, weighing approximately 500 g (1.1 lb). Its skin is dark green, even when mature, with a pebbly texture from the raised, flattened, hexagonal disks of individual flowers. The pulp is whitish-yellow when immature and deep yellow when ripe, with a sweet aroma and taste. The fruit is not as solid or dense as breadfruit because the individual flowers forming the fruit are fused together only at their bases. Fruit is produced mainly in summer.



Variable leaf form of dugdug. PHOTO: J. WISEMAN

### Seeds

The fruit contains up to 15 large, dark brown, shiny edible seeds 1.5 cm (0.6 in) long, with little to no endosperm and no period of dormancy. They germinate immediately and are unable to withstand desiccation. They are typically spread by flying foxes.

### How to distinguish from similar species/look-a-likes

This species can be readily distinguished from breadfruit (*A. altilis*) by the small, typically entire leaves. The dark green, lumpy fruit is smaller and more asymmetrical than breadfruit, with a dark yellow pulp. *Artocarpus camansi* (breadnut,



Left: Immature fruit and leaves. Right: Dugdug fruits are asymmetrical or kidney shaped with up to 15 large seeds. PHOTOS: D. RAGONE

kamansi) has oblong, very spiny fruits with little pulp and numerous large, light brown seeds, and large, shallowly dissected leaves with 4–6 pairs of lobes.

## GENETICS

### Variability of species

Dugdug is a genetically variable diploid species, produces abundant fertile pollen, and has naturally hybridized with *A. altilis* in Micronesia. Seeded hybrids and dugdug will readily cross with seeded forms of *A. altilis* when grown together, and there is much variation in the resulting seedlings.

### Known varieties

There are no varieties of dugdug, but there are numerous varieties that are hybrids of *A. mariannensis* and *A. altilis*. These hybrid varieties exhibit great variability in leaf and fruit form and can be seeded or seedless. The fruits typically are rough-skinned or pebbly, light to dark green in color, with flesh intermediate in fusion between dugdug and the dense, solid fruits typical of seedless Polynesian breadfruits. Seeded types typically have lumpy, asym-

metrical fruits 12–30 cm (3.7–11.8 in) long; some unusual forms have narrow, elongated fruits up to 45 cm long. Most seeded types are unique to a particular area, because they are local seedling selections. Some seedless hybrid cultivars such as ‘Mein padahk’ are widely distributed and grow on both high islands and coral atolls.

‘Mein padahk’ (‘Butatak’, ‘Betaaktak’) is important throughout the FSM and the Marshall Islands and is well adapted to atoll conditions. It is tall, reaching heights of 12–15 m (39–49 ft), with a dense, spreading canopy. The small, shiny, moderately dissected leaves have three to five pairs of lobes (some have only one or two pairs). The oval to asymmetrical, light yellow-green, seedless fruits are 12–24 cm (4.8–9.6 in) long and 11–16 cm (4.4–6.4 in) wide and weigh 0.7–3.1 kg (1.5–6.8 lb), averaging 1.8 kg (3.9 lb).

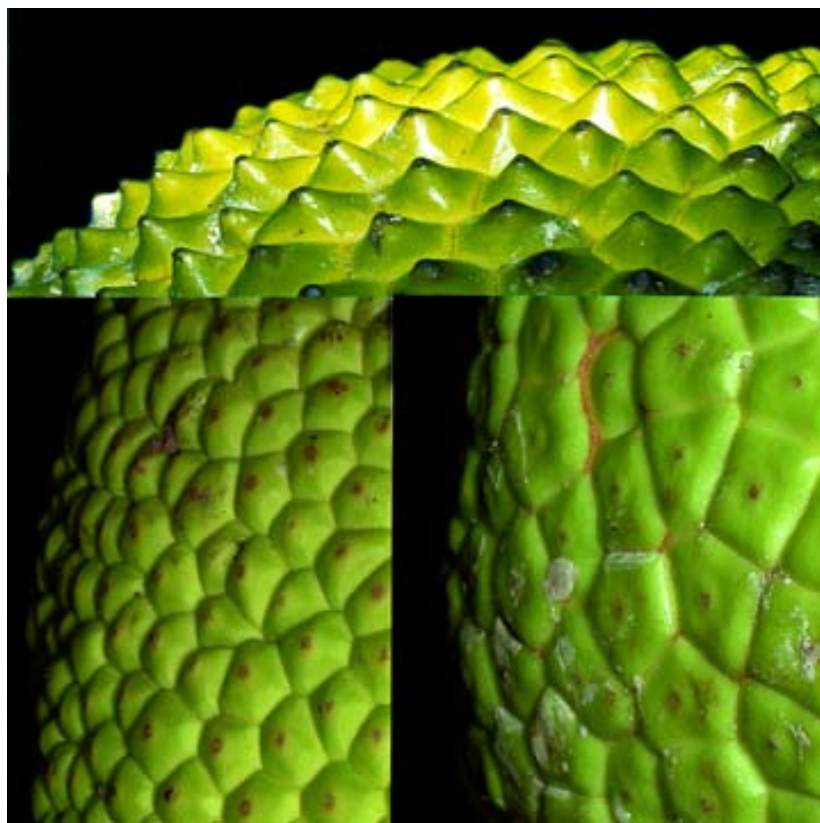
‘Te mai keang’ is found in Kiribati, the outer islands of Chuuk and Yap, Banaba, other Micronesian atolls, and Rabi island, Fiji. This seeded hybrid cultivar has pebbly-textured fruits typical of dugdug and deeply dissected leaves with 4–6 pairs of widely spaced, narrow lobes typical of *A. altilis*.

### Genetic resources where collections exist

A breadfruit germplasm collection at the National Tropical Botanical Garden in Hawai‘i has eight accessions of dugdug from the Northern Mariana Islands, Chuuk, and Pohnpei and more than 30 accessions of *A. altilis* × *A. mariannensis* hybrids from Chuuk, Pohnpei, Palau, Guam, and Tokelau.

## ASSOCIATED PLANT SPECIES

Dugdug is an important component of the vegetation associated with raised coral or elevated limestone. In the southern Marianas what remains of the once-extensive, tall, closed-canopy forest is dominated by enormous wild dugdug trees and banyan (*Ficus* spp.). The most common trees in inland areas of elevated limestone belong to the genera *Ficus*, *Pandanus*, *Intsia*, *Elaeocarpus*, *Aglaia*, *Fagraea*, *Pipturus*, *Cycas*, *Claoxylon*, *Osmoxylon*, *Syzygium* (*Eugenia*), *Premna*, *Guamia*, *Hernandia*, *Pouteria*, *Erythrina*, *Aidia*, *Melanolepis*, *Cynometra*, *Semecarpus*, *Meryta*, *Milletia*, and *Dracaena*. Depending on the area, the undergrowth includes *Psychotria*, *Clerodendrum*, *Morinda*, *Tarenna*, *Phyllanthus*, *Polyscias*, *Maesa*, *Ficus*, *Maytenus*, and *Syzygium* and tangled vines of *Canavalia*, *Mucuna*, *Operculina*, *Alyxia*, *Caesalpinia*, *Connarus*, and *Freycinetia*.



Hybrids are easily recognized by their shiny, bumpy or pebbly skin. PHOTOS: D. RAGONE



Clockwise from top left: Long hybrid; hybrid variety 'Te mai keang'; hybrid variety 'Mein padahk'; variation in fruits from different dugdug trees. PHOTOS: D. RAGONE

In the Marianas this forest occurs largely on flat terraces and cliffs.

In Palau dugdug occurs on elevated limestone islands with steep slopes and ridges as well as on coral platform islands and an atoll. The sharply eroded limestone karst is densely wooded with a closed and diverse broadleaf evergreen forest composed of *Eugenia reinwardtiana*, *Morinda latibracteata*, *Garcinia matudai*, *G. rumiyo* var. *calcicola*, *Intsia bijuga*, *Rinorea* sp., *Cycas circinalis*, *Flacourtia rukam*, *Aidia cochinchinensis*, *Mertya senffiana*, *Polyscias grandifolia*, *Geniostoma sessile*, *Premna serratifolia*, *Cyrtandra todaiensis*, *Guettarda speciosa*, *Badusa palauensis*, *Psychotria hombroniana*, *Ixora casei*, and *Tarenna sambucina*, with such lianas as *Alyxia palauensis*, *Cayratia trifolia*, *Trichosanthes hosokawae*,

*Derris trifoliata*, *Canavalia cathartica*, *Caesalpinia crista*, and others. The endemic palm *Gulubia palauensis* was once a conspicuous component of this forest. Epiphytes, especially ferns, are found in the Marianas and Palau, with *Asplenium nidus*, *Phymatosorus* spp., *Davallia solida*, and *Nephrolepis acutifolia* common.

Dugdug is usually not found on bluffs and seaward slopes. Much of the primary forest of the Marianas was cleared for agriculture, disturbed by war activities in the 1940s, or damaged by typhoons, and it has been replaced by secondary scrub vegetation or forest. Scrub vegetation includes *Leucaena leucocephala*, *Morinda citrifolia*, *Carica papaya*, *Triphasia trifolia*, and *Casuarina equisetifolia*. Trees of *Macaranga* spp., *Pipturus argenteus*, *Hibiscus tiliaceus*,

*Commersonia bartramia*, *Casuarina equisetifolia*, *Ambroma augusta*, *Pithecellobium dulce*, and *Pandanus* spp. form dense thickets with understory shrubs such as *Triphasia*, *Morinda*, and *Melochia*.

### Species commonly associated as aboriginal introductions

Dugdug is an aboriginal introduction in Micronesia and is cultivated around homes and in villages, especially on the coral atolls. On the atolls it is associated with coconut, taro (*Cyrtosperma chamissonis* and *Colocasia esculenta*), banana (*Musa* spp.), edible pandanus (*Pandanus tectorius*, screwpine), sugarcane, arrowroot (*Tacca leontopetaloides*), *Guettarda speciosa*, beach hibiscus (*Hibiscus tiliaceus*), *Cordia subcordata*, and Indian mulberry (*Morinda citrifolia*, noni). It is often grown with papaya (*Carica papaya*), citrus, and soursop (*Annona muricata*), all of which are modern introductions.

## ENVIRONMENTAL PREFERENCES AND TOLERANCES

### Climate

Dugdug requires a tropical climate and will not grow where the temperature goes below 5°C (41°F). Its latitudinal limits are approximately 10° S and 20° N in the Pacific, but this is due to its distribution by islanders, not by environmental factors. It should do well wherever breadfruit (*A. altilis*) is grown.

### Elevation range

0–150 m (0–490 ft)

### Mean annual rainfall

1300–3800 mm (50–150 in), but it can yield regularly on atolls that receive 1000 mm (40 in)

### Rainfall pattern

Prefers climates with summer rains

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

Two months, based on mean rainfall from Eniwetok: 23–27 mm (0.9–1.1 in)



Breadfruit canopy and vegetation zonation on Alei Islet, Puluwat Atoll, Chuuk, FSM. Photo taken from the lighthouse shows the 10 m (33 ft) high canopy of dugdug. Coconuts and more salt-resistant vegetation are found toward the coast. PHOTO: H. MANNER

### Mean annual temperature

26–28°C (79–82°F)

### Mean maximum temperature of hottest month

29–31°C (84–88°F)

### Mean minimum temperature of coldest month

16–18°C (61–64°F)

### Minimum temperature tolerated

5–10°C (41–50°F)

### Soils

This species is adapted to limestone ridges and outcrops and shallow calcareous soils. It thrives in volcanic soil but good drainage is essential. Hybrid varieties are well adapted to shallow sandy soils of coral atolls and should do well in coastal areas throughout the tropics.

### Soil texture

It prefers light, well drained soils (sands, sandy loams, loams)

### **Soil drainage**

It requires freely draining soils.

### **Soil acidity**

Alkaline to neutral soils (pH >6.1–7.4)

### **Special soil tolerances**

It tolerates saline soils as well as coralline soils and atolls (e.g., Histic Anthropics, Inceptisols, Psamments).

### **Tolerances**

#### **Drought**

The tree can withstand drought for a few months but will prematurely drop fruits.

#### **Full sun**

It does best in full sun.

#### **Shade**

Seedlings prefer 20–50% shade.

#### **Fire**

Dugdug can sprout back from the roots after a small fire, but the trunk and branches are not fire tolerant.

#### **Frost**

It is damaged by frost, which causes it to lose all fruits and leaves, and some branch dieback will occur.

#### **Waterlogging**

It cannot tolerate waterlogged soils.

#### **Salt spray**

It can tolerate salt spray for brief periods.

#### **Wind**

Trees are shallow-rooted and may topple during typhoon-intensity winds but will produce new shoots and branches after sustaining wind damage.

## **GROWTH AND DEVELOPMENT**

### **Growth rate**

This species is fast growing in favorable conditions, growing 0.5–1.5 m (1.5–5 ft) per year and to a diameter of up to 1 m (3.3 ft) for the first 10–12 years. Small branches often die back at the tip after fruiting, but new shoots and branches



**Dugdug tree at Pagat, Guam in April 2003 regenerating from typhoon damage that took place in December 2002. PHOTO: H. MANNER**

continue to develop throughout the life of the tree.

### **Flowering and fruiting**

Bearing is seasonal, with a peak during July through September throughout its range. Trees begin producing in approximately 5 years.

### **Yields**

Little information is available for yields. An estimated 100 or more fruits per year are produced with an average weight of 500 g (1.1 lb).

### **Rooting habit**

The roots spread and grow on or slightly below the surface.

The tree develops extensive buttresses when mature.

### Reaction to competition

As evidenced by its widespread distribution in the limestone forest, this species is able to withstand competition from other forest trees.

### Diseases and pests

It has few serious diseases or pests other than some damage by termites. Tree decline and dieback has been a problem throughout the atolls. No pathological cause has been identified. It is considered to be the result of storm damage, drought, aging of the trees, and salinity. Proper husbandry, such as removing dead and dying branches and mulching, are essential to maintaining its health and vigor.

## PROPAGATION

Dugdug is easily propagated by seed. The trees do not produce root shoots and cannot be grown from root cuttings. Seeds are collected and grown, and occasionally seedlings will be gathered from beneath fruiting trees and transplanted to the desired location. Varieties that are seedless hybrids with *A. altilis* are vegetatively propagated by root shoots, root cuttings, or air-layering (see propagation methods for breadfruit). Seeded hybrids are typically grown from seed, although few-seeded forms occasionally produce root shoots and can also be air-layered.

### Propagation by seeds

The seeds germinate quickly and will often sprout inside fallen fruits. Collect seeds from soft, ripe fruits and wash to remove all pulp. Select firm, shiny, uniform seeds that do not yield to the touch when squeezed. Discard any sprouted or aborted seeds. The latter are typically misshapen, flat, and contain little or no endosperm. Clean seed surface in a 2% bleach solution for 5–10 minutes or treat with a fungicide according to the manufacturer's recommendation. Plant immediately, as seeds are recalcitrant and cannot be dried or chilled. Germination rates are high, close to 100%.

Place seeds in seedling flats in a loose, well drained medium. Plant at a depth twice the width of the seed. Keep moist but not wet. Seeds germinate within 10–14 days. Transplant into 4–8 liter (1–2 gal) pots once the true leaves have hardened. If adding fertilizer (such as balanced 8-8-8), use only sparingly, at a rate of less than half the manufacturer's recommendations. Keep plants in partial shade and weed-free. Seedlings grow quickly, reaching 1 m in approximately 6 months, and are ready to plant into the field

in less than a year. Seedlings can also be gathered from beneath trees and transplanted into the nursery. Care must be taken when digging the seedling from the ground, because it is easy to damage or break the delicate roots and injure or kill the seedling.

### Establishment in the nursery

Young plants prefer partial shade. If plants are to be planted in full sun, gradually move to full sun conditions in the nursery for 1–2 months to harden them to the site conditions. Young plants should never be allowed to dry out or be exposed to strong wind.



Young dugdug seedlings always have entire leaves (without lobes). PHOTO: D. RAGONE

### Outplanting

Outplant when the plants have reached the desired size of approximately 1.25 m tall and 2 cm in stem diameter. The leaves have a large surface area and therefore lose a great deal of water to the air. It is best to reduce the size of the leaves to reduce transpiration. Carefully remove 1/2 to 2/3 of the lower leaves by trimming the blade and leaving only a small section attached to the petiole. Do not remove or damage the growing point of the plant where new leaves develop. Protect from wind and excessive heat during transport. Dig a hole the same depth and twice as wide as the container. Add a small amount of slow-release fertilizer such as 8-8-8 to the bottom of the hole and cover with soil. To prevent injury to the brittle root system, carefully cut off the container rather than pulling the plant out. Place the tree in the hole, add soil no higher than the level of the plant in the pot, top-dress with compost, and water



well.

Young plants grow best in partial shade. It is best to plant at the onset of the rainy season, but if the weather is dry, irrigate for the first 1–3 months of establishment. Once established, breadfruit trees can withstand a dry season of 3–4 months, although it prefers moist conditions. Mulching young plants is beneficial by helping keep the soil moist and adding a steady supply of nutrients. It also helps control weeds around the root system. Use of herbicide to control weeds around the base of the tree can damage the tree if it comes in contact with the surface roots or young trunk. Young trees need to be protected from cattle, goats, horses, and pigs, which will eat the bark and tender shoots. Close to 100% success rate can be expected.

## DISADVANTAGES

Compared to most varieties of breadfruit, this species produces small, seeded fruits and is not as suited as a backyard tree because of its large size and extensive buttress roots.

### Potential for invasiveness

This species has little potential for invasiveness because the seeds quickly lose viability and are not readily spread except by flying foxes. Since populations of flying foxes are seriously declining in many parts of the Pacific, there is little chance that this species will become invasive. In fact, the decline of flying fox populations has been accompanied by a decline in this species throughout its native habitat.

### Susceptibility to pests/pathogens

The plant is relatively trouble-free, with disease and pest problems localized. It does not appear to be as susceptible as breadfruit to fruit rots caused by *Phytophthora*, *Colletotrichum* (anthracnose), and *Rhizopus*. *Phellinus noxius*, a root rot, can be a problem, spreading through root contact, especially when trees are planted in areas of native forest that have been recently cleared. It may also be attacked by termites.

### Host to crop pests/pathogens

Fruit flies are attracted to ripe fruits on the trees and ground and infest many fruit and vegetable crops.

### Other disadvantages or design considerations

The surface roots can interfere with other plants. The soft wood is relatively weak. Canoes built of dugdug are often kept in shaded situations to prevent damage.

## AGROFORESTRY/ENVIRONMENTAL PRACTICES

### Mulch/organic matter

The leaves of this evergreen species provide abundant mulch for the tree and other plants growing beneath the canopy.

### Soil stabilization

Dugdug naturally occurs on steep ridges, cliffs, and shallow calcareous soils.

### Crop shade/overstory

Can be interplanted with a wide range of crops and plants such as yam, banana, medicinal plants, aroids, ginger, noni, etc.

### Homegardens

Dugdug is ideal for homegardens on atolls because of its adaptability to calcareous soils and saline conditions and especially for the beneficial shade it produces. On deep, fertile soils, the trees grow too large for homegardens.

### Animal fodder

All parts—flesh, peel, core, and seeds—of both mature and ripe fruits are edible and are fed to pigs and other livestock. The leaves also are edible.

### Native animal/bird food

Breadfruit is an important food source for flying foxes, native doves, and other birds in the Pacific islands.

### Host plant trellising

The tree can be used as a trellis for yam (*Dioscorea* spp.).

### Bee forage

Honeybees visit male inflorescences and collect pollen and also collect latex that oozes from the fruit surface.

### Ornamental

It is an attractive, stately evergreen tree with a rounded canopy.

## USES AND PRODUCTS

### Staple food

The nutritious fruits are consumed when mature or ripe and are typically roasted or baked. Ripe fruits can be eaten raw but are usually cooked. On Kapingamarangi and in the Marshall Islands fruits were commonly preserved by spreading mashed fruits into thin sheets and sun-drying

to make a “fruit leather.”

### **Nut/seed**

The seeds are high in protein, low in fat, and a good source of vitamins and minerals. They are cooked in the fruits and eaten, especially on atolls. Cooked sprouted seeds are a delicacy on some atolls.

### **Medicinal**

All parts are used medicinally, especially the latex, leaf tips, and inner bark. The latex is massaged into the skin to treat broken bones and sprains and is plastered on the spine to relieve sciatica. It is commonly used to treat skin ailments and fungus diseases such as “thrush,” which is also treated with crushed leaves. Diluted latex is taken internally to treat diarrhea, stomachaches, and dysentery. The sap from the crushed petioles (leaf stalks) is used to treat ear infections or sore eyes. The root is astringent and used as a purgative; when macerated, it is used as a poultice for skin ailments. The bark is also used to treat headaches in several locations.

### **Timber**

The light-weight, flexible wood is easy to work.

### **Fuelwood**

The wood is fast burning, but generally older, less productive trees are used for this purpose.

### **Craft wood/tools**

The wood is easy to work and carve into statues, bowls, fishing floats, and other objects.

### **Canoe/boat/raft making**

The light-weight timber is used to make small canoes.

### **Fiber/weaving/clothing**

The inner bark was once used to make bark cloth (tapa).

### **Rope/cordage/string**

The inner bast was traditionally used to make a strong cordage used for fishing.

### **Wrapping/parcelization**

The flexible leaves are used to wrap foods for cooking in earth ovens, and as plates.

### **Resin/gum/glue/latex**

The sticky white latex is used as a chewing gum and an adhesive. It is still used to caulk canoes.

## **THE MAGIC BREADFRUIT TREE**

Milad, the granddaughter of Latmikaik, lived on the islet of Ngibtal off Babeldaob Island, Palau. A magic breadfruit tree grew on her land. It had a hollow trunk that reached down into the lagoon, and once in a while a large wave would force a large fish up through the trunk and out of a broken branch. People became jealous and cut down the tree. The ocean poured through the cut trunk and flooded the island, which then sank beneath the sea. The sunken island can still be seen to this day. This legend is a popular motif for Palauan storyboards.

### **Toxin/insecticide/fish poison**

Dried male flowers can be burned to repel mosquitoes and other flying insects.

## **COMMERCIAL PRODUCTS**

Dugdug is a natural component of the forests of Palau and the Mariana Islands and is grown as a subsistence crop in Micronesia. It is not as widely used as breadfruit or seedless hybrid varieties due to the small, lumpy fruits with large seeds. It has no commercial use and limited potential. Hybrid seedless varieties receive the same treatment and recommendations as breadfruit (*A. altilis*).

## **INTERPLANTING/FARM APPLICATIONS**

Trees provide shade, mulch, and a beneficial microclimate. It is generally planted as part of a homegarden or mixed agroforestry system with a wide array of useful plants. Widely spaced trees in an orchard can be interplanted with small fruit trees such as citrus and a leguminous cover crop. Short-term fruit crops such as pineapple, banana, and papaya, or field and vegetable crops including taro, tomato, and eggplant can also be grown between breadfruit trees. A leguminous cover crop should replace these intercrops when they begin to interfere with orchard operations.

### **Example system**

#### **Location**

Federated States of Micronesia (Pohnpei)

#### **Description**

Hybrid varieties of breadfruit are typically grown with yam (*Dioscorea* spp.). The yam vines climb trellises of *Hi-*



Detail of a Palauan storyboard depicting the legend of the “Magic Breadfruit Tree.” PHOTO: D. RAGONE

*biscus tiliaceus*, grow into the canopy of the tree during the non-fruiting period, and are dormant when the fruits are harvested. This allows the fruits to be picked without damaging the yam vines.

## PUBLIC ASSISTANCE AND AGROFORESTRY EXTENSION

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

## GERMPLASM RESOURCES

The National Tropical Botanical Garden can provide selected varieties from an extensive breadfruit germplasm collection.

The USDA Clonal Germplasm Repository, Waiakea, Hawai‘i, can provide selected breadfruit varieties.

## INTERNET

The Breadfruit Institute: <<http://www.breadfruit.org>>.

## BIBLIOGRAPHY

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## *Artocarpus mariannensis* (dugdug)

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