

# TREES FOR LIFE IN OCEANIA

CONSERVATION AND UTILISATION OF GENETIC DIVERSITY

**Lex Thomson**  
**John Doran**  
**Bronwyn Clarke**



**Australian Government**  
**Australian Centre for  
International Agricultural Research**

# Piper methysticum

**Family:** Piperaceae

**Botanical name:** *Piper methysticum* Forst.f. In *Diss. Pl. Esc.* 76 (1786).

The plant derives its name from *piper* (Latin for pepper) and *methysticum* (Greek for intoxicating). Morphological, chemical, cytological and genetic evidence indicates that *P. methysticum* derives from the wild species, *P. wichmannii* C.DC., through domestication and selection. These two taxa are now considered as a single species, with the cultivars identified as var. *methysticum* and the wild forms as var. *wichmannii*. The species is dioecious and decaploid ( $2n = 10x = 130$ ).

*Piper methysticum* cultivars are exclusively propagated by stem cuttings and do not reproduce sexually. Neither seed nor fruit have ever been described and are absent from all herbarium vouchers preserved in all major herbaria of the world. Studies using isozymes, amplified fragment length polymorphisms (AFLPs), single sequence repeats (SSRs) and diversity arrays technology (DArT) revealed little genetic variation among cultivars grown throughout its area of distribution. Based on the limited sexual reproductive biology of the plant, it is thought that cultivars are most likely the result of human selection and preservation of somatic mutations in a few genetically similar, vegetatively propagated plants.

**Common names:** The most common name in English is kava, which derives from the same name in Tongan. The original Polynesian name was *kava* and it was changed to *ava* or *awa* in Samoa, Hawai'i, Tahiti and some other places. Outside of Polynesia, there are several other names in the Pacific Islands, including *malogu* in northern Vanuatu, *sika* or *kau* in PNG, *yaqona* in Fiji and *sakau* in Micronesia.

## Summary of attributes and why diversity matters

*Piper methysticum* is an economically vital crop species for smallholder farmers in Fiji, Samoa, Tonga, Vanuatu and several other Pacific Islands. The species has been domesticated principally in Vanuatu where 80 morphotypes or cultivars are known. A traditional beverage is made from the roots and lower stems which is used ceremonially and socially, and increasingly as a medicinal treatment for depression and other illnesses. Different cultivars have different kavalactone profiles and may be grouped into three distinct use categories corresponding to traditional classification: noble, medicinal

and *tudei* (two-day), with the last being unsuitable for consumption.

## Description

**Habit** a shrubby plant, 1–4 m tall; slow-growing perennial, generally resembling other *Piper* species with main stems monopodial and lateral branches sympodial; lateral branches grow from young parts of main stem and, as they age, fall away leaving cicatrices on the nodes; at maturity, the plant is a bouquet of ligneous stems



Mature 4-year-old plant, with Graham Mala'efo'ou; Vava'u, Tonga (Photo: R.R. Thaman)



Inflorescences and foliage (Photo: F. & K. Starr)

clustered together at their base; remarkable morphological variation between cultivars, some being prostrate with short internodes, others are normal with many stems, or erect with few stems and very long internodes. **Bark** stems green to dark purplish. **Leaves** alternate, light green, petiolate, heart-shaped, 13–20 cm long and similar width; blades have 11–13 veins radiating from their base. **Inflorescences** narrow spikes; the species is dioecious (produces male and female inflorescences on separate plants) but does not reproduce sexually; female inflorescences fall off before they produce fruit. **Flowers** male flowers appear continuously but are sterile. **Seed** never observed on cultivars.

### Distribution

*Piper methysticum* is the only cultivated plant of economic importance with an area of distribution restricted entirely to the Pacific Islands. Wild forms of the species are found in the lowland forests of PNG, Solomon Islands and northern Vanuatu.

Cultivars of *P. methysticum* have been clonally distributed by humans throughout Melanesia (Fiji, PNG, Vanuatu, and Papua province, eastern Indonesia), FSM (Kosrae and Pohnpei) and Polynesia (French Polynesia, Hawai'i [USA], Samoa and Tonga).

The distribution of *P. methysticum* is no longer as extensive as before the first contact with Europeans. *Piper methysticum* has been left to die out in many valleys of Hawai'i; the Marquesas Islands, Society Islands and Tubuai (French Polynesia); the Cook Islands; and Niue.

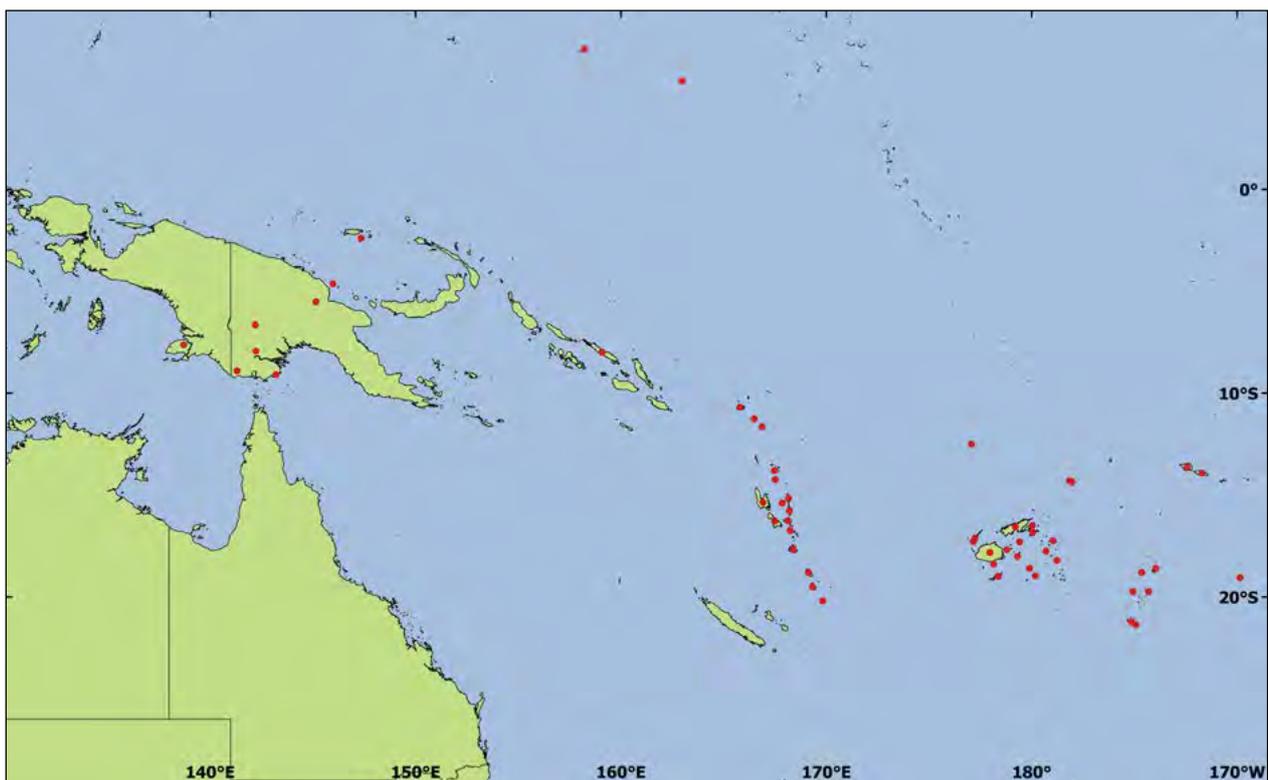
Due to interdiction by missionaries, its consumption and cultivation was abandoned and neglected; devastation caused by the wild pigs, competition from weeds and climbing vines were contributing factors to its near extinction on these islands. Nowadays, especially in Hawai'i, there is an attempt to develop its cultivation as an economic crop.

*Piper methysticum* grows best in humid subtropical to tropical climates (MAT range 20–25 °C) on fertile well-drained soils (pH 5.5–6.5) with protection from high winds. It thrives in shaded tropical agroforestry settings at lower elevations (0–800 m asl) with high rainfall (1,000–3,000 mm MAR).

### Uses

The most important product continues to be the traditional beverage—also known as kava, the plant's common name—made from the roots and lower stem portion of the *P. methysticum* plant. The plant is very well suited to incorporation into traditional agroforestry systems, given its tolerance of partial shade, and provides growers with substantial cash income after several years (e.g. 3–7 years). This fills a gap between income from annual and short-term crops and that from long-term timber and fruit/nut tree crops.

**Non-wood**—the traditional beverage of the Pacific Islands is prepared by cold water extraction of the underground organs of the noble cultivars of *P. methysticum* var. *methysticum* (var. *wichmannii* is



Natural and traditionally cultivated distribution of *P. methysticum* (excluding French Polynesia and Hawai'i)



**Left:** Roots of *P. methysticum* (referred to in Fijian as *waka*) specially wrapped for use as traditional gift (*sevusevu*) in local market; Savusavu, Vanua Levu, Fiji (Photo: SPC-LRD)



**Top right:** *Piper methysticum* with pineapple in agroforestry planting; Vava'u, Tonga (Photo: R.R. Thaman)



**Bottom right:** Mixing of *P. methysticum* extract (grog) in kava ceremony; Vanua Levu, Fiji (Photo: SPC-LRD)

never used). The most frequent use is a social drink taken for its relaxing properties. There are two different methods of preparation depending on whether fresh or dried roots are used. The grinding, squeezing and filtering process is very simple but efficient for producing a suspension of lipid-like compounds, known as kavalactones, which are non-soluble in water. The molecules are unique to *P. methysticum* and present a wide range of scientifically proven physiological properties, with efficient bactericidal, antifungal, anaesthetic, anxiety-relieving, sleep-inducing, muscle-relaxant and even anticancer effects. In the Pacific, *P. methysticum* is traditionally used to treat inflammations of the urogenital system, gonorrhoea and cystitis, feminine puberty syndrome and menstrual problems, painful migraine headache, chills and rheumatism.

### Diversity and its importance

Since the early 1980s, a standardised list of 8 morphological descriptors has been used to discriminate >100 different morphotypes of *P. methysticum* throughout the Pacific Islands: 80 in Vanuatu, 12 in Fiji, 11 in Hawai'i, 7 in Tonga, 6 in Samoa, 4 in PNG, 3 in Wallis

and Futuna, 3 in Tahiti, 2 in Pohnpei, and 1 in each of the Cook Islands, Marquesas Islands and Kosrae. Based on high-performance liquid chromatography (HPLC) chemotypes, wild forms of var. *wichmannii* are clearly differentiated from cultivars of var. *methysticum*. Cultivars are separated into three distinct use categories corresponding to traditional classification: noble, medicinal and *tudei* (two-day). These categories are based on the physiological effects of beverages made from the roots, which depend largely on the levels of six major kavalactones. Noble cultivars, which are safe for daily drinking, and medicinal cultivars have a chemotype rich in kavain and produce relaxing effects; however, noble cultivars have a higher kavain content. Medicinal and noble cultivars do not differ significantly in their kavalactone profiles and their classification refers to their uses: as a medicinal plant or for daily consumption of the beverage. However, *tudei* cultivars—low in kavain and rich in dihydrokavain and dihydromethysticin—are not suitable for consumption and are known for their deleterious side effects and nausea. In Vanuatu, these cultivars are considered as illegal for trade under that country's *Kava Act 2002*.



A selection of the diversity of stems in different Fijian *P. methysticum* varieties, the names of which reflect their stem characteristics: (top) *Vula Kasa Leka*—pale with short internodes; (middle) *Vulu Kasa Balavu*—pale with long internodes; and (bottom) *Loa Kasa Balavu*—blackish colour and long internodes (Photos: B. Wiseman)

*Piper methysticum* is susceptible to a wide range of insect pests and diseases. Following silvicultural practices that avoid or mitigate problems, such as crop rotation, are recommended. Some *P. methysticum* cultivars show significant resistance to important diseases and offer the potential for higher yields from monocultures if generally adopted.

### Conservation of genetic resources (including threats and needs)

Distinct morphotypes share a common molecular profile and this illustrates that mutations may arise following several or many generations of clonal or vegetative propagation which are able to be selected. Farmers from the Pacific Islands are prompt at tagging novel variants and integrating them into their cultivar portfolio as soon as they appear. The selection of particular mutants, therefore, is a continuous and conscious process conducted in *P. methysticum* fields. This selection is still dynamic and efficient in the species, where new cultivars have been found in farmers' fields over a 20-year period, but some are also disappearing.

For beverage plants such as *P. methysticum*, morphological characters are less prone to human selection than are chemical characters. Noble and medicinal cultivars belong to a single clonal lineage but important variations in total kavalactones exist between and within these cultivar categories. Although environmental factors may play a role, clonal selection is exerted on the total content of kavalactones as farmers judge the physiological effects of the beverage obtained from a single plant. In villages, this can occur on a daily basis and represents a continuous clonal selection process. However, if noble cultivars of *P. methysticum* are represented by clearly distinct morphotypes, these cultivars are genetically vulnerable and their potential to adapt to forthcoming climatic changes is limited.

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**Author:** Vincent Lebot