KAVA: THE PACIFIC ELIXIR

The most comprehensive treatment of kava ever written, *Kava: The Pacific Elixir* summarizes the literature and research on a plant that is now considered comparable or superior to anti-stress prescription drugs. Kava is consumed throughout the Pacific as a relaxing beverage for social interaction and as a support to religious inspiration. Because of its many beneficial qualities it is superior to alcohol, nicotine, tranquilizers, and other substances that serve to reduce stress and improve mood. Interest in kava is growing worldwide and its consumption is now extending well beyond the Pacific Rim as new products are developed from it for pharmacological and recreational markets worldwide.

Exhaustively researched, *Kava: The Pacific Elixir* offers an extensive survey of this amazing plant from the perspective of the horticulturalist, the ethnobotanist, and the pharmacologist. It provides compelling insights into this plant that has been an integral part of the religious, political, and economic life of the Pacific islands for centuries. It contains information that is invaluable to the serious scholar yet is not written with the specialist alone in mind. Beyond its soporific qualities Kava is also used throughout the islands of the Pacific as an analgesic, a diuretic, and an anesthetic. There is even evidence suggesting it is effective in the treatment of asthma, tuberculosis, and venereal disease.

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LEBOT • MERLIN • LINDSTROM

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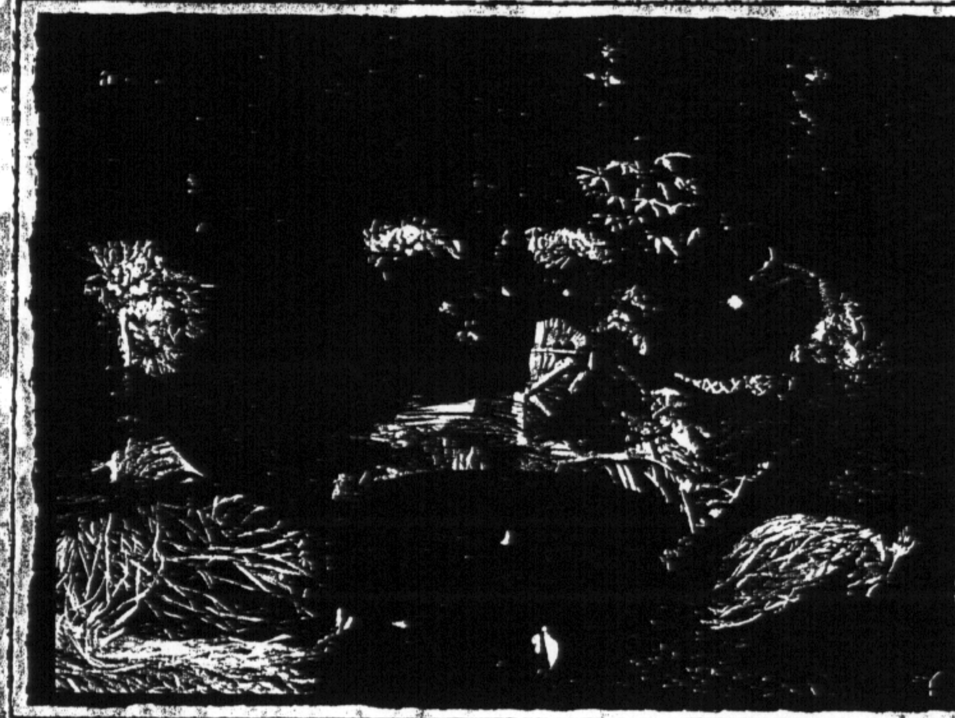
THE PACIFIC ELIXIR



THE DEFINITIVE GUIDE
TO ITS ETHNOBOTANY, HISTORY, AND CHEMISTRY

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The Pacific Elixir

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AND LAMONT LINDSTROM

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Note to the reader: This book is intended as an informational guide. The remedies, approaches, and techniques described herein are meant to supplement, and not to be a substitute for, professional medical care or treatment. They should not be used to treat a serious ailment without prior consultation with a qualified healthcare professional.

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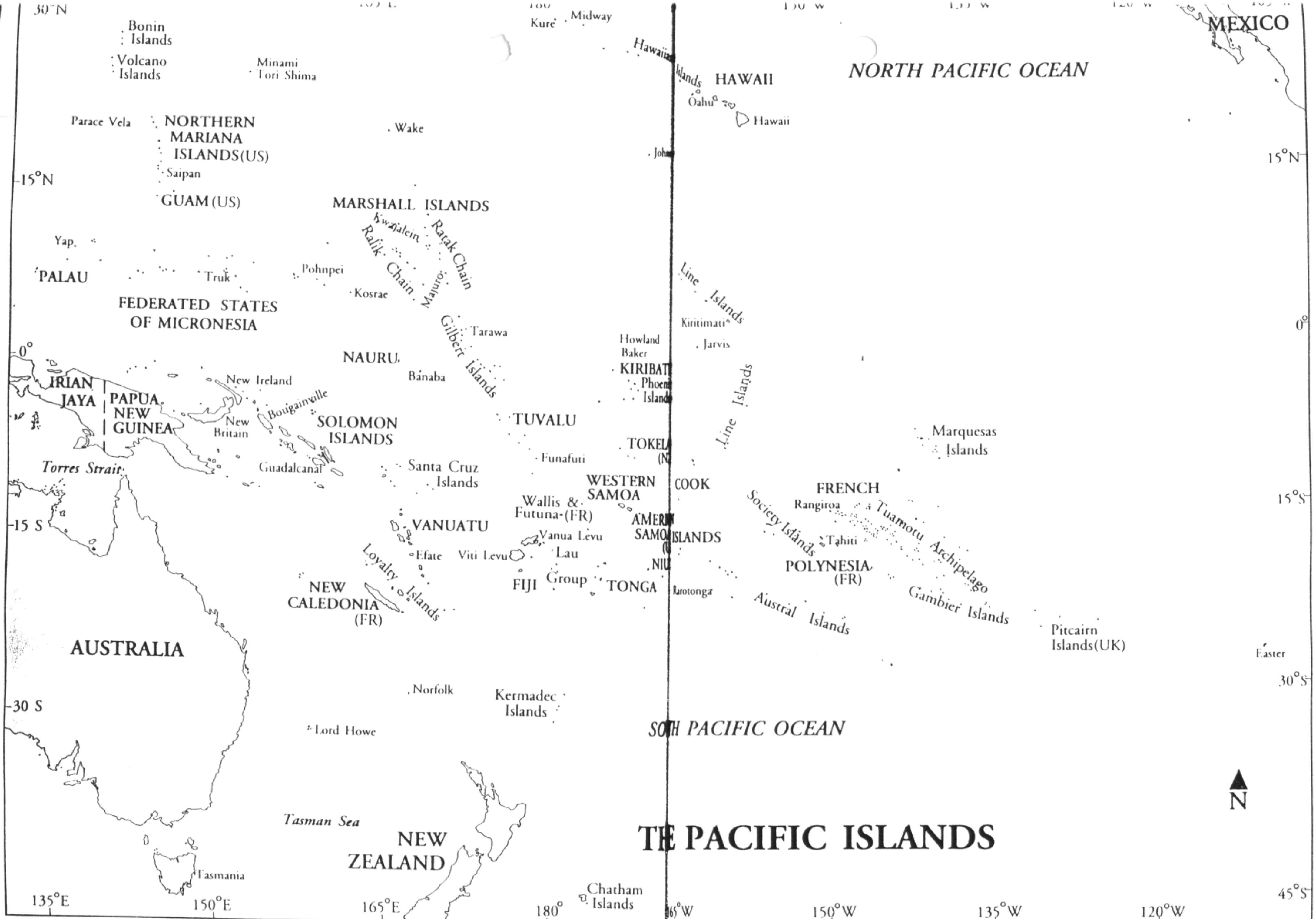
The Pacific Elixir



THE PACIFIC ISLANDS
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
MEXICO
HAWAII
Hawaiian Islands
Oahu
Hawaii
Kure
Midway
Bonin Islands
Volcano Islands
Minami Tori Shima
Parace Vela
NORTHERN MARIANA ISLANDS(US)
Saipan
GUAM (US)
Wake
MARSHALL ISLANDS
Kwajalein
Ralik Chain
Ratak Chain
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Yap
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Kosrae
FEDERATED STATES OF MICRONESIA
Gilbert Islands
Tarawa
NAURU
Banaba
Line Islands
Kiritimati
Jarvis
Howland
Baker
KIRIBATI
Phoenix Islands
IRIAN JAYA
PAPUA NEW GUINEA
New Ireland
New Britain
Bougainville
SOLOMON ISLANDS
Guadalcanal
Torres Strait
TUVALU
Funafuti
TOKELAU
Santa Cruz Islands
WESTERN SAMOA
AMERICAN SAMOA
COOK ISLANDS
Wallis & Futuna-(FR)
VANUATU
Vanua Levu
Viti Levu
Efate
Lau Group
FIJI
TONGA
NIUE
Rarotonga
Loyalty Islands
NEW CALEDONIA (FR)
Marquesas Islands
FRENCH POLYNESIA (FR)
Rangiroa
Tahiti
Society Islands
Tuamotu Archipelago
Austral Islands
Gambier Islands
Pitcairn Islands(UK)
Easter
AUSTRALIA
Norfolk
Kermadec Islands
Lord Howe
Tasman Sea
NEW ZEALAND
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30°N
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1. Introduction

Kava (*Piper methysticum* Forst. f.), a member of the pepper family Piperaceae, is an outstanding ethnopharmacological species. The drug is, or once was, consumed in a wide range of Pacific Ocean societies, from coastal areas on the large Melanesian island of New Guinea in the west to isolated Polynesian Hawai'i, 7000 kilometers distant to the northeast. Kava is a handsome shrub that is propagated vegetatively, as are most of the Pacific's major traditional crops. Its active principles, a series of kavalactones, are concentrated in the rootstock and roots. Islanders ingest these psychoactive chemicals by drinking cold-water infusions of chewed, ground, pounded, or otherwise macerated kava stumps and roots.

One concern of this book is to pinpoint the place in the Pacific region where kava was first domesticated. Of the Pacific's two main traditional drug plants, kava is the indigenous species. The other, a palm (*Areca catechu*), whose fruit is commonly called betel or betelnut, appears to have been domesticated in the vicinity of the Malay Peninsula and is used today throughout much of mainland and island Southeast Asia (Marshall 1987).

When European explorers first landed on remote Pacific islands, they encountered societies in which kava drinking was an integral part of religious, political, and economic life (figures 1.1, 1.2, and 1.3). Although cultivation and use of the plant has virtually disappeared from eastern Polynesia and Kosrae Island (previously Kusaie) in Micronesia, kava remains an important psychoactive drug in much of Melanesia, in most of the islands of western Polynesia (including Samoa and Tonga), and on Pohnpei Island in Micronesia (see appendix A).

Scientific observation of the use of kava dates to the earliest European voyages of exploration (figure 1.4). The eighteenth-century British explorer James Cook noted in his log that venturesome members of his crew who sampled heavy doses of the drug seemed to experience symptoms similar to those induced by opium. Cook's comparison was inaccurate, for kava is neither a hallucinogen nor a stupefacient. Rather, the drug is a mild narcotic, a soporific, a diuretic, and a major muscle relaxant.

Given the plant's complex and subtle psychoactivity, it is difficult to categorize in the terms of common drug classification schemes. Schultes and Hoffman (1979) follow Lewin (1924) and typify kava as both a narcotic and a hypnotic.

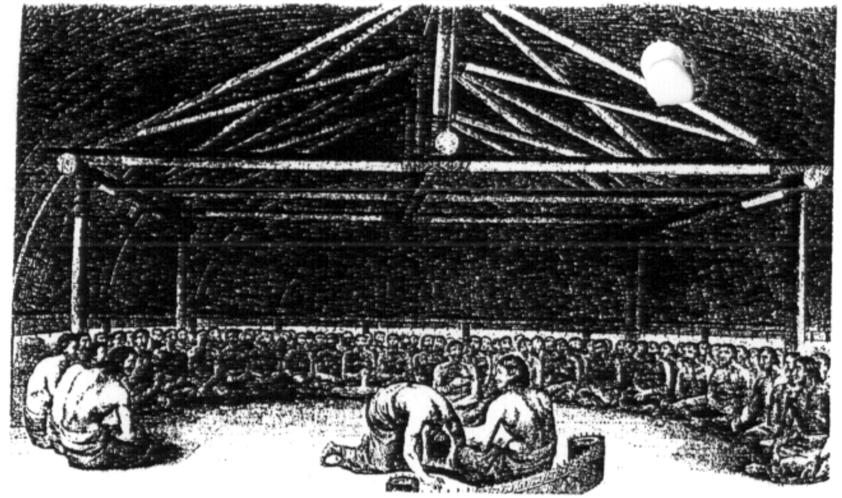


Figure 1.1. "Poulaho, King of the Friendly Islands [Tonga] Drinking Kava," by J. Webber, artist on Captain James Cook's third voyage to the Pacific (courtesy of Hawaii State Archives, Honolulu).

Figure 1.2. Nineteenth-century studio photograph of kava preparation, Fiji (courtesy of the British Museum, Department of Ethnography).

Figure 1.3. Samoan *taupou* (ceremonial virgin) prepares kava (courtesy of Bishop Museum, Honolulu).

Siegel (1989) describes the plant as a sedative hypnotic. The psychoactive potency of the drug can vary considerably, from very weak to quite strong. Kava may induce sociability, feelings of peace and harmony, and, in large doses, sleep, or it may fail to produce relaxation and provoke nausea. Typically, however, kava evokes an atmosphere of relaxation and easy sociability among drinkers. Although we use the terms *intoxication, drunkenness,* and *inebriation* to describe human physiological reaction to the plant, the state differs from that induced by ethanol or other familiar drugs found in the Western world.

Kava has a strong but not unpleasant smell. Its taste, which can be acrid and astringent, has been characterized as earthy (or "like dirt" by less friendly drinkers). The botanist J. G. Forster (1777), who sailed with Cook on his first exploratory voyage, described kava infusions he sampled in Polynesia as either tasteless or mildly peppery. (We may assume that his sample was watered down; the flavor of kava is normally strong.) Like tobacco and coffee, kava for most people is an acquired taste.

The most reliable evidence suggests that cultivated kava derives from a wild progenitor, *Piper wichmannii* C. DC., a fertile *Piper* indigenous to New Guinea, the Solomon Islands, and Vanuatu (previously the New Hebrides). Although many Western botanists distinguish *P. wichmannii* from *P. methysticum*, we argue that

Figure 1.4. *Piper methysticum*, drawn in 1769 by Sydney Parkinson, the expeditionary artist on Captain James Cook's first voyage to the Pacific.

there now exist [convincing] morphological, chemical, and genetic grounds for considering these two taxa of *Piper* to be wild and cultivated forms of the same species. *Piper methysticum* consists of sterile cultivars cloned ultimately from *P. wichmannii* in an ongoing selection process. When we speak of kava, or the kava drink, therefore, we refer in the main to what botanists know as *P. methysticum*, although Pacific Islanders also cultivate and use as kava several varieties of the plant that botanists label *P. wichmannii*. We also use the word *kava* synonymously, as do Pacific Islanders, to refer to both the plant itself and the psychoactive beverage made from its rootstock.

Today *P. methysticum* is a cultivated plant comprising many different cultivars grown widely throughout the insular tropical Pacific region. Each cultivar has specific requirements and a much more restricted range of distribution than *P. methysticum* as a whole. A remarkable variability in cultivar characters has developed over many generations of human selection of clones best adapted to the diverse local climates and soils.

The prehistory of the discovery and settlement of the remote tropical Pacific Islands has been a popular object of speculation and debate since the 1700s. It now is clear that Pacific Island peoples, along with most of their domesticated plant and animal assemblages, originated in Southeast Asia. Humans first colonized Sahul, the large land area of New Guinea and Australia (then connected by a land bridge), at least 40,000 years ago (Bellwood 1978). They reached the nearby islands of western Melanesia somewhat later (e.g., New Ireland circa 32,000 B.P.), and the western Solomon Islands circa 29,000 B.P.; Allen, Gosden, and White 1988). Until about 4000 years B.P., human settlement in the Pacific was restricted to these westernmost islands of Melanesia. Since then migrants in sailing canoes have located and populated all of the remaining inhabitable tropical and subtropical islands of the central and eastern Pacific.

The first settlers of Sahul foraged for food and other useful resources among the native plants and animals of newly occupied territories. Some of these people adopted agriculture at an early date. Archaeologists have found evidence of intensive agriculture in the highlands of New Guinea dating perhaps as far back as 9000 B.P. and certainly to 6000–5500 B.P. (Bellwood 1979; Golson 1985). Some prehistorians argue for an independent development of agriculture in New Guinea—perhaps even predating the emergence of agriculture in neighboring Southeast Asia. Others suggest, rather, that agriculture emerged simultaneously and independently in Southeast Asia and New Guinea.

Although some Pacific cultivars, such as fruited *Pandanus*, sugarcane, and the *Australimusa* banana, have been identified as New Guinea domesticates (Barrau 1965; Yen 1985, 1991), the major Pacific staple root crops, such as yams (*Dioscorea* spp.) and taros (*Colocasia esculenta*, *Cyrtosperma chamissonis*, and *Alocasia macror-*

rhyza), appear to have been first cultivated farther to the west a[illegible]ded or carried into New Guinea and the rest of the Pacific by migrant groups. A[illegible]oted above, the *Areca catechu* palm, the other major Pacific drug plant, also probably has Southeast Asian origins and an easterly pattern of diffusion into the Pacific Islands region.

Not all of the Pacific's traditional crops trace back to Southeast Asian or New Guinean roots. Yen provides numerous examples of species he believes were domesticated or selected by central Pacific farmers (Yen 1985, 1991). He suggests that "the Oceanians retained (or reinvented) the ethnobotanical concepts of domestication throughout their geographical spread and individual paths of development" (1985). We argue that kava, too, is a Pacific domesticate that originated outside Southeast Asia and New Guinea. We suggest that farmers in the northern islands of Vanuatu were the first to select and develop the species as a vegetatively reproduced root crop. Given the archaeological evidence of the relatively recent arrival of humans in eastern Melanesia, a Vanuatu origin for kava suggests that *P. methysticum* is a fairly young domesticate—perhaps less than 3000 years old. From Vanuatu, kava was carried eastward into Fiji and Polynesia and westward into scattered areas of New Guinea and into two islands of central Micronesia. We dispute some recent speculation that kava may first have been domesticated in the neighborhood of the Bismarck Archipelago off northeastern New Guinea (Brunton 1989; cf. Yen 1991). The botanical, genetic, and chemical evidence that supports our assertion of kava's Vanuatu origins and its westward diffusion to New Guinea, Pohnpei, and Kosrae is provided in chapters 2, 3, and 4 of this book.

Few human cultures are unacquainted with psychoactive drugs of some sort. Reflecting on the consumption of self-administered drugs by laboratory animals, some pharmacologists have concluded that "animal data strongly suggest that from a biological viewpoint drug-seeking behavior is normal" (Schuster, Renault, and Blaine 1979). Jaffe similarly has noted that "drugs themselves are powerful reinforcers, even in the absence of physical dependence" (1985). According to Siegel (1989), "there is a natural force that motivates the pursuit of intoxication. This biological force has found expression throughout history. . . . It has led to the discovery of many intoxicants, natural and artificial, and to demonstrations of its irrepressible drive" (see also Weil 1972).

If humans are biologically attracted to psychoactive chemicals, one might easily imagine members of isolated Pacific island communities having the desire and curiosity to experiment with locally available flora. If the people who undertook remarkable voyages of discovery to the far-flung island groups of the Pacific neglected to bring along in their canoes any previously known psychoactive species, they may have been particularly motivated to seek out and experience alternatives, such as *P. wichmannii*, from available native flora.

In addition to the ordinary human proclivities toward drug use and the self-

reinforcing cha[illegible]y of psychoactive chemicals themselves, a cultural rationale for the ethnobotanical pursuit and domestication of drug species has been identified by the anthropologist W. La Barre. Most traditional religions worldwide—with the exceptions of the great monotheistic religions based on well-established written traditions, such as as Judaism, Christianity, and Islam—rely on revelation and inspiration for the production of religious knowledge and experience. Drugs are frequently an integral means to achieve psychic states amenable to religious inspiration. Referring to New World peoples, La Barre (1970) writes, "Whether shaman alone, or shaman and communicants, or communicants alone imbibe or ingest the Ilex black drink, datura infusions, tobacco in whatever forms, native beers and wines, peyote cactus, ololiu seeds, mushrooms, narcotic mint leaves or coca, the ayahausca (*Banisteriopsis caapi*) or 'death vine'—or any of the vast array of Amerindian psychedelics—the principle is the same. These plants contain spirit power." Given the common importance of revelatory religious experience, humans can be culturally programmed, as well as naturally inclined, to search for and experiment with mind-altering plants to gain insight into human existence. Drugs provide a means by which people can establish and maintain communication with their ancestors and deities. Harner (1973), following La Barre, notes: "We of a literate civilization may get both our religion and our religious proofs from books; persons in non-literate societies often rely upon direct confrontation with the supernatural for evidence for religious reality. Such divine communication may be induced by fasting, flagellation, sensory deprivation, yogic exercises, meditation, or ritual dancing or drumming; but predominantly it is induced through the consumption of psychoactive drug-plants."

Kava acts to transport imbibers to the realm of ancestors and gods. Although the relative importance of kava's religious and secular functions varies from island to island within Polynesia, Melanesia, and Micronesia, everywhere the drug serves (or served) as a means of religious inspiration. Kava drinking is "an important kind of ritual, usually involving the invocation of ancestral spirits" (Kirch 1984). Kava can thus be compared with many other psychoactive plants utilized by people around the world to transcend normal consciousness and experience and to reinforce and validate spiritual beliefs (see Schultes and Hofmann 1979; Wasson 1980).

We can surmise that the prehistoric peoples who first colonized the tropical Pacific Islands had powerful religious and biological motivations to investigate the mind-altering potentials of the plants native to their new island homes. The floral and faunal inventory of remote Pacific landfalls, however, is notably depauperate. The floral assemblages of even the higher, larger, and more ecologically diverse volcanic islands lack the typical variety of most tropical continental ecosystems because of the great dispersal barrier of the Pacific Ocean. Settlers in Vanuatu, for example, were confronted by as few as 1500 plant species (Cabalion and Morat

1983). In spite of this limited botanical biodiversity, they suc[illegible]ed in locating, selecting, and domesticating a valuable ethnopharmacological species with prized psychoactive effects.

It is possible that humans were initially attracted to wild *P. wichmannii* because of its therapeutic effects. People from several northern Vanuatu islands still utilize this plant as a folk medicine. Significantly, a survey of folk medicines in Papua New Guinea discovered no therapeutic uses of *P. wichmannii* in areas where it grows naturally today (Holdsworth 1977). A vastly larger and more westerly land mass than Vanuatu, New Guinea has a floral assemblage of 1465 genera in 246 families (van Balgooy 1976), which is many times greater than that of Vanuatu. It may be that the relative impoverishment of the Vanuatu flora both required and enabled settlers to scrutinize the therapeutic and psychoactive potential of local species more intensively. In New Guinea, if residents overlooked the potentials of *P. wichmannii,* they did discover a spectrum of other psychoactive species. These include fungi (e.g., *Boletus* spp., *Heimiella* spp., *Russula* spp.), wild gingers (*Alpinia* spp., *Hornstedtia* spp., *Zingiber* spp.), and a variety of other potent tree leaves, barks, and saps, many of which do not occur on the more remote Pacific islands (see Schultes and Hofmann 1979; Marshall 1987).

Following its initial discovery, domestication, and diffusion throughout the eastern and central Pacific, kava became an integral part of island religious, economic, political, and social life. In the Pacific today, although some Islanders have abandoned its use, its traditional functions are being maintained and it is being developed into an important cash crop. The plant attracts a wide range of contemporary interest. For prehistorians and linguists, its distribution provides traces of the migrations of Oceanic peoples. For anthropologists and sociologists, the drug facilitates social interaction. For theologians, kava consumption is a religious act. For political scientists, kava ritual today symbolizes new national identities and unity within postcolonial Pacific states. Botanists are intrigued by the problems of defining the species and by the sterility of its cultivars. Geneticists have begun to survey its zymotypes and chemotypes. Agronomists view the plant as an increasingly valuable cash crop suited to the traditional agricultural practices of subsistence farmers. National development officials in some Melanesian countries suggest that investments in kava cultivation may generate desperately needed export earnings for newly independent Pacific Island nations. Pharmacologists search rain forests and folk medicinal systems for useful new therapies. And kava drinkers themselves may want to know more about their daily dose.

In the following chapters we discuss all these aspects of the Pacific drug. Chapter 2 addresses botanical aspects of wild and cultivated kavas, including geographic range, morphology, reproductive biology, and genetic fingerprinting. Nomenclatural and taxonomic problems are also discussed, including the question of whether [illegible]ethysticum* is a separate species or a series of sterile cloned cultivars derived from *P. wichmannii.* Morphological and zymotypic data, along with chemotypic evidence discussed in the succeeding chapter, point toward kava's origins in northern Vanuatu.

Kava's physiological effects on drinkers and the chemistry of its major psychoactive ingredients, the kavalactones, are described in chapter 3. The molecular structure of kavalactones and their physiological activity are discussed, and research that identifies nine chemotype groups of *P. methysticum* and *P. wichmannii* is presented. The chapter also addresses the geographic distribution, variable psychoactivity, and social uses of different kava chemotypes.

Chapter 4 describes ethnobotanical aspects of kava, including its cultivation, folk classifications of cultivars, and methods of preparation and consumption. The chapter reviews kava's importance in folk medicine, providing examples of its traditional use to treat various island illnesses.

The anthropology of kava use is summarized in chapter 5—particularly its mythic origins, its symbolic association with drunkenness and death, its relation to sexuality, and its impact on sociability. The religious importance of altered states produced by kava drinking and the use of the drug as a means of inspiration are also discussed. The chapter concludes with several vignettes (or perhaps we might call these "kavettes") of kava use in the contemporary Pacific.

Chapter 6 deals with the economic importance of kava today. The growing of kava as a cash crop in Fiji, Tonga, and especially Vanuatu is described, along with the production, trade, and sale of kava products in both the regional beverage and the export pharmacological markets. We also note the plant's further export potential.

The final chapter summarizes our position on the origins of kava, its history and dispersal, its traditional cultural role, its contemporary economic importance, and the innovative and creative ways Pacific Islanders and other communities continue to use the drug. We suggest that in the future kava, if taken up by international pharmacological and recreational drug markets and used in a variety of novel social contexts, may spread beyond its regional base. As kava is internationalized, the Pacific drug is becoming a world drug.

2. Botany
Morphology, Biogeography, and Origin of the Species

Piper methysticum Forst. f. has puzzled botanists for more than a century. It is one of the classic enigmas of Oceanic ethnobotany. Kava's relation to other *Piper* species, its point of origin, its spotty distribution across the Pacific, and its clues to the history of human migration into the region have long been unresolved. Whether kava, like other traditional Pacific crops that are propagated vegetatively, followed the main migratory routes of Oceanic peoples is an issue of debate. Yuncker (1959) characterized kava's origin as "problematical"; Barrau (1965) guessed that "the plant is a native of eastern Indonesia or Papua New Guinea"; A. C. Smith (1981) admitted that "the nativity of *Piper methysticum* is uncertain"; and Brunton (1989) has suggested a western Melanesian origin.

In this chapter, after describing morphological and reproductive characteristics of kava, we review the taxonomic relations of the plant and then discuss existing theories regarding its origins. Whereas previous speculations about the domestication of the Pacific drug have been based largely upon the plant's geographic distribution and comparative linguistic analysis of its vernacular names, we also take into account various other lines of evidence. Our discussion of recent morphological and genetic research provides, we believe, more definitive information about kava's taxonomic relations, as well as its origins and distribution throughout the Pacific.

Morphology

Piper methysticum is a member of the pepper family, Piperaceae, which belongs to the order Piperales in the class Dicotyledonae. The family includes about 5 genera and more than 2000 species of herbs, shrubs, small trees, and woody climbers distributed throughout the tropics, often in rainforests (Heywood 1978). The leaves of Piperaceae are usually alternate, entire, and petiolate, and the flowers are uniformly small and grouped on a dense spike.

The genus *Piper* comprises about 2000 species—the great majority of the species in Piperaceae. Ten of these render products that humans use as spices or medicinal drugs. These include pepper (*P. nigrum* L.), one of the oldest known spices; Ashanti pepper (*P. guineense* Schum. and Thonn.), which is used as a

pepper substitute [in tr]opical Africa; betel (*P. betle* L.), a native of India and Southeast Asia whose leaves and inflorescences are masticatories; matico (*P. angustifolium*), a tropical American species that is both a spice and a local medicinal plant; cubeb (*P. cubeba* L.), also known as Java pepper or tailed pepper, a plant native to Indonesia which was formerly used as a medicine and today is used as a spice; and the long peppers (*P. officinarum* C. DC. and *P. longum* L.) that are native to the Indian subcontinent and used as spices in India and Sri Lanka.

Piper methysticum is a hardy, slow-growing perennial, generally resembling other Piperaceae (figures 2.1 and 2.2). It is an attractive shrub that can attain heights of more than three meters. Kava is cultivated for its rootstock, also referred to as the stump, where the active ingredients are located. The stump has often been erroneously called a rhizome by botanists. A true rhizome is a horizontally creeping underground stem that bears leafy roots—an organ frequently found in monocotyledons. *Piper methysticum* has no rhizome. Monopodial stems with sympodial branches grow from the stump.

The stump is knotty, thick, and sometimes tuberous, and it often contains holes or cracks created by partial destruction of the parenchyma. From this pithy rootstock extends a fringe of lateral roots up to three meters long that are filiform at the

Figure 2.1. Samoan farmer and his two-year-old kava plants, Fagaloa Bay, Upolu, Western Samoa (photo V. Lebot).

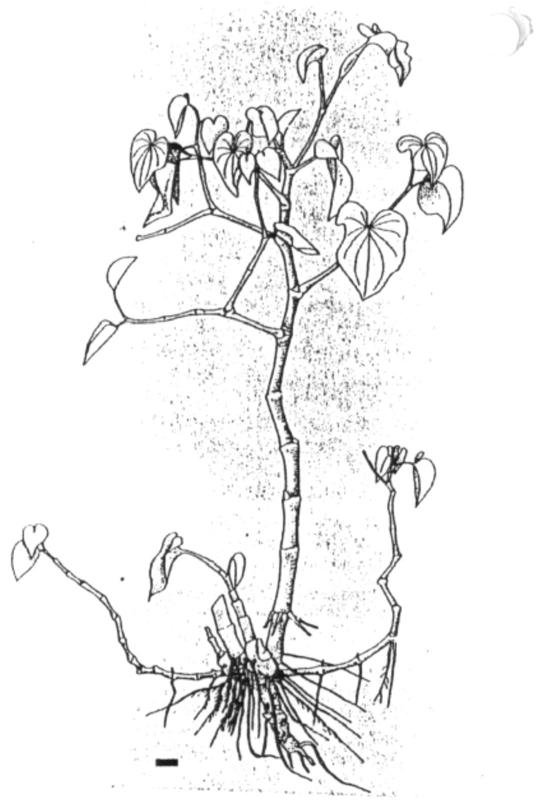


Figure 2.2. *Piper methysticum* Forst. f., general appearance of the plant. Bar equals 4 cm. (from Lebot and Cabalion 1986).

end. The roots comprise a multitude of ligneous fibers and consist of more than 60 percent starch. Around the center of the pith, which is made up of starch cells, are layers of vascular and ligneous tissue that alternate with small cells also filled with starch. Rootstock color varies from white to dark yellow, depending upon the amount of psychoactive kavalactones that are contained in a lemon-yellow resin.

A mature untended kava plant looks like a bouquet of ligneous stems growing from a cluster at the base. The stump grows no larger than the diameter of the plant's clumped basal stems and is located above ground level, where adventitious roots develop. Whereas cultivated kava plants often need extensive excavation of their root systems when harvested, relict kava plants in abandoned growing areas are easily uprooted by hand.

Under cultivation, kava rootstock develops into its characteristic voluminous

starchy mass as a r[illegible]t of intensive soil mounding by farmers who draw upon many generations of experience growing Pacific root crops. Kava cultivars show considerable variation of habit. Some are prostrate (having short internodes), and others are normal (many stems) or erect (few stems with long internodes). Kava's lateral branches grow from young parts of the main stems and, as they age, die and fall away, leaving prominent cicatrices on the nodes. Branches may sprout from a stem in either a levogyrate or a dextrogyrate arrangement. They are built by a linear succession of monophyllous modules that produce one cataphyll and one terminal spadix.

The kava plant does not have many leaves; those it has are thin, single, whole, heart-shaped, alternate, petiolate, and quite long (8–25 cm), and sometimes wider than they are long. Carried on petioles 2 to 6 cm in length, the leaves have three main veins that extend to their tips. They are deciduous and rot quickly. Although generally smooth, some leaves produce a pubescence on the underside, and occasionally on the upper surface, of the lamina or the veins. The base of the petioles and the stipules is enclosed in a caducous amplexicaul sheath.

The average fresh weight of kava's root system is 1 kg at the age of 10 months. The average number of stems is 11, and the number of nodes on the longest stem is 10 (based on agronomic experiments conducted in Vanuatu—see Lebot and Cabalion 1986). The first inflorescence appears at two to three years of age in the form of spadices that are irregular in size. Senescence does not set in until the age of 15 to 30 years, depending on cultivar type (Lebot, field observations, 1984).

Reproduction

Although *P. methysticum* does flower, it is incapable of reproducing itself sexually; its propagation is vegetative and solely due to human effort. Farmers plant cuttings taken from existing stems. New growth occurs at a stem bud at the axil of a lateral branch scar. An orthotropic (upright) shoot develops, and then axillary buds and plagiotropic (lateral) axes appear. In the same way, a root system develops from the underground part of a planted cutting. This directly feeds the portion of the stem corresponding to the original cutting, which grows rapidly in volume and forms the heart of a stump around which new growth points extend the aerial and underground parts of the plant.

Piper methysticum is typically dioecious and therefore cross-pollinating, although human interference has significantly affected its sexuality. None of the collected specimens of *P. methysticum* existing in herbaria throughout the world has seeds, and female plants are generally uncommon. The early botanist Delessert (1837) depicted male inflorescence without fruit, as did Degener (1940) for Hawaiian material. Degener stated that he had never observed a female plant in any of the plantations he had visited, and pointed out that Hille[illegible]d (1888), an indefatigable collector, also had been unable to locate and describe any female inflorescence of *P. methysticum* in his Hawaiian flora many years earlier. Hänsel (1968) similarly reported observing only male flowers. In fact, female flowers, although rare, occasionally do occur in cultivation. Recent observations in Hawai'i by Lebot (1991) documented both female flowers and monoecious plants. Even if hand-pollinated, however, female inflorescences fall off before they produce fruit. Lebot has also observed a bisexual *P. methysticum* inflorescence in Port Vila, Vanuatu. The ovaries of this plant were apparently immature, and its few brownish stamens seemed to have quickly expired (Lebot and Cabalion 1986).

Not surprisingly, the publications that describe *P. methysticum* provide few reports of seeds. In two that do (Cuzent 1860; Barrau 1957), no herbarium specimens are cited, rendering the claims impossible to verify. Two other references to kava seeds deposited in the Royal Botanical Garden at Kew, England, were misidentifications (Baker and Baker 1936; Guillaumin 1938). These were, in fact, seeds of another species, *Macropiper latifolium* (L. f.) Miq. (Lebot, Cabalion, and Lévesque 1986; figure 2.3). Pacific Island experience confirms Western botanical opinion that *P. methysticum* does not fruit. Growers in Vanuatu, for example, consistently claim that they have observed neither fruits nor seeds of kava.

Taxonomy and Nomenclature

Although the precise date when *P. methysticum* first caught the attention of European explorers is unknown, the Dutch navigators Le Maire and Schouten observed the plant on Wallis and Futuna islands as early as 1616 (Brosses 1756). Kava was certainly known to Pacific travelers by the time of the first Cook expedition; Parkinson (1773), the expeditionary artist, made one of the first drawings of the plant (entitled "*Piper inebrians*") in the Society Islands in 1769. The drawing is preserved in the British Museum (Natural History) in London, England (figure 1.4).

Piper methysticum was first described for taxonomic purposes by J. G. A. Forster (1786a), who joined Cook's second voyage (1772–75) as a botanist along with his father, J. R. Forster, and A. Sparrman. The binomial *P. methysticum* had previously been applied to a different species by the younger Linnaeus in 1781, but that usage was negated when Linnaeus (in a simultaneously published *Emendanda*) substituted for it the binomial *Piper latifolium*. Because Linnaeus had abandoned the original binomial, *P. methysticum*, its use by J. G. A. Forster in 1786 was nomenclaturally permissible (Moore 1934; A. C. Smith 1943, 1975, 1981). Forster described the species as follows:

> Pepper: cordate, acuminate, and multiveined leaves with axillary, leafy, very short, pedunculate, and very broad spikes. This species should be carefully distinguished from *Piper latifolium*, which is described in the *Supplem. Plantar.*, p. 91. By some accident it is called *Piper methysticum*. For indeed, though with many botanical indications, not only does that *P. latifolium* differ from the true *Piper methysticum*, but it also lacks a toxic property, nor is it ever applied by the natives toward this use [consumption, intoxication], and it grows of its own accord in tropical places on nearly all the islands of the southern ocean. (Forster 1786a, our translation)

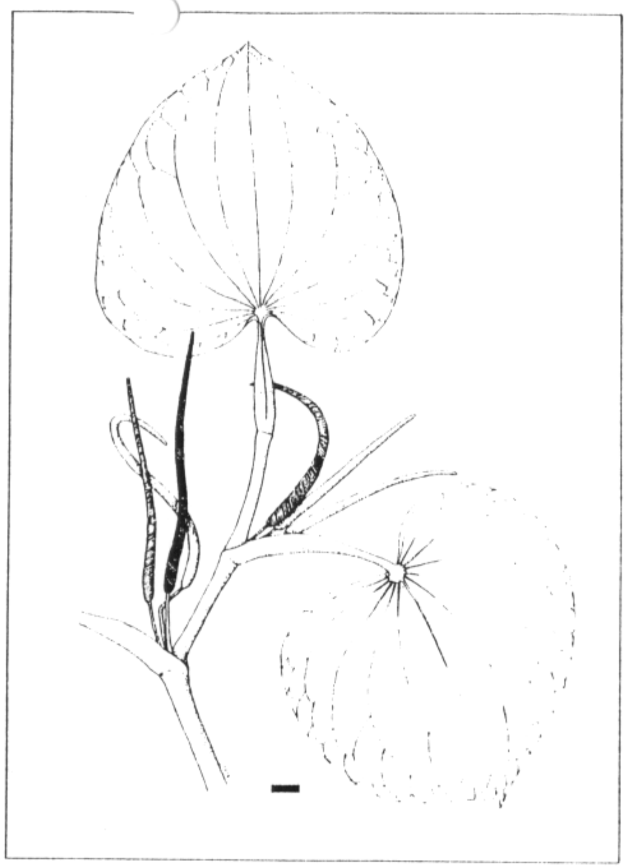


Figure 2.3. *Macropiper latifolium* (L. f.) Miq. Bar equals 2 cm. (from Lebot and Lévesque 1989).

There are a few botanical synonyms of *P. methysticum*, most of them merely listed without description (and hence of no botanical significance) or of later date than Forster's binomial of 1786. In some of the botanical literature, the name *P. methysticum* has been incorrectly applied to several species of a different genus, *Macropiper*—especially *Macropiper latifolium,* which is native t[illegible]nuatu and the Santa Cruz, Cook, Austral, Society, and Marquesas islands; an[illegible] *Macropiper excelsum* (Forst. f.) Miq., which is native to New Zealand and to Lord Howe, Norfolk, Kermadec, and the three Kings islands (A. C. Smith 1975). Although misidentifications of *M. latifolium* (L. f.) Miq. as kava are not uncommon in the literature and in herbaria, confusion in the field is far less likely because of the different inflorescence characteristics of the two genera.

Lewin (1886b) claimed to be the next to study kava botanically after Forster, although the French naval pharmacist Cuzent actually wrote the first detailed account of kava use, among the inhabitants of the Marquesas Islands, in 1856. Reproducing parts of his study of kava use and symbolism in several other publications, Cuzent (1857, 1858, 1860, 1873) described methods of kava preparation and its social significance for the Marquesans. Lewin (1886a) was nevertheless the first scientist to write a monograph on kava. In that book, he concluded erroneously that no differences in kava consumption patterns existed among the main regional groupings of Pacific Islanders (e.g., Micronesians, Melanesians, and Polynesians). Subsequent observers of the use of the drug soon began to document significant variation in kava consumption practices from one group of islands to another.

Because *P. methysticum* is always propagated vegetatively, the identification of its wild ancestor may enable us to identify its area of origin and to trace the ancient migrations of kava-using peoples in the Pacific. In general, the closer a Pacific island is to one of the main centers of biological evolution and domestication, such as Southeast Asia or the Indo-Malay archipelago, the more likely it is that its flora and fauna originated there. Conversely, the farther an oceanic island is from these centers, the higher the degree of endemism of its flora and fauna. The *Piper* genus is represented by many species in India and Southeast Asia, but determination of its exact center of origin is complicated by its presence in other centers of origin as well (e.g., tropical areas of Africa and South America). *Piper methysticum,* a cultivated species that resulted either from natural hybridization or from selected mutation, most likely originated in a geographical region rich in closely related species of the same genus—the area of greatest concentration of allied species of the same genus is considered by many botanists to be the probable area of origin.

Some botanists have suggested Polynesian origins for kava. Seemann, for example, claimed in his *Flora Vitiensis* (1868) that "kava was not cultivated in the islands which were inhabited only by the Papuans [that is, Melanesians]." An extra-Melanesian origin is unlikely, however, given how many more *Piper* species there are in Papua New Guinea and island Melanesia than in either Polynesia or Micronesia. Moreover, none of the native species of *Piper* of Polynesia or Micronesia are morphologically closely related to *P. methysticum.* The probability that kava was domesticated in either Polynesia or Micronesia is therefore very low. Rather, the

presence and numb[illegible] f related *Piper* species indicates that the area of kava origin is somewhere in Melanesia: in New Guinea, the Solomon Islands, or Vanuatu.

Misidentifications of herbarium specimens have led to the suggestion that *Macropiper latifolium* may have been a Melanesian ancestor of kava; a direct evolutionary relationship between *P. methysticum* and *M. latifolium* is unlikely, however, given the significant morphological and chemical differences between the two genera (Smith 1975). Although Cuzent (1857) claimed that Tahitians used *M. latifolium* to prepare kava, he almost surely meant *P. methysticum.* A chemical analysis of root samples of *M. latifolium* found no psychoactive kavalactones. Its major constituent is β-asarone, a depressant of the central nervous system (Lévesque, unpublished data, 1987).

Other possible ancestors of kava exist within the *Piper* genus itself. Two *Piper* species closely related to *P. methysticum* are endemic to northern Melanesia—*P. wichmannii* C. DC. (synonyms *P. erectum* C. DC., *P. schlechteri* C. DC., and *P. arbuscula* Trelease) and *P. gibbilimbum* C. DC. *Piper wichmannii* (figures 2.4 and 2.5) is common in Papua New Guinea, the Solomon Islands, and northern Vanuatu, particularly at elevations around 800 meters (Lebot, field observations, 1988 and 1990). *Piper gibbilimbum* is a successful colonizer of disturbed forests in New Guinea. For example, it is an efficient pioneer in the grasslands of the Strickland Gorge, where it grows at an altitude of 1000 to 2500 meters. A third candidate, *P. plagiophyllum* K. Schum. and Lauterb., is most likely a taxonomist's artifact in that it corresponds to a recognized *P. wichmannii* morphotype (W. L. Chew, personal communication, 1987).

One possibility is that *P. methysticum* originated as a hybrid of related *Piper* species. If, for example, *P. wichmannii* and *P. gibbilimbum* reproduce sexually rather than apomictically (which has not yet been definitively established), then *P. methysticum* could be a sterile (F_1) interspecific hybrid of the two. Hybridization of several different F_1s from genetically varied parent species might also explain the presence of different zymotypes in *P. methysticum* (see below). Experimental evidence and observations of *Piper* species (Semple 1974) indicate poor fruit set in the absence of staminate flowers, suggesting that active pollination is required for good fruit set. Observed inflorescence of *P. wichmannii* showed very good fruit set on crowded spikes. Possible pollination mechanisms are still unclear; wind pollination is unlikely for both *P. wichmannii* and *P. gibbilimbum* because of the glutinous nature of their pollen, which is not easily washed away even by heavy rainfall (Lebot, Aradhya, and Manshardt 1991). Fruits of these two species are very small but not easily dispersed by wind. They remain on the mature inflorescence until it falls to the ground. Bats, which have been observed eating the long (up to 30 cm) inflorescence of *P. wichmannii,* could be responsible for its dispersal in the forest and from island to island.

In spite of the possibility of cross-pollination among these *Piper* species, field

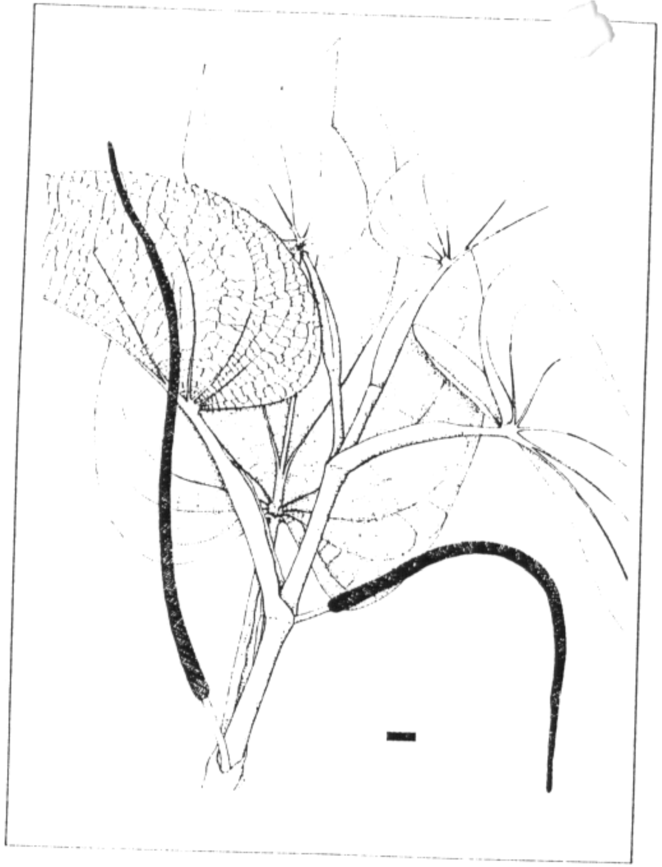


Figure 2.4. *Piper wichmannii* C. DC. Bar equals 2 cm. (from Lebot and Lévesque 1989).

observations suggest that hybrids of *P. wichmannii* and *P. gibbilimbum* do not occur. Plants of these species are often found growing close to each other without obvious sign of hybridization. A direct genetic relationship between *P. methysticum* and *P. gibbilimbum* is dubious, because the latter does not produce kavalactones (Lebot, personal observations, 1990).

The most likely ancestral candidate for *P. methysticum* is *P. wichmannii*. A number of lines of evidence lead to this conclusion. According to Chew's (1972) comprehensive revision of the *Piper* genus in Melanesia, *P. wichmannii* C. DC. is the most closely related taxon to *P. methysticum*. Morphologically the taxa are very similar—morphological differences between *P. wichmannii* and *P. methysticum* (e.g., coloring and pigmentation of stem internodes, leaf coloring or pubescence on lamina, woody elements of roots) are no more significant than those between

Figure 2.5. Farmers with a cultivated form of *Piper wichmannii*, Baluan, Manus Province, Papua New Guinea (photo V. Lebot).

different cultivars of *P. methysticum*. *Piper wichmannii* is a dioecious shrub indeed quite similar to *P. methysticum* in growth pattern and features. Chew (1972) notes that *P. wichmannii* "is perhaps the commonest species of *Piper* in New Guinea and the Solomon Islands; . . . its arborescent habit of growth coupled with the characteristically large cordate leaves with long spikes makes it the most distinctive species in the genus." *Piper wichmannii* inflorescences are as long as the leaves, with peduncles shorter than the petioles: "male flowers 2-staminate; stamens 0,5 mm long; anthers reniform, dehiscing apically; filaments short, broad, and stout. Female flowers sessile; stigmas 3-fid. subsessile; bracts round, peltate, long pedicillate. Fruits sessile, somewhat obconical, free at maturity" (Chew 1972). The natural habitat of *Piper wichmannii* is dense rain forest with persistent foliage. Like *P. methysticum*, it is a shade-loving species whose distribution as a wild or cultivated plant is restricted to wet equatorial or subtropical climates between 25° north latitude and 25° south latitude.

The major morphological difference between the two taxa is the length of the inflorescence. The inflorescence of *P. wichmannii* is as long as the lamina—15 to 30 cm. That of *P. methysticum* varies between 6 and 20 cm, but is always shorter than the lamina (figures 2.6a and 2.6b). A morphological rule of thumb is that any particular form, wild or cultivated, belongs to *P. wichmannii* when the spadix is as

Figure 2.6a. *Piper methysticum* inflorescences (from Lebot and Cabalion 1986).

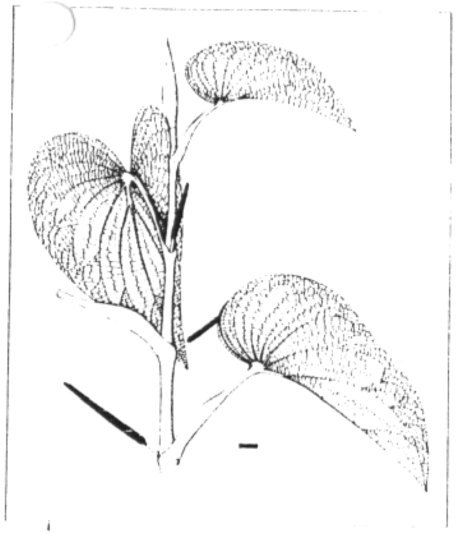


Figure 2.6b. *Piper methysticum* inflorescences. Bar equals 2 cm. (from Lebot and Cabalion 1986).

long as the lamina and the plant is erect with few stems. There are exceptions: for example, in Vanuatu we have found no significant difference in length of male and female inflorescences between *P. wichmannii* and *P. methysticum* specimens.

There are minor differences between the two taxa in root characteristics. The tissue of *P. wichmannii* is noticeably harder than that of *P. methysticum*, and the proportion of woody elements is higher. The woody elements in *P. wichmannii* are scattered around lumened tracheids; in contrast, *P. methysticum* rootstock is characterized by extraordinarily wide medullary ray segments. The parenchymatic material in *P. wichmannii* occupies a comparatively small area. *Piper wichmannii* possesses large, connected bands of brachysclereids, but the bark parenchyma of *P. methysticum* cultivars contains nearly separate brachysclereids.

The root hardness of *P. wichmannii* has been particularly noted in one specimen from Papua New Guinea. Saüer and Hänsel (1967) described, analyzed, and classified this specimen as *Piper* sp. Womersley, but it was subsequently identified as *P. wichmannii* (Chew 1972; specimen NGF 19746, Lae Herbarium). Saüer and Hänsel also isolated psychoactive kavalactones from this plant like those found in other specimens of *P. wichmannii*. Apart from *P. methysticum* and *P. wichmannii*, the only *Piper* species that produces similar compounds is *P. sanctum*, from which Hänsel and Beiersdorff (1958) isolated one minor kavalactone, 5-methoxy-5,6-dihydromethysticin (see chapter 3).

Misidentifications of *P. wichmannii* and *P. methysticum* are [illegible]mon in herbaria and in the field. For example, a specimen collected on the island of Tongoa, in Vanuatu, was sent to two regional specialists. One identified it as *P. methysticum,* and the other as *P. wichmannii* (Lebot and Lévesque 1989). Lebot's examination of purported specimens of *P. methysticum* in the Museum d'Histoire Naturelle in Paris revealed that a substantial number were either *P. wichmannii* or *M. latifolium.* Reports of *P. methysticum* growing wild must therefore be treated with suspicion.

In one of the earliest descriptions of kava, Miklouho-Maclay (1876) noted the difficulty of distinguishing the *Piper* species he found along the north coast of Papua New Guinea:

> Finding that the botanical character of the leaves of the *keu* [kava] plants taken from different bundles, presented some differences, I sent the whole concern (bundles, flattened leaves, etc.), to Dr. Scheffer for complete examination, with the request to tell me by-and-by his opinion: whether all the *keu* specimens belonged to the same species (*Piper methysticum*) or not. The same forenoon I received a short note from Dr. Scheffer, written in haste in the Botanical Garden, with the statement that the bundles of *keu* contained two different species of *Piper* and both different from the *Piper methysticum,* but that through the absence of flowers and fruits it was impossible for him to determine the species. . . . I had the opportunity of stating the information from the Rev. W. G. Lawes, that the *Piper methysticum* grows wild on the south-east of New Guinea without the natives knowing or making use of it. Rev. G. Brown wrote to me a few days ago about a similar case in New Britain, and New Ireland, and the Solomons islands, where *Piper methysticum* (or an allied species) grows wild, but the natives don't know the use of it (I got large roots of it, and natives from other islands said it was the true "kava," but not being cultivated it was coarse).

It is not only Western botanists who have difficulty distinguishing the two taxa. Some folk taxonomies in kava-using Pacific societies do not distinguish *P. methysticum* and *P. wichmannii.* On the island of Baluan in Manus Province of Papua New Guinea, for example, farmers recognize three cultivars as kava, one of which corresponds to the botanical species *P. wichmannii* (figure 2.5). In Vanuatu, island farmers who distinguish scores of cultivars on the basis of subtle morphological features classify all forms of *P. wichmannii* and *P. methysticum* together as the same "species," and refer to all these plants as kava. On Maewo and Pentecost islands, drinkers occasionally prepare kava drink from *P. wichmannii,* which they consider the primitive, wild form of kava (Lebot, Cabalion, and Lévesque 1986).

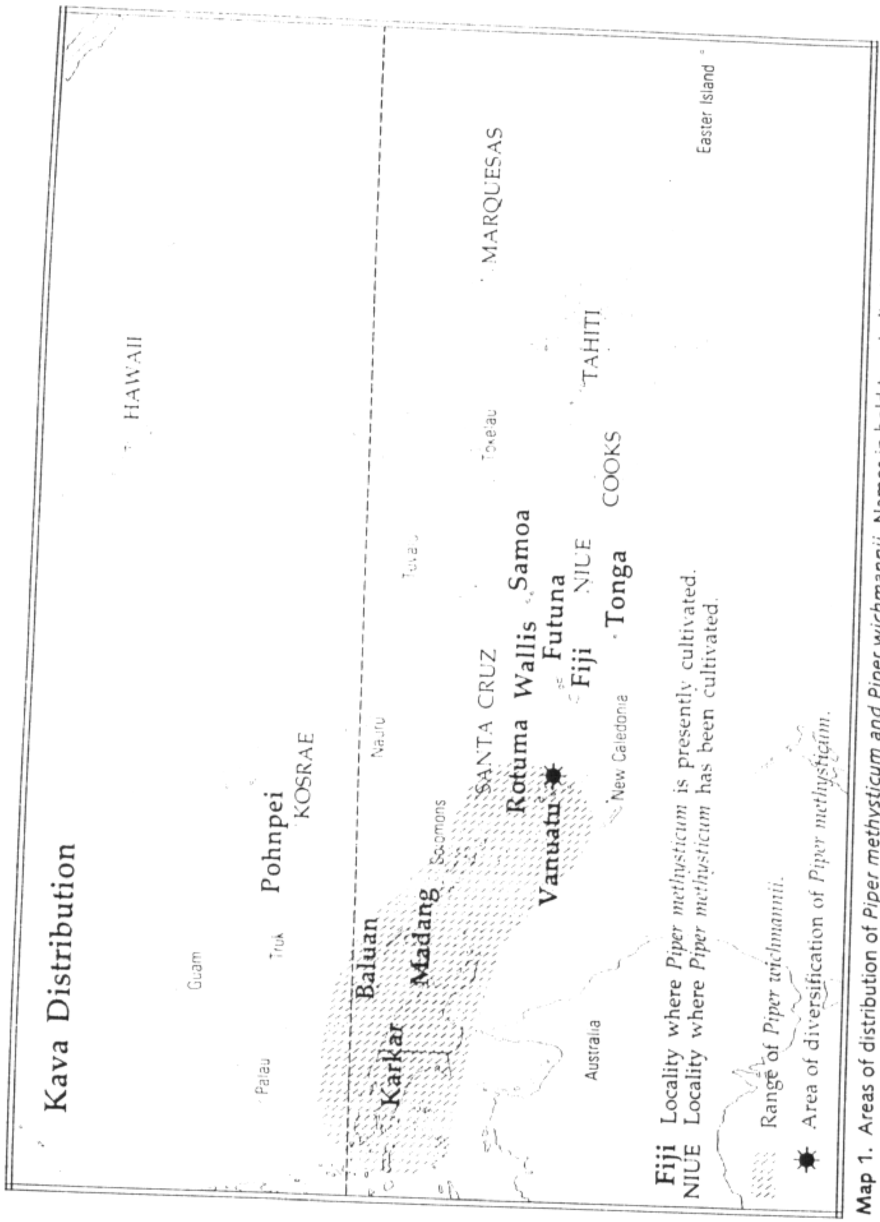
Recent genetic research provides additional evidence suggesting that *P. methysticum* is derived from *P. wichmannii.* We examined the genetic backgrounds of *P. methysticum* and *P. wichmannii* using electrophoresis and cytological techniques

(see the section belo[illegible]n distribution of kava cultivars). Cytological studies show 130 chromosomes for each of three *Piper* taxa: *P. methysticum, P. wichmannii,* and *P. gibbilimbum,* although in *P. methysticum* about a dozen of these chromosomes are four to five times the average size of the others (Lebot, Aradhya, and Manshardt 1991). Based on reports by Jose and Sharma (1985), Okada (1986), and Samuel (1986) indicating that the genus *Piper* is a homogeneous group with a basic number of $x = 13$, we presume that these three species are decaploid with $2n = 10x = 130$ chromosomes. Chromosome counts conducted on pollen mother cells of *P. methysticum* showed 65 bivalents. Although tetrad formation appeared normal, cotton blue staining revealed poorly formed pollen grains. No variation in chromosome number was found among *P. methysticum* clones presenting different morphotypes and chemotypes or between monoecious and dioecious plants. Meiotic counts were not conducted for *P. wichmannii* or *P. gibbilimbum* because of lack of material (Lebot, Aradhya, and Manshardt 1991).

Most other cultivated species of *Piper* (e.g., *P. betle, P. longum,* and *P. nigrum*) have wide ranges of ploidy levels among their numerous vegetatively propagated cultivars. This diversity is thought to reflect endomitosis which doubles the chromosome numbers in somatic cells. It is remarkable that, in spite of vegetative propagation, there is consistency in the chromosome numbers of all the kava cultivars analyzed. Notably, ploidy level was identical among sterile cultivars of *P. methysticum* and wild forms of *P. wichmannii* and *P. gibbilimbum.*

Available botanical data clearly indicate that *P. methysticum* is sterile. *Piper methysticum,* like most cultivated plants, is thus a derived form of a fertile wild species. Using field and herbarium observations and cytological and morphological comparisons as evidence, we conclude that *P. methysticum* is not a separate species but is rather a group of sterile cultivars selected from somatic mutants of *P. wichmannii.* We believe that wild forms of *P. wichmannii* were domesticated and their psychoactive properties improved through clonal selection of somatic mutants that possessed desirable psychoactive attributes (see the section on kava chemotypes in chapter 3). *Piper methysticum* should therefore be considered not a species but rather a putative cultivar. However, because *P. methysticum* was described before *P. wichmannii* (Candolle 1910), and because kava is such an important economic plant, subsuming *P. methysticum* within *P. wichmannii* would create both conceptual and practical problems. We henceforth refer to both *P. methysticum* and *P. wichmannii* as kava.

The area of origin of *P. methysticum* clearly lies somewhere within the range of distribution of *P. wichmannii,* an area including New Guinea, the Solomon Islands, and the northern part of Vanuatu (Chew 1972; Lebot, Cabalion, and Lévesque 1986). The large number of varieties of *P. methysticum* found in northern Vanuatu and the occurrence there of *P. wichmannii* suggest that location as the center (or the most important center) of domestication of *P. methysticum.*



Map 1. Areas of distribution of *Piper methysticum and Piper wichmannii.* Names in bold type indicate places where *P. methysticum* is now cultivated; names in all capital letters indicate places where it was formerly cultivated.

Geographic D bution

There are striking gaps in kava's occurrence across the tropical Pacific. Herbarium specimens, comparative linguistic analyses, and botanical field observations provide information about the geographic range of kava at the time of Western contact with Pacific Islands societies but fail to explain its disjunct distribution (map 1).

F ture archaeological research, including palynological studies, may offer insight into the ancient use and distribution of kava. To date, however, only one tantalizing find exists in the archaeological record—a fossilized stem fragment belonging to a member of a large Piperaceae species that was recently excavated from a waterlo gged deposit at Talepakemalai, Eloaua Island (Kirch 1988, 1989; P. V. Kirch, personal communication, 1990).

Eloaua is one of the Mussau islands, in the Saint Matthias group, located about 80 km north of New Hanover in the Bismarck Archipelago of Papua New Guinea. Radio carbon dates frbm Talepakemalai range from 3600 to 2400 B.P. (Kirch 1989; Kirch and Hunt 1988). This site was a node "in an extensive long-distance exchange network evidenced by imported ceramics, obsidian, chert, metavolcanic adzes, oven-stones, and other materials" (Kirch 1988). Its assemblage of artifacts identifies Talepakemalai as a Lapita site. Many archaeologists consider the people who made and traded an intricately designed style of pottery—Lapita—the ancestors of modern Polynesians. The widespread occurrence of Lapita artifacts in the Bismarck archipelago and beyond is evidence for extensive trading activity and, possibly, significant population movement associated with rapid colonization of the southwest Pacific approximately 3600 years ago (Hunt 1989). "Lapita populations dispersed over more than 4,500 km in probably less than 300 to 500 years" (Kirch 1989).

Although the Piperaceae fossil has not been identified or dated, its artifactual context indicates that the species probably was ethnobotanically important for the people who once inhabited Talepakemalai. The stem fossil was found in "solid association" with a number of Lapita-style artifacts (P. V. Kirch, personal communication, 1990) and "preserved seeds and other floral remains representing 20+ taxa" (P. V. Kirch, personal communication, 1990).

At present we have no way of knowing exactly which *Piper* the fossil is or even if it is a member of the *Piper* genus. It could also be a *Macropiper* species, which like *P. wichmannii* grow wild throughout the Bismarck Archipelago. If the stem is indeed fossilized drinkable kava and not *P. wichmannii* or a *Macropipe*[illegible]cies, then one could suppose that the trading voyages that dispersed Lapita pottery and other artifacts also carried domesticated kava from northern Vanuatu westward to Eloaua. Because the stem fossil is undated, it is not yet possible to pinpoint the timing of a hypothetical introduction of kava within the period 3600 to 2400 B.P. It perhaps is significant to note that the Saint Matthias group, at the northern edge of the Bismarck Archipelago, includes some of the closest of those islands to Baluan, Pohnpei, and Kosrae—the other isolated kava-drinking areas of the western Pacific. Kava may have reached Saint Matthias along the same routes that took it to Baluan, Pohnpei, and Kosrae.

As Brunton (1989) has noted, a general association of kava use with Lapita traders is complicated by the fact that many Lapita sites are found in regions of Melanesia where kava is not consumed. Green has suggested that people from the eastern end of the Lapita complex began to drink kava only after they had settled parts of the Fiji group:

> The drinking of kava was never diffused in the initial Lapita settlement period to New Caledonia or the Loyalty Islands (again suggesting it was not part of the Lapita cultural complex during the initial settlement of Remote Oceania, i.e., beyond the Solomon Island chain proper), nor do these assemblages contain the types of pottery bowls and cups appropriate for its drinking. . . . [Kava's] patchy distribution farther west and north is the result of later backward contacts from Vanuatu, from which the Lapita [pottery-making community] in Vanuatu got its Lou Island (Admiralty) and Talasea (New Britain) obsidians, or from the movement at a slightly later stage of "plain ware" Lapita from Vanuatu to Eastern Micronesia (marked by pottery and *Tridacna* shell adzes). (R. Green, personal communication, 1990)

The far western Lapita cultural complex centered in the Bismarck Archipelago does not appear to include any pottery bowls or cups that were used for drinking kava. People there chewed betel (the nut of the palm *Areca catechu*) instead (R. Green, personal communication, 1990). At the eastern end of the Lapita complex, however, certain plain and rim-decorated pottery vessels from assemblages of eastern Fiji and Samoa may have served as kava bowls and cups (illustrated in Green 1974). Green suggests that a style of flat-lipped shallow open bowl was ancestral to contemporary carved wooden kava bowls of Samoa, Tonga, and Fiji. The pottery bowls had round bottoms and were kept upright by woven or braided plant fiber rings. Carvers of today's wooden bowls, maintaining the original flat-lipped, rounded-bottom style, have added legs to support the vessel.

Linguistic reconstruction of the names given to kava bowls of this style also links the eastern Lapita cultural complex with kava consumption (Geraghty 1983;

R. Green, personal c[illegible]munication, 1990). Contemporary Tongan and Fijian names for the vessel—*tano'a* and *tanoa*, respectively—derive from Proto-Tokalau (eastern Fiji) **takona* by means of a metathesis (**tanoka*) and a replacement of *k* with a glottal stop (*tano'a*). The word *kona*, as is discussed below, means "bitterness" or "poison" in various Oceanic languages and is reflected in the standard Fijian word for kava today (*yaqona*). Green suggests that people in the Proto-Tokalau region adopted kava drinking sometime during the period 2800–2500 B.P., when Proto-Polynesian was emerging as a distinct language (personal communication, 1990). Proto-Polynesian speakers borrowed both the word *tano'a* and the kava vessel form itself, which they began to reproduce in wood when pottery making declined east of Fiji. The tano'a and an associated Polynesian ritualized drinking protocol later diffused westward into Fiji proper (see chapter 7).

A comparison of the vernacular names used for kava by Pacific Islanders provides an important though somewhat confusing perspective on the history of kava's distribution among Pacific peoples. Linguistically, there are two main distribution zones. In the Polynesian region, Pohnpei, Kosrae, parts of New Guinea, and southern Vanuatu, the plant is known by cognate terms, all of which are reflexes of Proto-Polynesian **kawa* (Walsh and Biggs 1966). Elsewhere in New Guinea, Fiji, and northern Vanuatu the plant is known by a range of sometimes differing, sometimes affiliated names. Brunton (1989) provides a comprehensive linguistic mapping of these terms.

In Polynesia, people also use the word *kava* and its cognates as adjectives to describe unpleasant flavors of foods and drinks. In the Cook Islands, for example, the word *kavakava* means "bitter" (Whistler 1990). In Hawai'i and the Marquesas, *'ava* signifies "bitter," "sour," "sharp," and "pungent." In Tahiti the range of meaning of *'ava* is broader, including "bitter," "sour," "acid," "acrid," and "pungent" (Churchill 1916b; Pétard 1984). A similar semantic pattern occurs in Fiji, where kava is known as *yaqona* (pronounced yanggona). The word probably derives from **kona*, meaning "bitter" (Crowley 1990). Early Polynesians probably borrowed both the plant and the semantic pattern of associating its use with sensations of bitterness, but replaced the Fijian word **kona* with their own **kawa*. Alternatively, the Fijians may have modified the Polynesian word **kava* or both the Fijians and the Polynesians may have adopted their kava nomenclature from a third source. One indication of antiquity of words is semantic opacity, so a transparency like the extension of a word for bad-tasting to name the beverage can be taken to indicate a comparatively recent act of naming. It might also be supposed that the Polynesian and Fijian terms for kava are younger than some of their linguistically opaque northern Melanesian counterparts.

Green has suggested that the Polynesian word *kava*, like pottery drinking bowls and cups, dates back to the emergence of the Proto-Polynesian language approximately 2800 to 2500 years ago (personal communication, 199‸ ‸so, then kava's subsequent northwestward movement along Lapita trade networks might explain scattered reflexes of Proto-Polynesian **kawa* in the Admiralties, Micronesia, and mainland New Guinea (Brunton 1989). On Tongoa, for example, a cultivated form of *P. wichmannii* is called *kau*. On the island of Baluan in the Admiralties, kava (both *P. wichmannii* and *P. methysticum*) is also called kau. Along the Maclay Coast, south of Madang, kava is likewise called *keu* or kau. Similar linguistic forms exist on the two Micronesian islands where kava is (or was) consumed: on Pohnpei kava is known as *sakau*, and on Kosrae is called *seka* (Glassman 1950, 1952).

Compared with the linguistic situation in Polynesia, that in Melanesia exhibits a far more complex and more diverse pattern of vernacular kava names. These names, along with practices of kava consumption and cultivation, are very localized. The diversity might be explained in part by the greater availability and suitability of land for kava cultivation on the larger Melanesian islands and by the more pronounced cultural diversity of this region. It might also be explained by the greater antiquity of kava drinking in Melanesia.

An overview of places where kava is grown provides another perspective on its origins and history. The collections of pioneer botanists are important in this regard. In 1986 and 1987, Lebot compiled an inventory of specimens of *P. methysticum* and *P. wichmannii* in major world herbaria. (Paris Museum; Singapore Botanical Garden; Lae Herbarium; and Bernice P. Bishop Museum, Honolulu, were visited; Royal Botanical Garden at Kew; British Museum of Natural History, London; Rijksherbarium, The Hague; University of Malaysia, Kuala Lumpur; Bogor Herbarium; Queensland Herbarium; Royal Botanic Gardens of Sydney; New Zealand Department of Scientific and Industrial Research in Christchurch; Missouri Botanical Garden, St. Louis; and Arnold Arboretum, Cambridge, Massachusetts, submitted lists). Data from these collections were compared with data on specimens from smaller herbaria located in the Solomons, Vanuatu, Fiji, New Caledonia, Tahiti, and Guam.

A total of 111 specimens of *P. wichmannii* are preserved in these herbaria, all from Papua New Guinea, the Solomons, and Vanuatu. The 284 specimens identified as *P. methysticum* were collected in Micronesia, from Pohnpei and Kosrae; in Polynesia, from Kaua'i, O'ahu, Moloka'i, Maui, Hawai'i, Nuku Hiva, Fatu Hiva, Uapou, Raiatea, Tahiti, Mangaia, Rarotonga, Aitutaki, Niue, Ta'u, Tutuila, Upolu, Savai'i, Tongatapu, Vava'u, Eua, Wallis, Futuna, and Alofi; and in Melanesia, from Vanua Levu, Viti Levu, Vanua Balavu, Lakeba, Rewa, Tanna, Anatom, Pentecost, Papua New Guinea, and Irian Jaya. It is likely that other herbarium specimens exist, but we feel that the material reviewed provides a comprehensive overview of kava collections since the first European voyages into the Pacific.

Among the *P. methysticum* specimens listed, only 13 were collected in Papua

New Guinea (Wes‸ ‸Province, Lake Kutubu, and Madang), all at the beginning of this century. Three other specimens came from Irian Jaya, on its southeastern border with Papua New Guinea. No specimens were from the Solomons or New Caledonia. The reports of early explorers provide additional information about the distribution of kava at the time of European contact, beginning in the late 1700s. Region by region, these document the local knowledge of kava.

New Guinea

Piper methysticum has a spotty distribution in Papua New Guinea (map 2) and Irian Jaya. Brunton (1989) has mapped New Guinean vernacular kava names to analyze the plant's distribution in this region. (See appendix B for generic names for kava in Papua New Guinea.) Although Brunton is unable to reconstruct a definitive history of kava transmission within Papua New Guinea and Irian Jaya, linguistic affinities are so striking among the 40 or so recorded names that there can be no doubt that contacts and exchanges took place among some of the regions where kava was used.

The Admiralty Islands were once the area of greatest kava consumption in Papua New Guinea. Kava was used on Lou, Baluan, Pam, the Fedarb Islands, and Rambutyo. Islanders employed large flat stones, similar to those of Pohnpei in Micronesia, to pound kava rootstock. On Lou, the last remaining plants were uprooted when the population was converted to the Seventh-Day Adventist church, about 1970. Although kava continues to be grown in isolated spots in the Admiralty Islands, most residents now chew betel.

A second area of kava use is the northeastern New Guinea coast (Madang and Morobe provinces). *Piper methysticum* is here cultivated in a few isolated villages for local consumption, or for sale. In Sipaia Village, for example, kava is grown and sold to Fijians living in the city of Lae (Lebot, field observations, 1987). The people of the offshore islands Karkar and Bagabag used kava traditionally, although the Bagabag Islanders no longer drink it. Miklouho-Maclay, the first European to visit northeastern New Guinea, saw kava being prepared at Torendu, Astrolabe Bay, in 1872, which indicated that use of the drug was established there before European contact. The unexpected presence of kava in New Guinea was an enigma of great interest for the Russian anthropologist. In a note written for the Linnean Society of New South Wales, Miklouho-Maclay (1886b) stated:

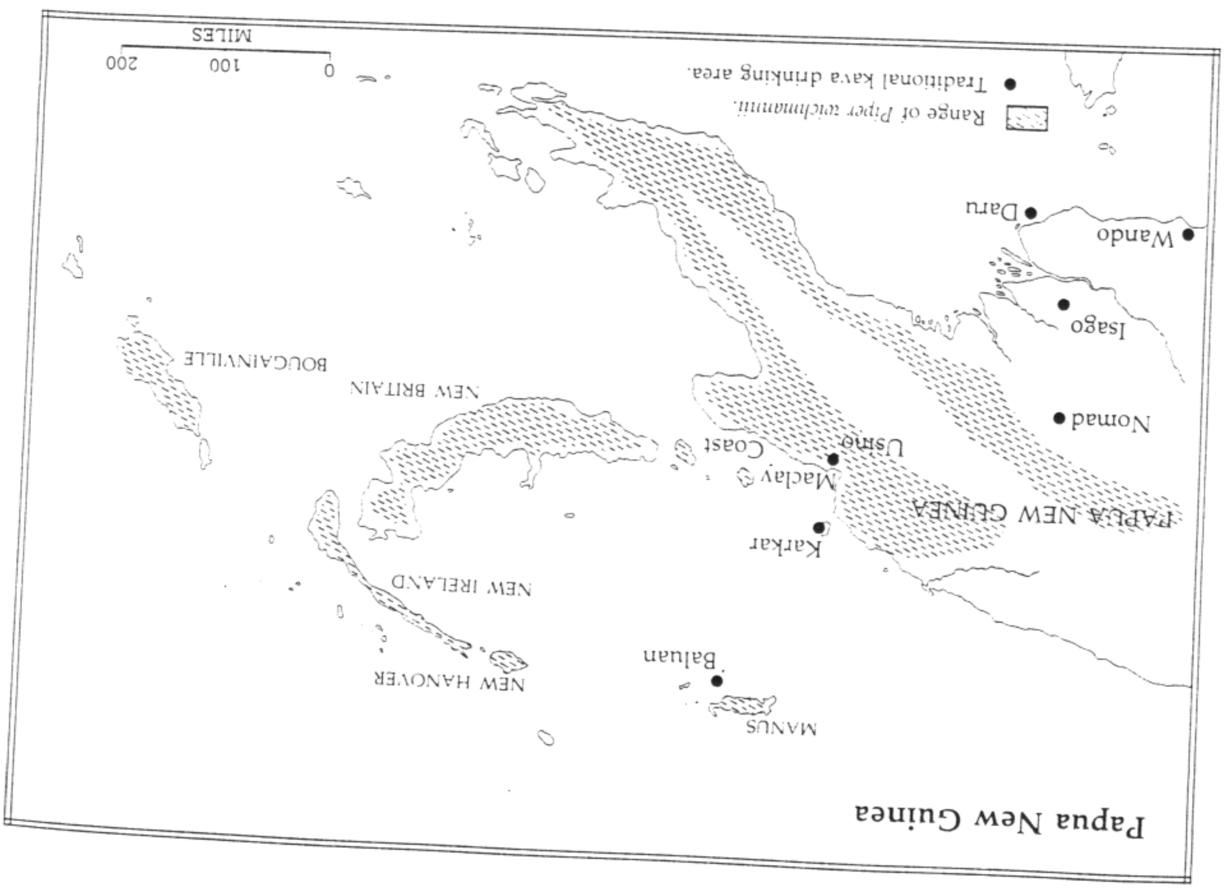
> How the use of *keu* [kava] became known to the natives of the Maclay coast, remains still to be found. . . . All the natives do not use the *keu*, in some villages, this stimulant and its effect are known, but the use of it has not been adopted; in some others it is not known at all. These facts make me think that

the custom of dri[illegible]g the *keu* has been introduced on the Maclay coast not very long ago (the natives however have no tradition about its introduction) and is still in the progressive stage. . . . The *keu* shrub is cultivated in the villages and on plantations but I never heard that it grows wild at the Maclay coast.

A third major kava-drinking region within Papua New Guinea covers a large part of its Western Province with an extension into Irian Jaya. Two specimens of *P. methysticum* were identified before World War II in the Lake Kutubu area (Williams 1940). Crawford (1981) has described kava consumption during mortuary rituals in Isago Village, not far from Balimo. Some distance inland, the Samo of the Nomad River area use kava, which they call *oyo* (Shaw 1981). In neighboring Irian Jaya, it is called *waghi, bari, tigwa, ikawati, dikoi,* and *wati.*

Lebot visited most of the Western Province villages that cultivate kava and found only one cultivar type in an area extending over approximately 90,000 square kilometers, from Nomad, Isago, and Daru to Wando. Throughout the Western Province, plants are commonly cultivated in raised beds under sago palm leaves (*Metroxylon sago* Rottb.). Serpenti (1965) has described similar agricultural techniques across the border in Irian Jaya, at Bamol on Frederik-Henrik Island (now called Kolepom), where kava is known as *tigwa.* There, as in the Western Province of Papua New Guinea, kava is difficult to grow. Plants must be carefully tended and shaded. According to Western Province farmers, their kava plantings never survive more than two years. During recent field surveys (Lebot and Lévesque 1989; Lebot, Aradhya, and Manshardt 1991), it was impossible to find a single lignified plant. All appeared to be very young, confirming farmers' statements. Stumps produced in such conditions are rather small. In both Irian Jaya and Papua New Guinea's Western Province, kava has all the attributes of an introduced crop because the environment is generally unsuitable for this species—swamps with alkaline soils supporting mangrove species such as *Rhizophora,* and savannas with *Eucalyptus, Acacia, Melaleuca,* and *Pandanus* with an understory dominated by *Asplenium* ferns. This region has a monsoon-type climate with about 80 percent of its annual rainfall (2000 mm) occurring between December and April. Such conditions are unfavorable for the unirrigated cultivation of kava, which is best adapted to rainfall spread more evenly throughout the year.

A linguistic analysis of vernacular kava names in south central coastal areas of New Guinea might suggest that the plant here could be indigenous, for the languages of this region are Papuan (or non-Austronesian). If kava were recently introduced, one might suppose that an Austronesian name would have been adopted along with the plant. Moreover, some of the communities in the region, in spite of their proximity, do not share names for kava with each other, each identifying the plant with a different vernacular lexeme (Brunton 1989). This, too, might



Map 2. Distribution of kava in New Guinea. The striated area is the current range of *Piper wichmannii.* Dots show where *P. wichmannii* and *P. methysticum* are used today.

imply that the plant has long been present. However, it is important to note that most Western Province names for kava mean simply "root" (Department of Linguistics, Unitech Lae, personal communication, 1987). An alternative explanation is that kava planting material was first introduced into the area in the recent past, given that kava is referred to simply by the name of its most useful part.

E. E. Henty, who spent nearly 20 years as the curator of Lae Herbarium in Papua New Guinea, has also suggested that

> kava arrived in the Maclay area by direct introduction rather than diffusion . . . [and similarly that] there are no early records of *P. methysticum* in the Western Province. This was a very isolated area and was made so by the Asmats, the dangers of navigation in Torres Strait, and the hostility of the local people. When missionary work began, earlier this century, "catechists" or "lay readers" were recruited, trained in Tonga and Fiji, and employed. It is possible that one of them took a root to Daru or one of the other stations. (E. E. Henty, personal communication, 1988)

Serpenti (1965) similarly suspected that kava had only recently been introduced into southern Irian Jaya. He speculated that the plant was brought into the region after the Dutch government had occupied the territory in the nineteenth century (although he suggests that farmers on Kolepom Island recognized five cultivar types). On the north coast, Miklouho-Maclay (1886a) observed only one type of kava in Astrolabe Bay and on Karkar Island. Today kava is represented by only one cultivar in the whole Western Province, as well as along the north coast of the island. In Baluan (Admiralties), kava is represented by only two cultivars. This limited diversity of kava cultivars in New Guinea is additional evidence for the plant's recent introduction.

All indications are that *P. methysticum* and its use are alien introductions to both Papua New Guinea and Irian Jaya. Cultivation of *P. methysticum* there is always very localized and restricted to coastal areas or their hinterlands. We conclude that *P. methysticum* was introduced by chance contact and exchange in the relatively few places where it grows.

Solomon Islands

According to Whitmore (1966), no proven specimen of *P. methysticum* has been found in the Solomon Islands, and today kava is consumed nowhere in this archipelago. It was used in the past in a few areas in the far southeast part of the country. Rivers (1914), for example, claimed that kava was drunk on Vanikoro and Utupua in the Santa Cruz Islands, although Codrington (1891) and Thomson (1908) had both previously observed that the plant was unknown on these islands.

Fox (1924) noted that he saw kava plants on San Cristobal and that island men drank kava occasionally at mortuary ceremonies: "The root was ground up in a stone basin, wrung out, and then each man drank in a small cup called *kukumanu*, and I think poured out a portion on the ground." It is possible, however, that this root was *P. wichmannii*, which is native to the rain forests of the Solomon Islands. Brass, for example, recorded that the local name for *P. wichmannii* in the southeast part of Santa Isabel was *kava qwua* (R. Brunton, personal communication, 1987); on Guadalcanal this species is called *kwakwako* (Lebot, field observations, 1987 and 1989); and on neighboring Malaita, the 'Are 'Are word *kakawa* is used for an unidentified tree whose roots are sucked to produce intoxication.

It is also possible that Fox observed *P. methysticum* plants that had been recently imported from Fiji. In the late nineteenth century, many Solomon Islanders were recruited to work on sugarcane plantations in Queensland and Fiji (Hilliard 1978). Missionary accounts note that some veterans of the Fiji plantations returned home as kava drinkers. Solomon Islanders would also have encountered kava drinkers among the students enrolled at the Anglican mission's religious training institution on Norfolk Island. A. Mason, an Anglican missionary on north Malaita, complained:

> In the two Fiu villages there has been serious trouble in connection with the drinking of kava, introduced from Fiji. A certain culture has grown up around it, ceremonial drinking and malpractices, which had to be condemned, as Communicants were tending to put this before Holy Communion, and inclined to neglect Church duties because of it. A careful investigation extending over more than two years showed that the matter was becoming very serious, two Norfolk Island trained boys, one an acting teacher, being leaders. (Melanesian Mission 1925)

Mason's report is contemporaneous with Fox's kava sightings on San Cristobal. The Melanesian mission was in general hostile to the introduction of kava to the Solomon Islands and, although use of the drug persisted on Malaita into the 1930s (Melanesian Mission 1933), it is not surprising that the introduced plant subsequently disappeared from the region.

Limited and scattered kava use has also been reported on Vanikoro and Utupua and on the Polynesian outliers of Anuta and Tikopia, located in the Santa Cruz group of the eastern Solomon Islands (Rivers 1914; Firth 1954). Polynesians arriving from their homelands of Samoa, Tonga, and Uvea (Wallis Island) most likely brought the plant with them into the Santa Cruz Archipelago during the past 1000 years or so. Firth (1954) noted that although kava was no longer cultivated on Anuta, traditional myth implied that it was once drunk there. When Kirch and Yen (1982) visited Tikopia in the late 1970s, they reported that "kava has now become extinct, with only a wild form *kavakava atua* (kava-diminutive spirit) remaining that cannot, according to informants, be used for preparation (although it has been identified as *P. methysticum* by Solomon Islands and Bishop Museum botanists)." In other Polynesian communities, such as the Marquesas and Cook islands, the name *kavakava atua* refers to *M. latifolium* (F. B. H. Brown 1935; Whistler 1990).

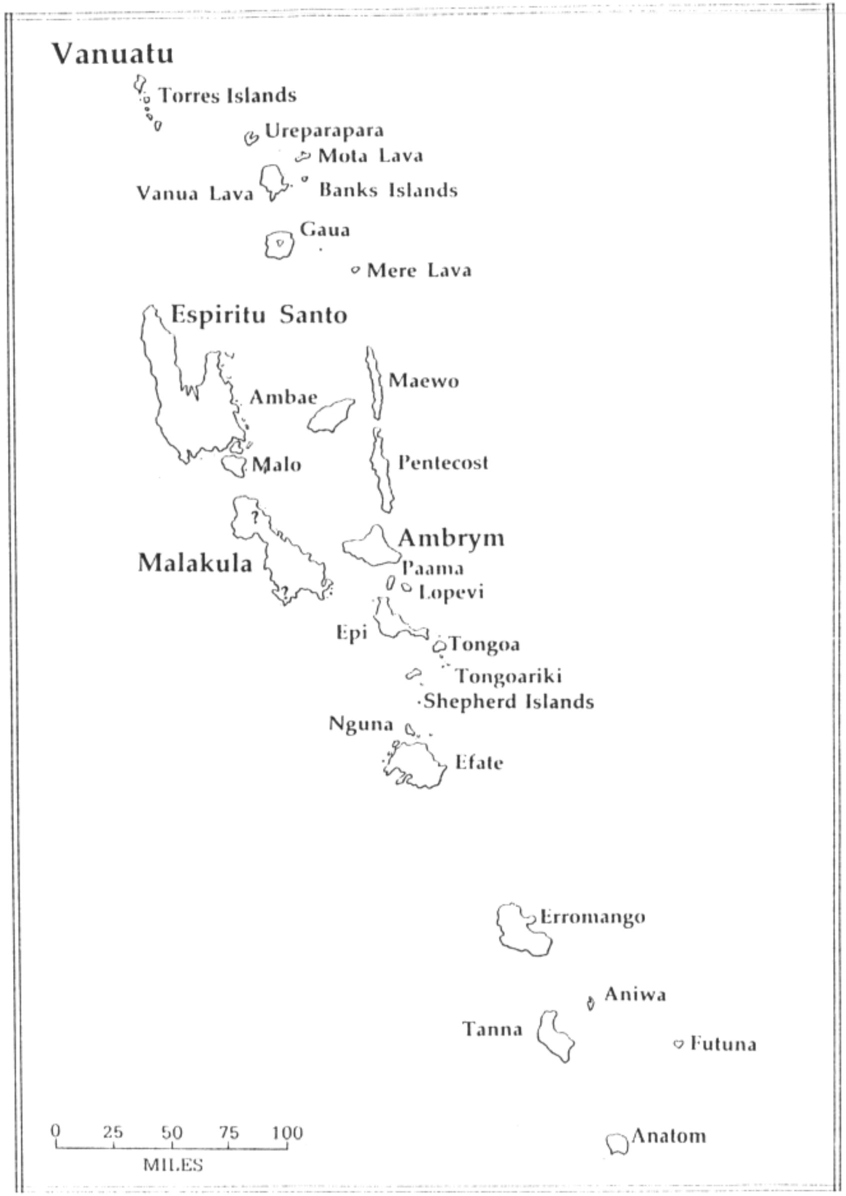
Vanuatu

As we have suggested, because there are more *P. methysticum* cultivars in Vanuatu than anywhere else in the Pacific (80 out of a total 118), this archipelago is the best candidate to be the homeland of kava (map 3). Vanuatu certainly had long been a propagation and improvement center for kava cultivars that subsequently were spread eastward by Polynesian migrants who settled the reaches of the Pacific.

To date, only six herbarium samples of *P. methysticum* have been collected from Vanuatu. This is sparse coverage compared to the number of articles and publications describing kava consumption in this archipelago. Forster noted kava's presence in Vanuatu in 1774, although he actually collected a specimen of *M. latifolium.* MacGillivray observed *P. methysticum* on West Futuna in 1851 without, however, taking any samples. He included it in a list of food crops and useful plants as one of "the more remarkable plants not before alluded to (Cocoa-nut, Bread-fruit, reed-like grass, yam, taro, Horse-taro, kava, etc.)" (MacGillivray 1854). The first botanical specimen of *P. methysticum* from Vanuatu was collected in the early twentieth century by Levat in Port Vila (Guillaumin 1919). A second herbarium specimen was collected in 1928 at Lenakel, Tanna, by Kajewski: "The roots make the native intoxicant *n'kava*" (Guillaumin 1932).

Consumption of kava is common nearly everywhere in Vanuatu. Reportedly some Vanuatu communities traditionally did not use the drug, but claims that kava was unknown should be entertained with some suspicion. Lester (1941), for example, was obviously wrong in stating that the people of Paama Island did not drink kava. The Paamese today report to have always known kava as *malou* (see appendix C for generic names for kava in Vanuatu). Lester may have been misinformed because of pressures from colonial authorities and missionaries to ban drinking of kava at the time of his research. Codrington (1891) is more credible when he writes that there was no kava on Gaua in the Banks group, although Rivers (1914) suggested that islanders had only recently given up its use. Today kava once again is grown on Gaua, although it is still not a common plant. Its introduction, or its reintroduction, is evidently recent, most probably from the neighboring island of Vanua Lava.

The best-documented absences of kava drinking in Vanuatu occur among a



Map 3. Vanuatu.

few small groups on Santo and Ambrym and among inhabitant[illegible]he central and southern parts of Malakula (Speiser 1923). On Ambrym *M.* [illegible]*folium* and *P. wichmannii*—known in Bislama as *wael kava* (wild kava)—were both used ritually but not drunk (Paton 1973).

A recent survey of areas of western Santo purported to be without a tradition of kava use revealed that the inhabitants of Nokovoula Village, at 1132 meters altitude, had in fact long been familiar with the plant and called it *malohu* (Lebot and Cabalion 1986; Harrison 1936). If this local oral tradition is to be believed, kava must have been introduced here long ago, in spite of the isolation of this mountainous region.

A linguistic affinity exists between the name *malohu* and the reconstructed term **maloku* (kava) from Proto-North Central Vanuatu, which, according to Crowley (1990), is "the language ancestral to probably all of the languages spoken between Efate and the Torres in Vanuatu." Crowley provides other north Vanuatu reflexes of this lexeme and notes that the "wide variety in the shape of reflexes certainly suggests that the form is quite old" (1990). (Other sources include MacDonald [1889] who records that kava was known as *meruh* on the east coast of Malakula.) Crowley reports that **maloku* also has Fijian reflexes that mean "quiet" and "subdued." Although the history and relations of northern Vanuatu languages are still being determined, this linguistic heritage could date kava's domestication to before the breakup of Proto-North Central Vanuatu language some 3000 years ago. Horticultural evidence—the large number of present-day kava cultivars—supports these linguistic clues to kava's antiquity in Vanuatu.

New Caledonia

Kava was never cultivated in New Caledonia or in the neighboring Loyalty Islands. Aside from Forster (1786a), the only report of kava comes from Bourgarel (1865): "Kava exists in a few locations on the island, but I do not know if the natives know its properties or if they have ever prepared an intoxicating beverage from it" (our translation). However, this statement that kava grew wild cannot be taken seriously; *P. methysticum*, *P. wichmannii*, and *M. latifolium* were not observed or collected in New Caledonia by any botanist until the 1980s, when immigrants from Vanuatu imported planting material for their own use.

Fiji

Kava is consumed throughout the Fijian archipelago, where it is called *yaqona*. Lester (1941) reports that the word *qona* is still used on the northwest coast of the island of Viti Levu to designate both the kava beverage and a bitter taste. He speculates that this may indicate that the plant was introduced first to this part of

Fiji. Northwest Viti [illegible]u is the region of Fiji that reflects the most Melanesian cultural influence; it is the part of the archipelago closest to Vanuatu.

Polynesia

In Polynesia, people living on all the high mountainous islands (except New Zealand, Easter Island, Rapa, and the atolls or low-lying islands of Kiribati, Tuvalu, Tuamotus and the Chathams) cultivated and used kava at one time or another (Marshall 1976; Gatty 1956). The plant and beverage are known as *kava* on Wallis and Futuna and the islands of Tonga; as *'ava 'ava* in Samoa; as *'awa* in Hawai'i; as *kava-kava* in the Marquesas; as *kavainu* in Niue; as *'ava* in Tubuai; and as *'ava, 'ava 'ava,* or *evava* in Tahiti (Cuzent 1857). In New Zealand, where the climate is too cold for kava, the Maori gave the name *kawa-kawa* to another Piperaceae, *M. excelsum,* in memory of the kava plants they undoubtedly brought with them and unsuccessfully attempted to cultivate. The Maori word *kawa* also means "ceremonial protocol," recalling the stylized consumption of the drug typical of Polynesian societies.

Because all Polynesian languages possess reflexes of the Proto-Polynesian word **kawa,* it is likely that kava was known and used in Polynesia before its people spread eastward from their nuclear homeland Sawaiki (Samoa and Tonga) sometime around 1700 B.P. (Howe 1984). Because of the cultural importance of kava, the plant may have been one of the first that aboriginal voyagers took with them (A. C. Smith 1981).

There are some arguments for a more recent introduction of kava to eastern Polynesia. Ferdon (1981), for example, states that kava was "certainly the last introduced plant into Tahiti. . . . The active diffusion east towards Tahiti was still going on as late as 1774–75." He notes that a chief of one district of Tahiti did not have a single plant; two years later large kava plantations had been established in this same district. Parkinson claimed in 1773 that kava was not common in Tahiti, being "scarce and little used," although it was cultivated in large plantations on neighboring Huahine. Because kava was introduced to Hawai'i from either the Marquesas or Tahiti long before the 1700s, the scarcity noted by Parkinson in the 1760s may reflect a temporary, localized shortage of planting material like those that occur quite often today (e.g., in Tonga).

Owing to missionary influence, cultivation of kava in Tahiti declined steeply by 1830, so that "it was no longer possible to find a single specimen of the plant and many Tahitians no longer even knew it by name" (Lewin 1927). Nevertheless, Cuzent (1857) managed to collect 12 different kava cultivars between November 1854 and May 1857 on Tahiti, probably with the help of a few old traditional herbal healers; kava could also still be found on Raiatea, on Moorea, and in the Marquesas. Kava consumption has declined on several other Polynesian islands, such as Niue, where kava was once common but is now almost n istent. Sykes (1970) however, reported a few recent "small plantings" of kava i. .s flora of the island.

Ceremonial regulation of drug consumption by rank is typical across Polynesia (see chapter 5). This regulation is influenced by hierarchical political systems, but in isolated Polynesian locales shortages due to ecological limitations or scarcity of original planting material may also underlie the greater degree of ritualization of kava consumption in Polynesia versus that in Melanesia. If periodic shortages of the drug occurred, consumption may have been restricted to important occasions and people. Gaillot (1962) notes that in East Futuna, where kava was probably introduced from Samoa, traditional consumption demanded a highly hierarchical and strictly ceremonial protocol. On Tubuai, the main island of the Austral group, kava was drunk primarily by people of high rank (Morrison 1966).

As drug supply and the stock of planting material increases, consumption may then broaden, especially if legal restrictions are removed. According to Titcomb (1948), in Hawaiian prehistory *'awa* was drunk by chiefs or people of high social rank and only rarely by commoners. By the beginning of the nineteenth century, however, consumption had spread with increasing supplies of kava, and *'awa* was drunk by all social classes. Hawaiians in the early post-contact period replicated the typical drinking pattern of many Melanesian societies today, where the purpose of daily consumption of locally abundant fresh kava is to attain a state of relaxed intoxication.

Micronesia

In Micronesia at the time of European contact kava was consumed on just two of the Caroline islands, Kosrae and Pohnpei, where the plant is known as *seka* and *sakau* respectively. Although one plant specimen identified as *P. methysticum* was gathered on Palau in 1929 (Kanehira Herbarium specimen 453) and plants were once allegedly seen on Guam, Safford (1905) had correctly noted that kava was not consumed on these islands. Reported kava sightings were possibly misidentified specimens of *Macropiper guahamense* C. DC. (Smith 1975), or *P. methysticum* introduced after European contact. Today kava is still consumed on Pohnpei, but its use has been abandoned on Kosrae because of intense missionary influence.

Dispersal of Cultivars

Explorers' accounts, herbarium collections, and comparative linguistics provide basic information about where kava was cultivated at the time of European

contact. They do not, h er, tell us much about the prehistoric details of kava's spread across the Pacific region. As noted, comparative analysis of vernacular kava terms yields only a foggy purview of the exchange and movement of planting stock among island societies, so we turn here to morphological and genetic analysis for insight into kava's history. We suggest that similarities of plant forms and zymotypic affinities within existing kava stock provide better evidence of the prehistoric cultural dispersal of the Pacific drug than do affinities of kava vernacular names.

Cultivar Selection

The kava plant is propagated exclusively by stem cuttings, and growers must make judicious choices when selecting individuals from which to cultivate clones. They must eliminate unsuitable mutations while choosing favorable variants. The variation among kava cultivars originated in somatic mutation. The selection of particular mutants by kava farmers must have been a conscious process, at least to the extent of preserving new characters as they appeared; otherwise, it would be difficult to explain the presence of the scores of kava variants found today and their spread beyond the areas of their origin. Kava growers have selected cultivars to improve such appreciated characteristics as yield, length of time to harvest, and, especially, chemical composition responsible for the physiological effects. No other psychoactive species in the Pacific has been subjected to such intense artificial selection.

Genetic mutations in kava, as in many horticultural plants, sometimes occur because of viral infections. Physical and chemical factors can also induce the appearance of one or several new and genetically stable characters. Most variations occur as general mutations of the meristematic cells of the bud. Mutations involving the somatic (nonsexual) cells can also produce chimeras—individuals carrying genetically different tissue (figure 2.7). Polymorphism (of asexual origin) has occasionally been observed in the field. Indeed, during recent surveys in Vanuatu (Lebot and Lévesque 1989), farmers often stated that some of their cultivars would change after cuttings were planted. Other clones only reveal their heterogeneity after several generations.

Good gemmate mutations occur infrequently, but these nonetheless have been essential for improving clonally propagated planting material. The majority of morphological or physiological mutations are undesirable and ordinarily are eliminated through selection. Cases of degeneration can occasionally occur when bacterial or viral diseases are transmitted or when disadvantageous mutations are not eliminated. According to present genetic theory, however, risk of degeneration of kava clones over time is minimal, inasmuch as most clones are free of pathogens.

Figure 2.7. Chimera, Waimea Botanical Garden, Hawaii. Note stem with spotted internodes and stem not exhibiting this character (photo R. M. Manshardt).

Morphotypes

To establish the range of polymorphism of kava cultivars and to devise a descriptive morphological model, fieldwork was conducted throughout 21 islands of the Vanuatu archipelago. Local cultivars were collected and identified by their vernacular names. Because the morphological description of one cultivar recorded at its place of collection may not serve to identify it growing elsewhere under different ecological conditions, it was also necessary to study the morphological parameters of cultivars in a homogeneous environment. A total of 247 accessions were planted in a common garden (figure 2.8). The number of specimens was relatively large owing to collection of the same cultivars from different islands and to the diversity

Figure 2.8. Germplasm collection at Tagabe Agricultural Station in Port Vila, Vanuatu (photo V. Lebot).

of kava in Vanuatu. The folk taxonomy of kava cultivars in Vanuatu is inflated by synonymy; the plurality of vernacular languages there ensures that many cultivars are known by several names. Subsequent morphological description of each accession revealed that many were duplicates.

Cultivar specimens were described during their second year of growth. A list of morphological descriptors was developed, although the number of distinctive features used was restricted to seven because of the large size of the germplasm collection (figures 2.9–2.13). Descriptive characters selected were those that are used within folk taxonomics to distinguish local cultivars (Lebot and Lévesque 1989):

- A General appearance of the plant: erect, normal, prostrate
- C Stem coloring: pale green, dark green, green with purple shading, purple, black
- I Internode configuration: uniform, mottled, speckled, striated and mottled
- L Leaf coloring: pale green, dark green, purple
- E Lamina edges: undulate, raised, drooping, regular
- P Leaf pubescence: present, absent
- S Internode shape: short and thick, long and thin, long and thick

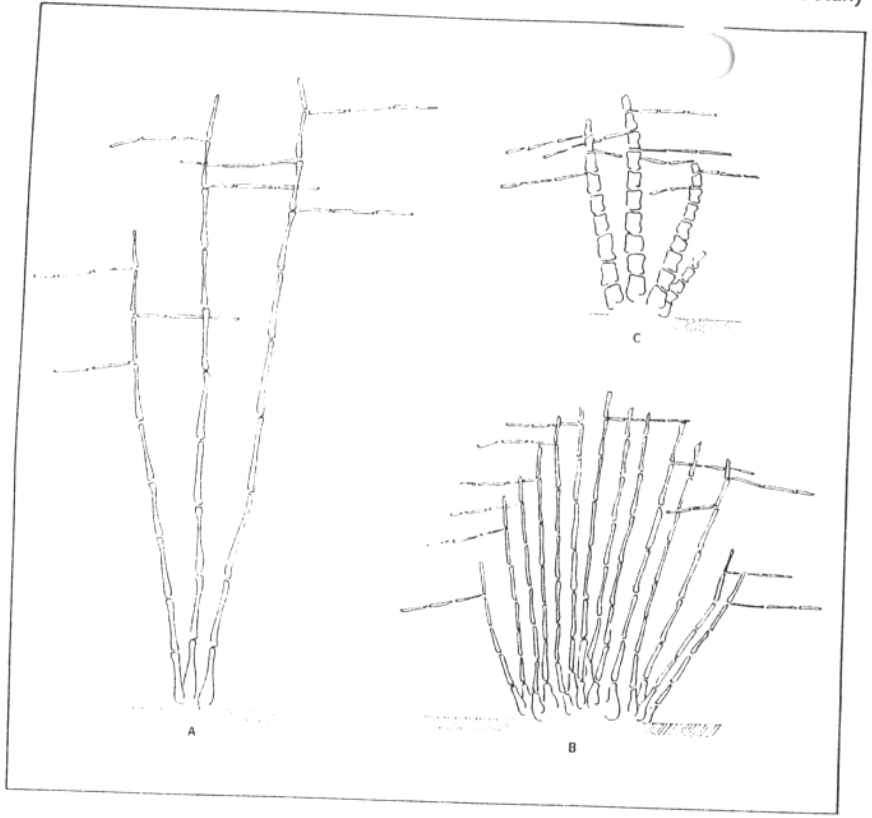


Figure 2.9. Morphological descriptors: growth patterns. (A) erect, (B) normal, (C) prostrate (from Lebot and Lévesque 1989).

All seven morphological features were coded for every cultivar. Those accessions with identical phenotypic descriptions received the same cultivar number (or morphotype). The 247 accessions exhibited 82 different morphotypes (see appendix D). Kava in Vanuatu is thus represented by 82 different cultivars, assuming that the different cultivars, when planted and described in the same plot, present stable morphotypes. Although some morphotypes are very similar, these nonetheless are distinct cultivars that are also differentiated and named by local farmers (Lebot and Lévesque 1989).

The study revealed that kava's variability and the number of cultivars recognized and used are greater on some Vanuatu islands (e.g., Pentecost and Tanna) than on others. Morphotypic coding suggests that some cultivars have traveled along traditional exchange routes. An important biogeographic boundary, however, exists south of Efate Island (see map 3) and divides two distinct cultivar

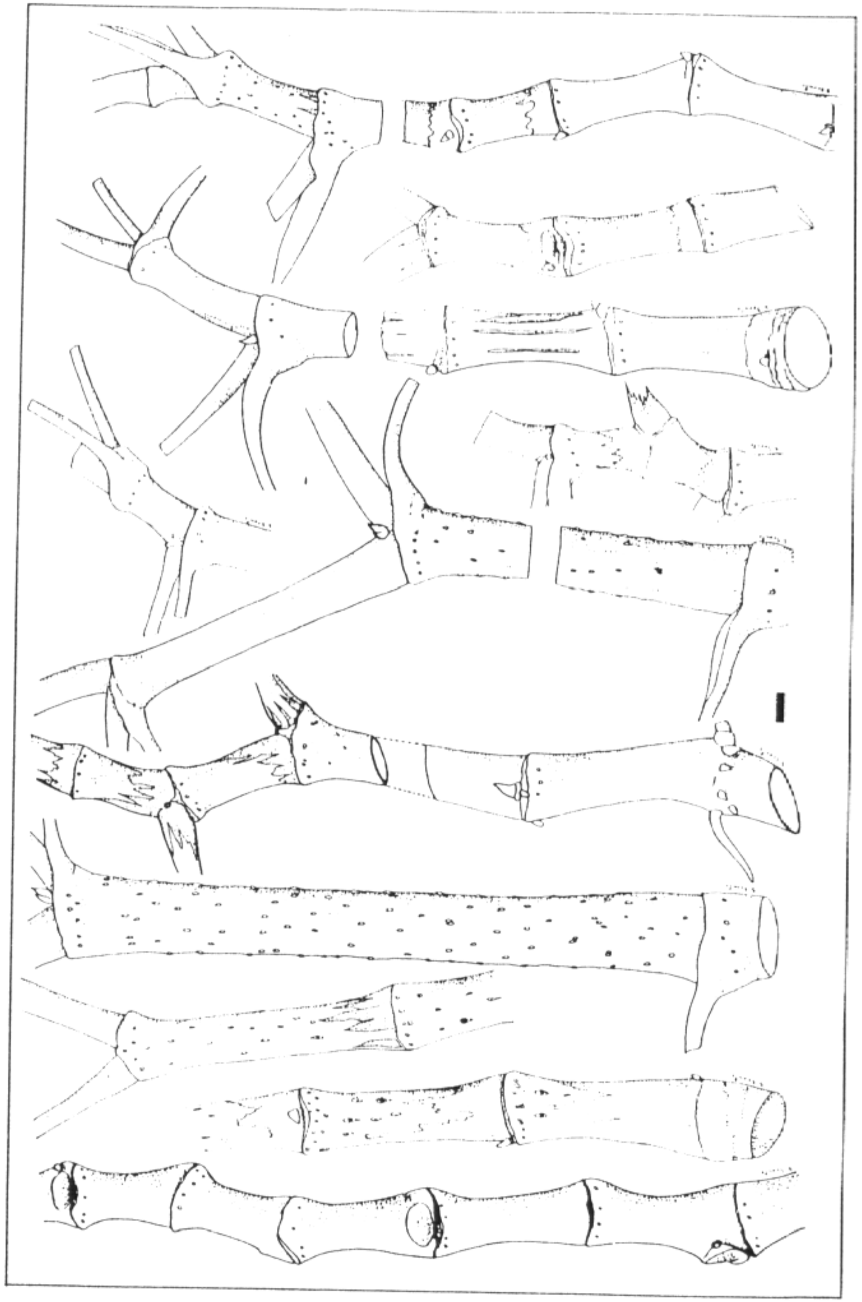


Figure 2.10. Morphological descriptors: stem configurations (from Lebot and Lévesque 1989).

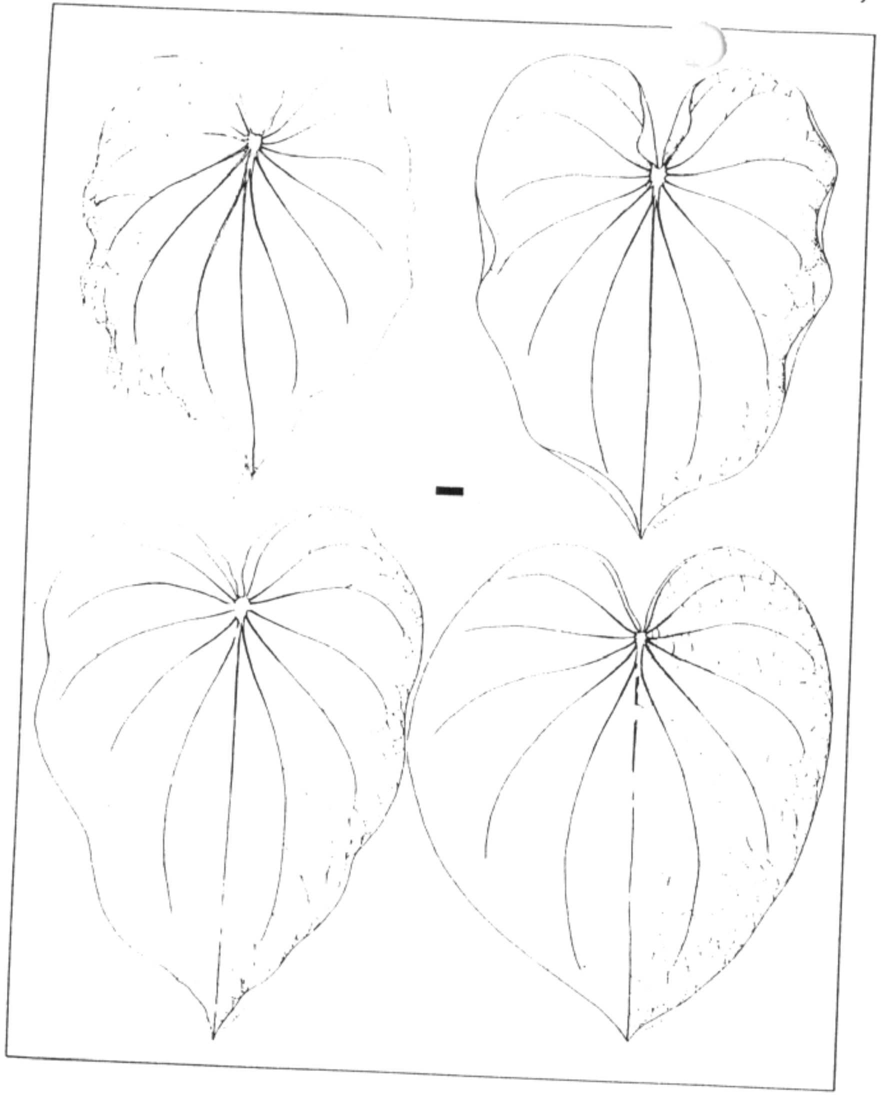


Figure 2.11. Morphological descriptors: lamina shape (from Lebot and Lévesque 1989).

assemblages. This boundary reflects the fact that traditional exchanges of goods and movements of people most commonly occurred within the southern or northern regions of Vanuatu but were less frequent between these two areas.

A comprehensive survey of the genetic resources of *P. methysticum* and *P. wichmannii* was subsequently conducted throughout the tropical Pacific region (Lebot and Lévesque 1989). Herbarium specimens and the field reports of ecolo-

Figure 2.12. Fijian cultivar *matakaro* with long and spotted internodes, Taveuni Island (photo V. Lebot).

gists, botanists, and anthropologists were used to screen locations to be sampled. A total of 55 Pacific islands were visited, including Fiji, Wallis and East Futuna, Western Samoa, American Samoa, Tonga, Tahiti, the Marquesas, Hawai'i, Pohnpei, Papua New Guinea, and the Solomon Islands. Local kava stock was surveyed using the morphotypic descriptive system developed and tested in Vanuatu. Although, as in Vanuatu, common gardens of *P. methysticum* cultivars from each country (or political unit) were established, time limitations made it impossible to carry out long-term field trials of cultivars planted in a homogeneous environment. However, because the numbers of kava cultivars in these regions is rather small, the descriptive system permitted a quick and easy differentiation of local cultivar morphotypes. Only 4 morphotypes exist in New Guinea, 2 in Pohnpei, 12 in Fiji, 6 in Samoa, 3 in Wallis and Futuna, 7 in Tonga, 2 in Tahiti, 1 in the Marquesas, and 9 in Hawai'i.

Zymotypes

A second objective of the kava cultivar survey was to determine whether isozymes could be used to characterize and differentiate cultivars (see Lebot, Aradhya, and Manshardt 1991). Isozymes are proteins synthesized by genes; isozyme polymor-

Figure 2.13. Fijian cultivar *loa kasa leka* with short and dark internodes, Taveuni Island (photo V. Lebot).

phism, or dissimilarity between individuals, serves as a measure of genetic diversity. The survey was designed to determine whether kava morphotypes from different Pacific islands correspond to different isozyme genotypes (zymotypes). The isozyme technique has proved suitable for identifying duplicates in germplasm collections, for ascertaining the genetic fingerprints of cultivars, and for clarifying phylogenetic relationships. The use of isozymic markers can elucidate the evolutionary dynamics that have led to the development of existing kava clones. Isozyme analysis provides an assessment of the degree of genetic diversity within and between *P. methysticum* and *P. wichmannii* and helps to trace the human dispersal of clones.

More than 300 leaf samples were electrophoresed and their zymograms ana-

lyzed. We found that specimens of *P. wichmannii* could be grouped into only seven different zymotypes and *P. methysticum* cultivars into just three. Significantly, one zymotype includes individuals from both botanical taxa.

Although *P. wichmannii* is apparently dioecious, it shows remarkably little genetic variation. The progeny of two collections (approximately 120 individuals) from Western Province, Papua New Guinea, for example, were monomorphic for most of the enzymes studied. At any particular collection site plant populations were genetically uniform. Chew (1972) referred to *P. wichmannii* as dioecious, but our field observations have noted that monoecious plants also exist. If *P. wichmannii* is dioecious in the wild, then the progeny should be segregating at least for male and female types. The very limited variation observed in more than 120 *P. wichmannii* seedlings suggests that apomixis or self-pollination occurs; further evidence is needed to confirm this hypothesis.

Piper wichmannii is most variable genetically in the western part of its natural range. Less variation is present in eastern Melanesia. Plants from Guadalcanal and Malaita in the Solomon Islands were zymotypically the same as plants collected in the Santa Cruz Islands. These were also identical to *P. wichmannii* from Vanua Lava (Banks archipelago) in Vanuatu, although different from *P. wichmannii* specimens from the islands of Tongoa (Shepherds group) and Pentecost, also in northern Vanuatu.

The most intriguing finding of the cultivar survey is the markedly low isozymic variability among cultivars of *P. methysticum*—just three zymotypes. In contrast, recent isozyme studies on taro (*Colocasia esculenta*), bananas (*Musa* spp.), and breadfruit (*Artocarpus altilis*) have shown that these species each exhibit over 100 zymotypes in the same geographic area (on taro, breadfruit, and bananas see Lebot 1992; on taro see Lebot and Aradhya 1991; on breadfruit see Ragone 1991). There are several possible explanations for lack of genetic variability in kava at the isozyme level. It may be an artifact of methodology, although this is unlikely, for the technique used has proved highly reliable. The discriminative ability of enzyme electrophoresis depends on the number of polymorphic loci that can be resolved. For this study 25 enzyme systems were assayed, and 8 were successfully resolved (aconitase, aldolase, diaphorase, isocitrate dehydrogenase, malate dehydrogenase, mallic enzyme, phosphoglucoisomerase, and phosphoglucomutase); for these eight enzymes there are at least 16 resolvable loci, and probably more owing to polyploidy.

A more plausible hypothesis to account for low levels of isozyme variability in *P. methysticum* is that this taxon consists of sterile clones resulting from human selection of somatic mutants rather than from sexual reproduction, which would have produced a greater diversity of zymotypes. If this hypothesis is valid, then only a few genes are responsible for the morphological and chemical variation in kava.

Probably none of these genes are linked with loci that contro[illegible]yme markers. Moreover, the domestication of kava was relatively recent and occurred, as we suggest, in Northern Vanuatu. Taro, bananas, and breadfruit, conversely, were domesticated earlier, in Southeast Asia or New Guinea, and spread over much larger areas; human selection for somatic mutants over a longer period may account for greater isozymic variability among these older cultivars.

Ninety-three samples representing 59 cultivars of *P. methysticum* from Polynesia, Fiji, and Micronesia and including male, female, and monoecious plants were analyzed and found to be genetically monomorphic. Although the electrophoresed specimens were differentiated into 28 morphotypes and 4 chemotype groups (see chapter 3; cf. Lebot and Lévesque 1989), only one zymotype (number 10) was identified within this large geographic area.

A set of 61 *P. methysticum* cultivars collected from Papua New Guinea and Vanuatu revealed slight genetic variation, sorting into two additional zymotypes (8 and 9). All plants collected in southern Papua New Guinea were zymotypically uniform (9) and differed from those of the north coast of that country (8) only in the malate dehydrogenase enzyme system. Zymotype 8, found only in northern Papua New Guinea, may have originated as a local selection from zymotype 9 (which originated in Vanuatu). The two zymotypes are so similar that the differences in malate dehydrogenase and diaphorase could be explained as mutations of zymotype 9 that occurred after it was carried to New Guinea. Zymotypes 8 and 9 share the same chemotype (F, see chapter 3; cf. Lebot and Lévesque 1989), and their cultivar morphotypes are also similar.

Kava cultivars used today in Vanuatu exhibit both zymotype 9 and 10 and thus encompass most of the isozymic and chemical variability found in *P. methysticum* throughout the Pacific region. Collections from Vanuatu include zymotypes identical to the cultivars of southern New Guinea, the island of Baluan in the Admiralties, Pohnpei, Fiji, and all of Polynesia.

Isozymes can be used as genetic markers to estimate the degree of diversity between *P. methysticum* cultivars and *P. wichmannii*. Statistical analysis of zymotypes (presence or absence of stained bands) demonstrates that *P. wichmannii* accessions originating from the Western Province of Papua New Guinea (zymotypes 1 and 2) are genetically very different from *P. methysticum* (see figure 2.14). This suggests that these *P. wichmannii* populations are unlikely to have been the wild progenitors of cultivated, sterile *P. methysticum*. The *P. wichmannii* zymotype most similar to *P. methysticum* is, in fact, found in Vanuatu, where the *vambu* cultivated form of *P. wichmannii* from Vanua Lava has the same zymotype (9) as cultivars of *P. methysticum* from elsewhere in Vanuatu.

Isozyme analysis confirms previous remarks about the lack of nomenclatural validity of *P. methysticum* and *P. wichmannii* (Lebot and Lévesque 1989). *Piper*

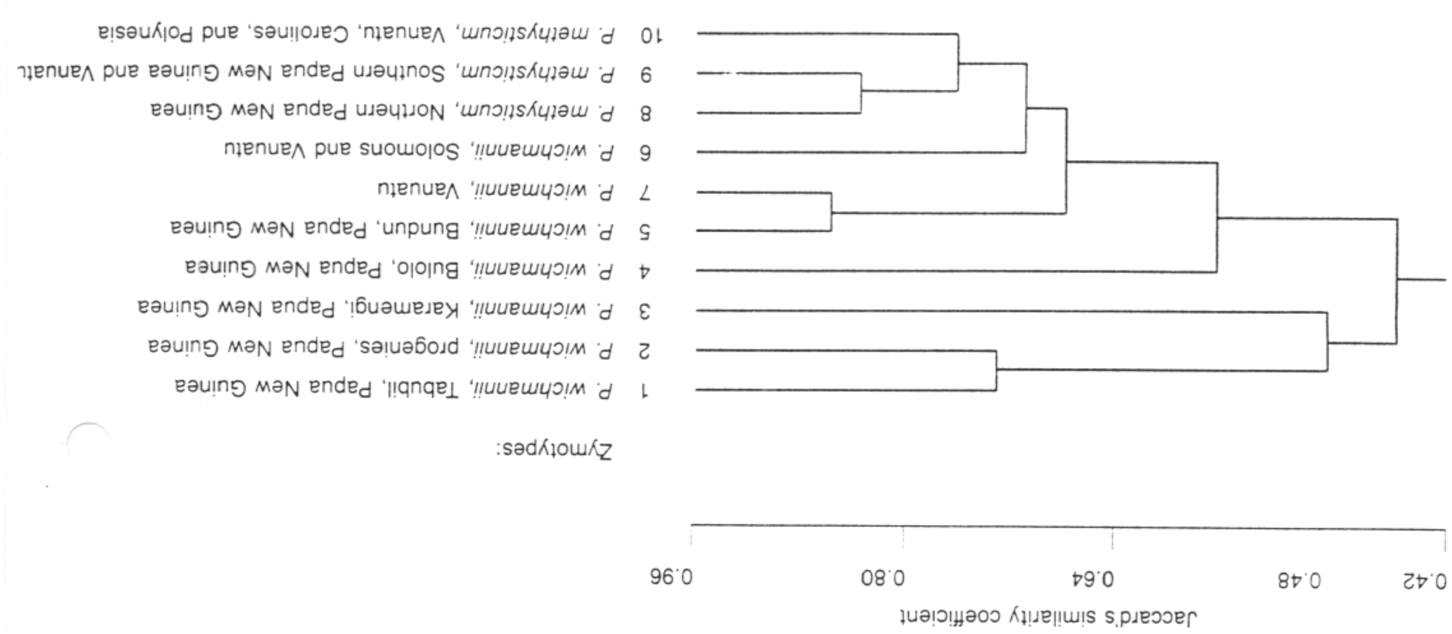


Figure 2.14. Dendrogram based on zymotypes similarities (from Lebot, Aradhya, and Manshardt 1991).

wichmannii has seven discrete zymotypes, *P. methysticum* has [illegible] and remarkably they share one. This is insufficient to warrant distinctive sp[illegible]es recognition. Therefore, as noted previously, these two binomials appear to describe the same species. Because *P. methysticum* was used first (Forster 1786b) it has priority, and de Candolle's *P. wichmannii* (1910) is superfluous.

Piper methysticum (zymotypes 8, 9, and 10) could have originated in Vanuatu from clones of *P. wichmannii* zymotype 9. In addition to its distribution in Vanuatu, zymotype 9 is also found in the Fly and Strickland river areas of the Western Province of Papua New Guinea. However, in this region of lowland swamps, mangroves, and savannas, where farmers complain that the kava plant is very difficult to cultivate, the species exhibits no morphological or genetic variation. Furthermore, *P. methysticum* cultivars found along the north coast of Papua New Guinea are genetically very similar to *P. wichmannii* cultivated forms from the island of Tongoa in Vanuatu (zymotype 7). *Piper methysticum* in this region of Papua New Guinea is genetically closer to the *P. wichmannii* of Tongoa in Vanuatu than it is to local populations of wild *P. wichmannii* or to the type of *P. methysticum* cultivated in the south of New Guinea. Zymotypically, *P. methysticum* clearly traces back to cultivars that originated in Vanuatu.

Isozyme evidence suggests that clones of zymotype 10 were collected in Vanuatu by migrants or traders and distributed throughout Fiji and Polynesia as far as the Marquesas and Hawai'i. The kava plants of Pohnpei and Baluan (Admiralties) are also of zymotype 10. Accordingly, Micronesian kava is probably an introduction from Vanuatu, either directly or via the Admiralty Islands, rather than from a more distant Polynesian source.

Given the similarity of zymotypes 8 and 9, one might speculate that kava grown in the Western Province of Papua New Guinea was introduced from the Astrolabe Bay area on the north coast. However, considering the geographic barrier of the New Guinea Highlands, this seems less likely than two separate introductions of the plant from the same overseas source—Vanuatu. The sole morphotype grown in the Western Province (Fly River area) seems to be most closely related to *malmalbo*, a cultivar from Pentecost in Vanuatu. Furthermore, *P. methysticum* in the northern part of New Guinea (i.e., Usino, Morobe, Madang, and Karkar; zymotype 8), has a single distinctive morphotype that has not been found elsewhere. The two morphotypes of *P. methysticum* grown on Baluan are also closely related to cultivars located in the Shepherds group in Vanuatu—all are zymotype 10.

We conclude that zymotypic distributions indicate Vanuatu as the site of kava's domestication. Clones of *P. methysticum* cultivated in the Western Province of Papua New Guinea (zymotype 9), on Baluan Island and Pohnpei (zymotype 10) and in Fiji and Polynesia (zymotype 10) all occur in and, we argue, originated in Vanuatu.

Origin of *Pip[illegible] [illegible]ethysticum*

Pulling together the strands of argument above, we draw the following conclusions about the origins of kava:

1. *Piper methysticum* Forst. f. is a species whose natural range and area of traditional cultivation are restricted to tropical Pacific islands. It is the only cultivated plant of major regional economic importance for which this can be said. *Piper methysticum* is the binomial for sterile cultivars of *P. wichmannii* C. DC., the fertile wild form that is known to have a distribution area limited to Melanesia. These two botanical species (or, rather, forms of the same species) are the only ones in the genus *Piper* from which major psychoactive kavalactones have been isolated. The other possible kava ancestor, *P. gibbilimbum*, is an unlikely candidate because this species occupies a very different ecological niche—grasslands at high elevations in Papua New Guinea. A third candidate, *P. plagiophyllum*, seems to be an artifact of taxonomy and probably represents mislabeling of diverse morphotypes of *P. wichmannii*.

2. Wild plants of *P. wichmannii* in Melanesia appear to have at least partial fertility and show more isozyme variation, which suggests outcrossing. In eastern Papua New Guinea, the Solomon Islands, and Vanuatu, apomixis may predominate, for there is less evidence for fertility and low isozyme variation.

3. Taxonomic distinction between *P. methysticum* and *P. wichmannii* is not supported by isozyme analysis or chromosome counts. The so-called species overlap. Kava was domesticated through vegetative propagation from a narrow genetic base in wild fertile *P. wichmannii* progenitors, as indicated by its limited range of existing isozyme diversity. Kava may have become sterile through an accumulation of mutations affecting fertility. Another, less likely, possibility is that kava originated as an interspecific hybrid. This possibility is supported by the cytological observation that the one genome of larger chromosomes observed in *P. methysticum* is apparently not found in wild *Piper* forms.

4. Kava's morphological and chemical variability is largely the result of human selection and cloning of somatic mutations in genetically similar, vegetatively propagated cultivars. However, no significant correlations among cultivar morphology, chemical composition, and zymotype have been detected. Variation at the isozyme level does not obviously correspond to variation at the morphological and chemotypic levels that were selected and shaped by farmers.

5. Vanuatu is the center of origin of kava cultivars. *Piper methysticum* exhibits its highest degree of diversification in this archipelago. Vanuatu possesses in situ collections of the range of clones produced during the domestication process of *P. wichmannii. Piper wichmannii* is also sometimes cultivated vegetatively in Vanuatu.

6. Kava was developed from *P. wichmannii* of zymotype 7 or 9, or both. The

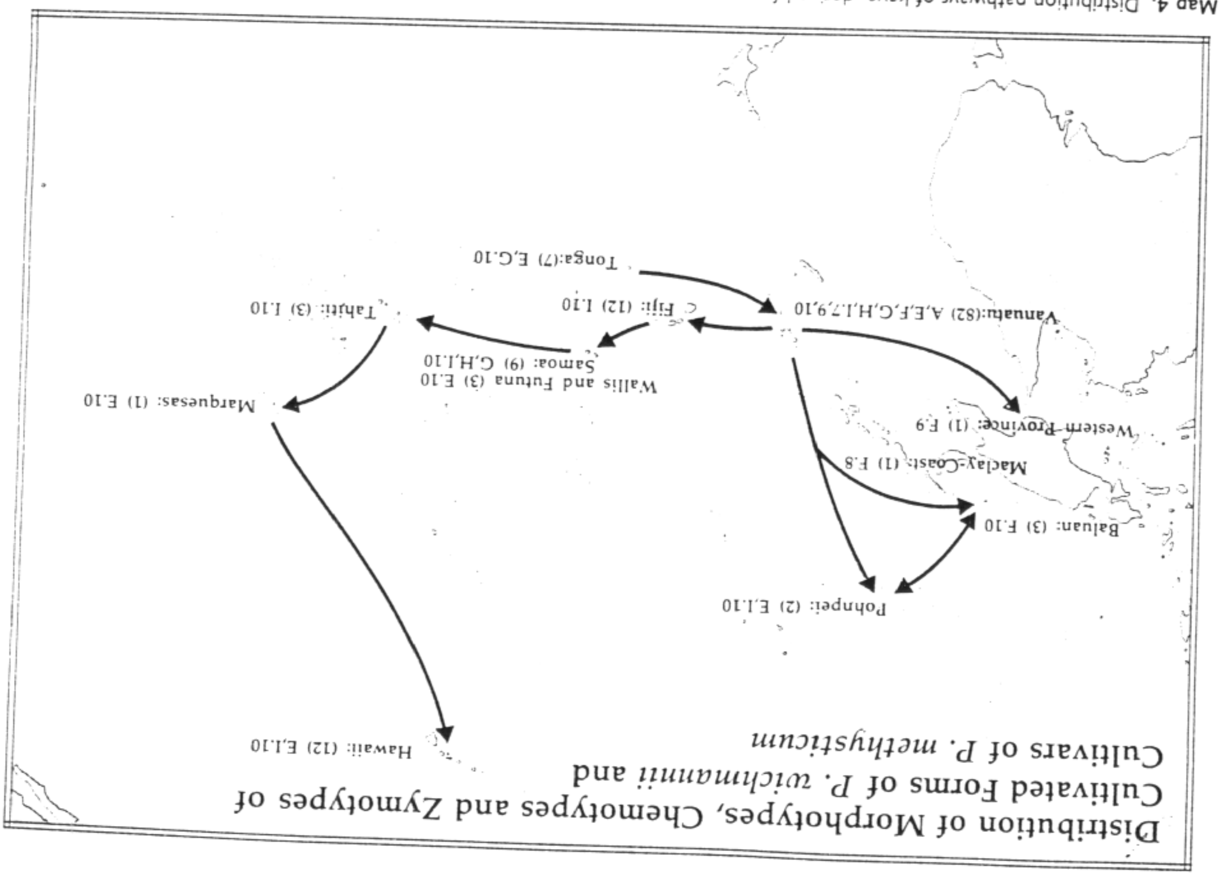
development of zymot[...] 8 and 10 probably dates to later selected mutations. It is possible that all kava cultivars trace back to a single ancestral plant somewhere in northern Vanuatu that has been repeatedly cloned, developed, and dispersed by stem cuttings over perhaps three millennia.

7. From northern Vanuatu, kava clones spread disjunctively throughout the Pacific Islands, carried by a flux of back migrations, accidental canoe drift voyages, and intentional exchanges of plant material. Papua New Guinean, Micronesian, and Polynesian kavas seem to be relatively late introductions, direct and indirect, from Vanuatu because of the absence of variation in cultivar isozymes and the limited variation in morphotypes and chemotypes in these regions (map 4).

8. *Piper methysticum*, clearly a human creation, appears to be a young crop with little genetic variation. It may be less than 2500 to 3000 years old, based on the date of arrival of Austronesian settlers in Vanuatu (Bellwood 1979; Spriggs 1984).

These conclusions challenge existing theories about the origins and dispersal history of kava. Most recent commentators (e.g., Barrau 1965; Brunton 1989; Yen 1991) presume that kava, like a number of other tropical Pacific Island crops, was domesticated in the New Guinea region. Assumptions of a western Melanesian origin of kava date back to the work of British diffusionist anthropologist W. H. R. Rivers (1914). Erroneously believing that Islanders who chew betel—the other major traditional drug in the Pacific—invariably do not also use kava, Rivers transformed the pattern of geographic distribution of these two drugs into a narrative of two successive waves of human migration he labeled the kava-people and the betel-people.

To explain the patchy distribution of kava in Melanesia Rivers (1914) argued: "It follows from the distribution of kava and betel that the kava-people settled in southern Melanesia, Fiji and Polynesia, while the betel-people did not extend beyond the Solomon and Santa Cruz Islands." Betel, he claimed, later replaced kava in several regions that once had cultivated *P. methysticum*, such as the Solomon Islands. An absence of kava in a region thus results from subsequent migrations from the west of peoples with a different drug of choice. However, the presence of kava-consuming people left isolated back in Papua New Guinea, and the reason these kava-people often also chew betel remains unexplained. Rivers's theory, moreover, has no answer for the situation in New Caledonia, where people neither drink kava nor chew betel; a theory of replacement of the former drug by the latter cannot explain the absence of kava in either New Caledonia or the Loyalty Islands.



Map 4. Distribution pathways of kava, derived from zymotypic evidence. The numbers in parentheses are the number of morphotypes found, the letters indicate chemotype groups, and the numbers following the letters indicate zymotypes.

Brunton (1989) has updated Rivers's arguments, elaborati more sophisticated hypothesis about kava origins with archaeological eviden hat Rivers did not have. Brunton suggests that kava was probably domesticated and then spread by Proto-Oceanic-speaking peoples. These people may also be those who produced and traded Lapita-style pottery. In Brunton's scenario, kava was domesticated somewhere in the Bismarck Archipelago, the so-called Lapita Homeland. From the Bismarck Archipelago, kava cultivars could have been carried eastward by Lapita trading expeditions and migrations as part of a Lapita cultural package, so that ultimately the plant was cultivated throughout Melanesia and Polynesia. Kava consumption was subsequently abandoned in most of Papua New Guinea and the Solomons owing to what Brunton sees as a fundamental cultural instability built into the political and religious structures of Melanesian societies.

Brunton's neodiffusionist approach to kava origins can be challenged on a number of grounds, particularly in light of recent morphological and genetic studies of kava cultivars. First, although domestication is an uncommon and sophisticated procedure, we believe it is unlikely that all Pacific domesticates originated from a single locale. For example, although breadfruit (*Artocarpus altilis*) probably originated in Papua New Guinea, recent genetic research indicates that the subsequent development of seedless domestic types most likely occurred in central Polynesia (Diane Ragone 1991). In Papua New Guinea and the rest of Melanesia, only seeded breadfruits are found. According to Barrau (1965), the few seedless types found in the Western Province of New Guinea were introduced by Samoan missionaries at this beginning of the century. Similarly, although *P. wichmannii* probably originated in New Guinea and was then spread to the Solomons and Vanuatu by fruit bats or other natural dispersal agents, we argue that domestication of *P. methysticum* from the wild species occurred in Vanuatu and that clones were carried to New Guinea and elsewhere.

Second, botanical evidence clearly indicates that *P. methysticum* is not a native domesticate of New Guinea. Most observers with field experience and firsthand knowledge of kava there (Miklouho-Maclay 1886b; E. E. Henty, personal communication, 1988; Lebot 1988) share this opinion. *Piper methysticum* in New Guinea possesses all the attributes of an introduced clone. Moreover, kava plants today in New Guinea are cultivated only on coastal plains, around Madang and the Maclay Coast, or in the lowlands of the Western Province. The highest elevation of cultivation is 240 m, in Nomad. The two likely ancestors of kava do not grow spontaneously at these lower elevations. Because *P. methysticum* in New Guinea is cultivated outside the natural range of distribution of both *P. wichmannii* (400–2000 m above sea level) and *P. gibbilimbum*, it is unlikely to have been domesticated in this region.

Third, the area that supposedly abandoned kava drinking, from the Bismarck

Archipelago to the Sa. ruz Islands, comprises over 100 islands and even more language groups and societies. All of these societies would have had to reject kava to account for the extinction of the plant across more than 1600 km of the Pacific. A second large gap exists in the middle of the kava-consuming region—kava was never consumed in New Caledonia or the Loyalty Islands. Rivers (1914) and Brunton (1989) seem uninterested in accounting for the absence of kava drinking in these islands; presumably, people also abandoned the drug there because of Melanesian ritual instability but did not replace it with betel. We suggest instead that *P. methysticum* planting material was never introduced to New Caledonia. Sporadic contact between Vanuatu and New Caledonia did not involve the introduction of viable kava stock to the latter. Nor was kava planting stock successfully established in the Solomon Islands. Kava, thus, is not "the abandoned narcotic" (Brunton 1989).

Fourth, if kava was once cultivated in the Solomon Islands and New Caledonia, it should be possible there, as it is today in Hawai'i, Kosrae, Tahiti, and the Marquesas, to find relict plants surviving in old growing areas through natural vegetative reproduction. Although suitable environmental conditions necessary for such survival do exist in the Solomons, no relict has been collected in these islands, even during the earliest botanical expeditions. The kava observed earlier this century on the Polynesian outliers of Tikopia and Vanikoro (Kirch and Yen 1982) was likely carried there by Polynesian back migrants.

The distribution of *P. methysticum* from Vanuatu eastward into Polynesia is fairly easy to explain because it follows the widely accepted human migration routes. Movement of kava from Vanuatu back to scattered areas of New Guinea and up to the Caroline Islands is more difficult to accept because archaeological, linguistic, and ethnographic data supporting such back migrations are less common.

Brunton (1989) is certainly correct to suggest that kava consumption was abandoned in some areas, but no doubt it was also just as often adopted. A mass abandonment of the plant seems less likely to account for the spotty distribution of kava than sporadic and chance transfers of rootstock between communities, no matter how distant. Both accidental drift voyages and planned explorations are known to have occurred many times in Pacific prehistory. Occasional contact between inhabitants of places like northern Vanuatu and the Admiralty Islands or Vanuatu and Pohnpei, if extraordinary, is not impossible to imagine.

In both Pohnpei and Kosrae, cultural elements associated with kava drinking suggest relations with both the Admiralties to the south and Vanuatu to the more distant southeast (Brunton 1989). Pohnpei and the Admiralty Islands are the only places in the Pacific where kava is prepared by pounding the fresh roots on large, flat basalt slabs. The Pohnpei name for kava, *sakau*, and the Kosrae word *seka* both appear cognate with *kau* on Baluan. However, it is currently n… …ssible to determine whether the plant was initially introduced to the Admiralty Islands from Kosrae and Pohnpei or vice versa. Whatever the direction of diffusion, Vanuatu would have been the ultimate source.

Significantly, linguistic research indicates affinities between the languages of northern Vanuatu and those of Nuclear Micronesia. Tryon (1984) suggests that around 3500 B.P. "a set of migrations apparently began in the northern/central Vanuatu region, one moving north, spreading the Austronesian languages throughout Micronesia . . . another moving southeast to the Fiji group." Pawley and Green (1984) also recognize these linguistic affinities and cluster together Vanuatu and Nuclear Micronesian languages in their subgroupings of the Oceanic languages. These linkages corroborate the observation that linguistic relations "indicate a movement from the New Hebrides [Vanuatu] to Micronesia" (Grace 1964). In addition to linguistic affinities, ongoing isozyme studies on cultivars of taro (*C. esculenta*; Lebot 1992) and on breadfruit (Ragone 1991) also indicate a movement of plant clones from Vanuatu to the eastern Carolines. Taro, breadfruit, and kava all share this route of dispersal.

As we will see in following chapters, the linguistic, botanical, and genetic evidence that suggests a northern Vanuatu origin for *P. methysticum* is supported by island mythologies, similarities in drug preparation techniques, and cultivar chemistry. The history of kava is about the human dispersal of planting material throughout the Pacific. It is about kava adoption, rather than kava abandonment, by island societies. Today, in spite of 150 years of religious and governmental prohibitions on its cultivation and consumption, kava and its use are still spreading.

3. Chemistry
Active Principles and Their Effects

Numerous chemical and pharmacological studies of kava have been published over the past 140 years, producing a wealth of data. However, the results of these efforts have often been tentative, fragmentary, and contradictory. This chemical research has had a dual aim: (1) to identify the active principles responsible for kava's psychoactive effects and (2) to analyze the physiological activity of those ingredients. In this chapter we first describe the psychoactive effects of kava drinking and then present a chronological review of scientific research focusing on the chemistry of *P. methysticum*. We do not discuss the neurological mechanisms that underlie kava's psychoactive effects on human emotions. Significant research into kava's alteration of brain chemistry has yet to be undertaken.

Physiological Effects of Kava

Fresh kava rootstock, when prepared by mastication, pounding, or grinding, yields a greenish milky potion that is considerably stronger than the grayer mixture obtained from dry roots. Before L. Lewin began his scientific research on the plant in Germany during the nineteenth century, it was generally believed that the method of preparation was the only factor that determined the strength and kind of kava's physiological effects. It was assumed that saliva, mixed in during the mastication process, converted starches contained in kava rootstock into sugar, which produced alcohol when fermented. Lewin (1886a) concluded more than a century ago that "this theory is incorrect in every respect."

Steinmetz (1960) was the first to point out that the main factor determining the psychoactive impact of kava is the degree of separation in water of the resinous active ingredients. Van Veen (1939) had noted that for kava to be most effective, rootstock must be emulsified very finely in water, saliva, lecithin, or oil to disperse the active ingredients. Mastication transforms rootstock mass into tiny particles, releasing the resin stored in the cell tissues. The active substances in this resin, insoluble in water, become available to the drinker after emulsification. This, rather than the action of saliva, explains why kava drink prepared by grinding or pounding rootstock often has less physiological effect than that produced from finely chewed, emulsified rootstock.