

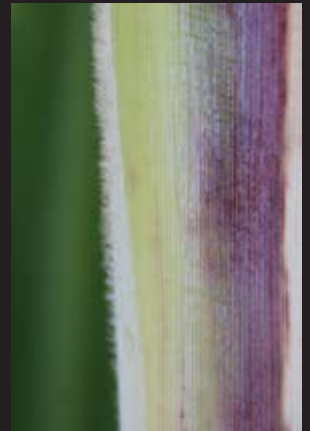
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Kō

An Ethnobotanical Guide to
Hawaiian Sugarcane Cultivars

Noa Kekuewa Lincoln



Kō



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An Ethnobotanical Guide to Hawaiian Sugarcane Cultivars

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Cover art: The extraordinary beauty of the heirloom Hawaiian sugarcanes is exceeded only by their incredible diversity.

Page vii art: An original drawing of kō 'Mahai'ula' by Arillyn Moran-Lawrence, American Society of Botanical Artists & Botanical Artists Guild of Southern California.

Page viii art: An assortment of heirloom Hawaiian canes in watercolor. Painting by Chris Faye. Reproduced with permission.

Page x photo: An ancient scene of a thatched hale surrounded by sugarcane—a common sight in the past—is recreated at the Limahuli Garden on the north shore of Kaua'i.

Design by Mardee Melton

I dedicate this publication to
'ANAKALA JERRY KONANUI,
whose mentorship and guidance were
essential to this work. He was a constant
inspiration, without which I would not
have had the perseverance to come even
this far. He embodied the horticultural
and observational excellence of our
ancestors, and his knowledge of our
kūpuna (ancestral) crops was exceeded
only by his heart and humility. He was
an example for us all. *Mahalo ke akua.*



Ola a kau kō kea
Live till the sugarcane tassels





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Preface

The principal purpose of this guide is to provide a common ground for discussing our indigenous Hawaiian sugarcane varieties. Without this foundation, it is impossible to build upon our collective knowledge. Case in point, Schenck et al. (2004) conducted an excellent study on the genetic relationships of many Hawaiian canes, but how do we interpret the results? Is ‘Hinahina’ in the study the same as what is called ‘Hinahina’ by others? Moreover, are those the same as the ‘Hinahina’ of old? Unfortunately, more often than not, the answer to these questions is no—they are not the same. This makes meaningful dialog nearly impossible. This guide does not presume to be complete or authoritative, but rather a touchstone to ground the discussion.

While much is known about the native and heirloom sugarcane varieties, there is still much that is lacking. Interest in heirloom varieties of sugarcane has increased dramatically in the past decade and our knowledge will undoubtedly continue to grow in the coming years. More insight is emerging every day through the revived usage of these varieties, the voices of our elders, and continued research. I hope this project catalyzes further contributions of knowledge and experience, and that this guide will continue to evolve.

In order to give a name to a cane, it must be identifiable. While some sugarcane cultivars are distinct and easy to recognize, others are challenging to distinguish. This guide provides an overview of each variety to support quick identification, along with more detailed morphological descriptions and accompanying photographs. All photos are by the author, except where stated otherwise. A botanical key is provided to help identify unknown sugarcane varieties. For the most part, each cane can be linked to historical documentation. If traditional and present-day descriptions do not align, the present-day

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variety is given a generic name by the author. For instance, ‘Hinahina’ in collections today does not match the historical descriptions of that cane name; therefore, ‘Hinahina’ is described using historical testimony and the name ‘Not Hinahina’ is applied to the contemporary cane.

Traditionally, a single variety could be known by different names in different locales; conversely, the same name could refer to two different canes in separate regions. This volume applies the most common name to each of the varieties as can be traced to historical sources. Each cane’s profile includes any alternative names identified and their meanings. A cross-referenced list of all *kō* names precedes the section on cultivar descriptions to indicate the primary name used. The cross-reference is particularly useful for canes with multiple common names, such as ‘Pua’ole’, which is often called ‘Awela’. A “correct” name is not presumed, but the use of a primary name provides a common ground for discussion.

While this guide focuses on unique Hawaiian sugarcane cultivars, it also includes other heirloom canes from elsewhere in the Pacific and a handful of early commercial hybrids because of their historical significance, their place in the ethnobotanical collections, and because these common heirloom varieties are often mistaken for indigenous *kō* cultivars.

The canes in this book can be seen in several collections today. Most of the *kō* varieties were first collected in the late 1800s and early 1900s by the Hawaiian Sugar Planters’ Association (HSPA). HSPA was established in 1895 and began to test and hybridize sugarcane in the early 1900s. Botanist W. W. G. Moir, who worked for HSPA, traveled around the Hawaiian Islands to accession all the sugarcane varieties he could find. Moir’s publication in

1932, simply titled “The Native Hawaiian Canes,” is still the authoritative guide to Hawaiian sugarcane varieties; a synthesis of his classification and descriptions is presented as Appendix I. Several ethnobotanical gardens with interest in traditional Hawaiian crops have established repositories of *kō* based on the original HSPA collection, with each garden also adding unique accessions over time. These collections are in addition to a number of canes grown in backyards and diversified agricultural systems across the state. There are six significant collections of Hawaiian sugarcane:

1. Hawaii Agriculture Research Center in Kunia, O’ahu, and Maunawili, O’ahu, previously the Hawaiian Sugar Planters’ Association.
2. The Amy B. H. Greenwell Ethnobotanical Garden in Captain Cook, Hawai’i, operated by the Bishop Museum.
3. The National Tropical Botanical Garden, composed of the Allerton Garden and adjoining McBryde Garden on Kaua’i, Kahanu Garden in Hāna, Maui, and Limahuli Garden and Preserve in Hā’ena, Kaua’i.
4. The Maui Nui Botanical Gardens in Kahului, Maui.
5. The Waimea Valley Arboretum and Botanical Garden in Waimea, O’ahu, managed by Hi’ipaka LLC.
6. The National Clonal Germplasm Repository in Miami, Florida, managed by the United States Department of Agriculture

Together, let us grow our collective knowledge of this beautiful crop!

Acknowledgments

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Kō

An Overview



An Introduction to Sugarcane

Sugarcane, known as *kō* in the Hawaiian language, is the single most important crop in the colonial history of Hawai'i (Gray 1972; MacLennan 1997, 2014; Wilcox 1997). Trade agreements around sugar resulted in the establishment of the first US military base in Hawai'i—the infamous Pearl Harbor. The need for sugarcane labor powered the immigration that gives Hawai'i its multicultural background today. The influence of the early sugarcane plantations formed the basis of Hawai'i's unique labor laws. Sugar's demand for water fueled the construction of elaborate canals, the emptying of rivers, and the development of the most exclusive water rights in the nation. The conversion of vast areas of land used for sugar production erased extensive natural and cultural histories. The greed for profits from sugarcane was an influential driver of the illegal overthrow of the Hawaiian monarchy, followed by territorialism and, eventually, statehood.

The overwhelming impact of the sugarcane plantations in Hawai'i tends to overshadow the fact that Native Hawaiians introduced sugarcane to the islands nearly a millennium before Europeans arrived; that Hawaiians cultivated sugarcane extensively in a broad range of ecosystems using diverse agricultural systems; that dozens of native varieties of *kō* were developed; and that sugarcane played a vital role in the culture and livelihood of Native Hawaiians, as it did for many other indigenous peoples across the Pacific (Abbot and Shimazu 1985; Brigham 1899, 1906; Handy 1940; Kamakea 1930; Moir and Caum 1928; Whistler 2009).

(opposite page) The scale of the sugar plantations forever shaped the landscape, demographics, culture, and politics of Hawai'i. Photo by unknown photographer, from Hawai'i State Archives Digital Collection.

Hawaiian *mahi'ai* (cultivators) were among the most adept farmers in the Pacific, sustaining agriculture for hundreds of years across an impressive range of soils and climates (Lincoln and Vitousek 2017). Even a basic understanding of the indigenous planting and horticulture gives reason to respect the extensive knowledge developed and



An aerial view of the Waimanalo Sugar Plantation in the early twentieth century, covering what was once diversified indigenous agriculture. Photo by Keystone View Company, from the New York Public Library's Digital Library.

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encoded into traditional practices. One of the many areas Hawaiian agriculturalists excelled in was the systematic differentiation, identification, and naming of their crop varieties. These varieties were, and are still, utilized in ways that enhance the resilience, production, and practicality of agriculture (Lincoln and Vitousek 2016, 2017; Lincoln et al. 2017).

Contemporarily, there is a revived interest in indigenous crops and cropping systems (Kagawa-Viviani et al. 2018a; Lincoln et al. 2018). In light of growing environmental and social issues associated with conventional agriculture, many people are acknowledging the multiple benefits derived from traditional, diversified farming (Altieri 1990, 2004, 2009, 2018). These crops and cultivation systems are not only important as a cultural resource and a link to the past but may play a critical role in future food systems. Modern agriculture relies heavily on inputs of fertilizers, pesticides, and machinery for production. More and more research demonstrates that this form of farming minimizes the services provided by ecosystems, has significant adverse effects on environmental health and global climate, and increases vulnerability to natural and social disasters (Foley et al. 2011; Godfray et al. 2010). Because modern crops have been bred to operate within these industrialized systems, they have lost many of the traits that would allow them to excel in diversified systems.

If the world is to embrace more resilient farming that utilizes fewer inputs and greater diversity, then heirloom varieties—such as *kō*—will be needed in developing new cultivars that will thrive in diversified, place-specific agricultural systems (Garnett et al. 2013).

The Sugarcane Plant

Sugarcane is one of the largest members of the grass (Poaceae) family, second only to members of the bamboo group (Hitchcock and Spear 1951; Purseglove 1968). It is a perennial plant found throughout tropical and subtropical areas, preferring environments that are warm and wet but tolerating a range of habitats.

Several species of the genus *Saccharum* make up the sugarcane group (Amalraj and Balasundaram 2006; Bonnett and Henry 2011). Two of the species, *S. spontaneum* and *S. robustum*, are considered wild (Bonnett and Henry 2011; Brandes 1938). These two naturally occurring species of sugarcane are considerably different. *Saccharum spontaneum* looks very grasslike, with skinny stalks and lots of slender leaves. On the other hand, *S. robustum* looks much like the sugarcane most people envision, except bigger. Preferring to grow in wet or boggy areas, the thick, well-defined stalks of this species can reach 10 m in length (Brandes 1956)!

Table 1. The Scientific Classification of the Noble Sugarcanes

Plantae	Plants	Kingdom
Tracheobionta	Vascular plants	Subkingdom
Spermatophyta	Seed plants	Superdivision
Magnoliophyta	Flower-bearing plants	Phylum
Liliopsida	Monocots	Class
Commelinids		Subclass
Cyperales		Order
Poaceae	Grass family	Family
Panicoideae		Subfamily
Andropogoneae		Tribe
Saccharum		Genus
<i>S. officinarum</i>		Species

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- Origin, migration, and diversification centers of noble sugarcanes:
- is the location of the origin of *Saccharum officinarum*, derived from *S. robustum*, which occurred 8000 to 15000 B. C.
 - shows first track of migration of *S. officinarum*, beginning about 8000 B. C.
 - shows second tracks of migration, beginning about 6000 B. C.
 - - - shows third tracks of migration, about 500 to 1100 A. D.
 - ★ indicates satellite centers of diversity along tracks of migration.
- Shaded portion of map indicates outline of the former great Asiatic-Australian Continent.

A map of the origin and migration of *S. officinarum*, from USDA Agricultural Handbook 122.

Saccharum spontaneum is much more widespread than its cousin (Artschwager and Brandes 1958; James 2004; Sharpe 1998). It occurs in a band that stretches from northern Africa to Papua New Guinea, with large native habitats throughout the Middle East, India, China, and Malaysia. *Saccharum spontaneum* is believed to have originated in India, which is the geographic center of its natural range and where varieties with the smallest number of chromosomes occur. In contrast, *S. robustum* is only indigenous to Papua New Guinea and the surrounding islands, possibly including the Philippines, Taiwan, Indonesia, and Malaysia (there is debate regarding how much of this range may have been caused by human distribution).

The domestication and crossing of the two wild species, possibly with other closely related genera, has given rise to new cultivated species (Mukherjee 1957). Sugarcane genetics are very complicated, with plants having a variable number of chromosomes and being polyploidy (having extra sets of chromosomes). Thus, there is no consensus

yet as to how many species there are [see Bonnett and Henry (2011) for a good overview of differing opinions]. Most sources will tell you there are four cultivated species of sugarcane: *S. officinarum*, *S. barberi*, *S. sinense*, and *S. edule*. Of these groupings, *S. barberi* and *S. sinense* have been grown in northern India since prehistoric times, and are thought to be intergeneric hybrids between *Saccharum* and other genera. *Saccharum officinarum* and *S. edule* are both domesticated species thought to be derived from *S. robustum* (Amalraj and Balasundaram 2006; Bonnett and Henry 2011; Roach 1972; Vilela et al. 2017; Warner 1962).

Within these species, there are hundreds of cultivars and countless commercial hybrids that farmers and breeders have developed. As new varieties were established, the superior ones were cherished, traded, and passed on to form a unique horticultural diversity in each location (Abbott and Shimazu 1985; Handy et al. 1972; Price and Daniels 1968; Whistler 2009). Through millennia of cultivation, humans have developed thousands of varieties that

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exhibit different qualities such as sugar content, disease and pest resistance, environmental tolerance, and maturity time. More recently, modern breeding programs have crossed and backcrossed different *Saccharum* species so many times that many commercial hybrids could not be called any one species (Bonnett and Henry 2011; Mangelsdorf 1956).

Among the heirloom varieties, cultivars of *S. officinarum* stand alone as the most impressive (Roach 1972). Varieties of *S. officinarum* are often called the “Noble Canes” because of their thick stalks, bright colors, and regal stature in comparison to the generally less striking varieties of the other species (James 2004). Furthermore, the sugar content of *S. officinarum* is much higher than any of the other species (Sharpe 1998; Deerr 1921). These are the cane varieties that were cherished spoils of war in ancient times, that powered the colonial sugar industry,

and whose lineage is embedded in commercial hybrids today. The high sugar content and soft flesh of these canes led to another affectionate name, the Chewing Canes; the most popular way to extract the sugar was simply to chew on a stalk and suck out the juice!

Saccharum officinarum originated in the Indonesian/New Guinea area, where the highest diversity of Noble Canes is found (Artschwager and Brandes 1958; Brandes 1938, 1956; Warner 1962). It is still unclear if *S. officinarum* is a result of hybridization, or if it evolved from the selection of sweet forms of *S. robustum*, but either way, it is intimately linked with humans and considered a cultivated species that is not found in the wild. Regardless of its origins, the Noble Canes represented a highly productive crop that tolerates a wide range of habitats; accordingly, it spread rapidly and became an important component to agriculture everywhere it could be grown.



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Experts place the origin of *S. officinarum* around 8000 BCE, with the first outmigration from Papua New Guinea to neighboring areas shortly after (Daniels and Daniels 1993; James 2004).

Brief Description of *S. officinarum*

Saccharum officinarum exhibits a high weight per cane, high sugar content, low fiber, and high purity of juice (Deerr 1921; James 2004; Sharpe 1998). The plant consists of a root clump supporting several straight, typically unbranched stalks. Stalks are long and skinny, ranging from 2 to 8 m in height but only from 2 to 8 cm in width. These shoots emerge upright but often lean as they grow, and may fall over and continue to grow prostrate along the ground.

Distinct and often exotic colors paint the stalks and are typically the first characteristic noticed when observing

a Noble Cane (Lincoln 2009). There are the Ribbon or Banded Canes, named for their brightly colored stripes reminiscent of a giant candy cane. In contrast, the Solid Canes are not striped, but the name is misleading as multiple, mottled colors may still be present. All sugarcane varieties are glazed with a waxy coating, called the bloom, which can be virtually nonexistent or so thick as to obscure the cane's true color behind a frosty facade. A rigid skin, or rind, protects the soft interior filled with a spongy tissue, known as the pith. Conspicuous nodes occur every 2–30 cm along the stalk where the alternating leaves attach. A narrow band of wax, 1–2 cm wide, occurs just below the leaf scar, while root eyes and shoot buds can be found just above it (Hitchcock and Chase 1951; Artschwager 1939, 1940).

Several long, linear leaves that are 0.5–2 m in length and 2–20 cm wide are supported near the tip of each stalk (Artschwager and Brandes 1958; Hitchcock and Chase



Botanical illustrations of *S. officinarum* (a) in Köhler's *Medicinal Plants in Lifelike Pictures and Explanatory Texts* published in 1890, (b) by Fr. Manuel Blanco in *Flora de Filipinas* published in 1837, (c) by D. Blair circa 1876, and (d) by W. J. Hooker circa 1840.

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1951). The upper and lower surfaces are generally smooth but, like all grasses, have serrated edges that irritate the skin and can even cause cuts. The foliage is typically a shade of green, but may be tinged with yellow, blue, red, or purple, or be variegated with white, pink, or green striping. Some varieties shed their dead leaves on the lower part of the stalk, while others maintain them to hang down like a long grass skirt.

Sugarcane takes approximately two years (though as little as ten months) from planting before it begins to flower (James 2004). Flowering occurs in the late fall or early winter, typically between November and January in Hawai'i. The 0.3–1 m inflorescence, commonly called a tassel, is held aloft over the plant on an erect stem up to 2 m long (Artschwager and Brandes 1958; Hitchcock and Chase 1951). The individual flowers vary in color from



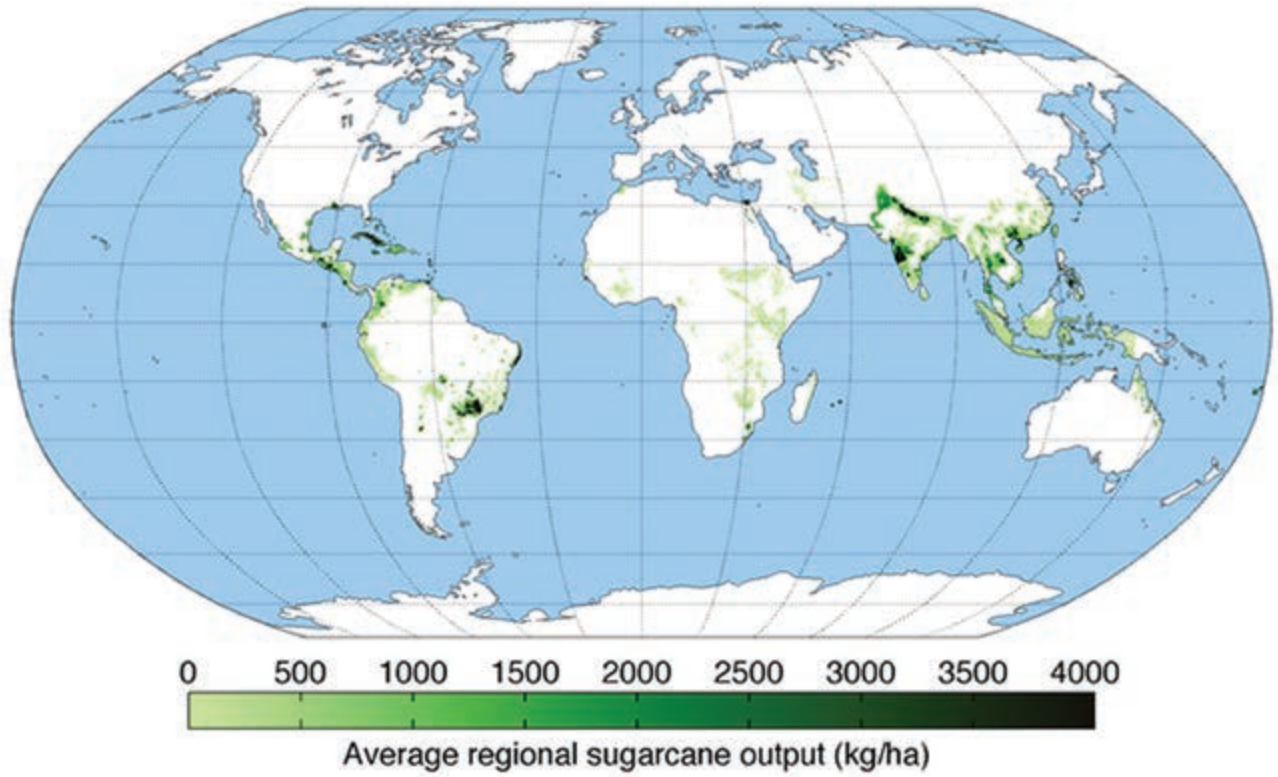
A single sugarcane tassel will produce several hundred small seeds, but they are largely sterile.

slightly rosy to lavender and fade to white or silver as they seed. While the flowers are perfect, having both male and female parts, each flower varies in the amount of pollen it makes, from virtually none (a “female” flower) to a lot (a “male” flower). Although *S. officinarum* can self-pollinate, many Noble Cane varieties are primarily sterile and rarely form viable seeds (though they can be fertile, especially at warmer temperatures). Because many of the Noble Canes produce very little or no seed, much of the varietal diversity arose through somatic or bud mutations: any stalk emerging from a clump may be a new, mutant variety (Moir and Caum 1928; Moir 1932a). If propagated by cutting, these mutant stalks will grow true to form and create an entire clump of the new variety (Moir and Caum 1928; Moir 1932a; Shamel 1922). Frequently Banded varieties give rise to Solid mutants, and vice versa.

Sugarcane prefers high sunlight, temperature, water, and nutrient levels; while it can survive in colder or drier climates, it will not thrive (Deerr 1921, 1949; James 2004; Sharpe 1998; Stubbs 1897; Ware 1881). Most sugarcane plantations achieved the best production by irrigating naturally dry areas that were hot and sunny, providing the best of both worlds. In the right conditions, sugarcane yields the highest number of calories per unit area of any cultivated plant, capable of producing over 20 tons/ha of sucrose. The average yield of cane stalk is 60–70 tons/ha; however, this figure can vary between 30 and 160 tons/ha depending on the area, knowledge, and crop management.

The Spread of Sugar

The earliest known visual record of crystallized sugar is approximately 5,000 years ago from the Indus Valley Civilization, and the earliest written records date back over 2,500 years to the Gupta dynasty in India (Deerr 1921, 1949). In 510 BCE, soldiers of the Persian emperor Darius the Great were near the river Indus when they discovered some “reeds which produce honey without bees.” Alexander the Great of Greece, while leading his army westward, recorded an instance of crystallized sugar during their conquest of India in 326 BCE, followed closely by Nearchus, who mentions sugarcane in western India in 325 BCE. Descriptions of sugar production are also nearly 2,000 years old. In the first century CE, Dioscorides depicts “a honey called sakkharon collected from reeds in India and Arabia, with the consistency of salt and which could be crunched between the teeth.”



Map of the average yields from sugarcane-producing regions around the world. Derived with data from Monfreda et al. (2008).



An ancient processing mill in Jericho, in modern-day West Bank. Photo by user Salamandra123, Wikimedia; CC-BY-SA-3.0.

(right) Raw sugar crystals have been made for at least 2,500 years by evaporating sugarcane juice. Photo by Alden Chadwick, Wikimedia; CC-BY-2.0.

(below) Remnants of historical sugar mills from the colonial period can be found throughout the New World, such as this mill on Moloka'i, Hawai'i. Photo by Jim Shoemaker © 2014. Reproduced with permission.



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It is questionable whether these early descriptions of sugar and sugarcane refer to *S. officinarum* that had migrated out of Papua New Guinea or to *S. spontaneum*, the cane species native to India and the surrounding regions. The use of the word “reeds” in the descriptions seem to indicate *S. spontaneum*. However, the sugarcane that was a central part of the flourishing culture on the island of New Guinea for thousands of years was certainly *S. officinarum* (Artschwager and Brandes 1958; Price and Daniels 1968; Vilela et al. 2017; Warner 1962; Whistler

2009). Here, the Papuan people cultivated sugarcane extensively in a variety of agricultural settings and transformed the growing of sugarcane into an art form. Papuans would build large scaffoldings to maintain their sugarcane stalks, which were “taller than five men” (Artschwager and Brandes 1958). Individual sugarcane varieties were so prized and protected in the indigenous Papuan culture they were considered one of the esteemed spoils of war when conquering an opposing tribe and were used for tribute or exchange in political interactions (Warner 1962).



A general conceptual diagram of the Pacific, indicating groups by shared cultural traits. The Noble Canes originated in the Melanesian area and were spread throughout Polynesia in prehistoric times. Map produced by CartoGIS Services, College of Asia and the Pacific, the Australian National University.

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From New Guinea, the Noble Canes were spread around the world to both the east and the west. A single variety of *S. officinarum*, commonly called 'Creole', is known to have reached Persia by the sixth century CE. The Arabs were then responsible for its spread into Egypt, Syria, Cyprus, and Crete in the seventh century (Artschwager and Brandes 1958; Deerr 1921, 1949; James 2004). Sugarcane finally reached Europe through Spain around 714, where sugar became one of the best-documented products of the Middle Ages. By the middle of the twelfth century, southern Europe cultivated some 30,000 ha of sugarcane.

Starting in the 1400s, Europeans spread sugar around the world during their imperial colonization. Initial regions include the Madeira Islands, the Canary Islands, West Africa, the Dominican Republic, and the Americas. By the end of the 1500s significant sugarcane production was occurring in Brazil, Cuba, Jamaica, Puerto Rico, and other Antilles islands (Harrison 2001). Until the establishment of these sugar-based colonies in tropical regions

sugar was a luxury item in Europe and Asia, but exports from these overseas plantations made sugar a household condiment to the Western culture.

There is no written record conveying the migration of sugarcane westward from New Guinea, but oral histories provide rich documentation. Sugarcane was an important agricultural crop that accompanied the Oceanic peoples in their exploration of the Pacific Ocean (Whistler 2009). The settlement of the extremely remote Pacific islands is one of the notable accomplishments of humankind (Kirch 2017). The expansion into Oceania, commencing about 1200 BCE, led ultimately to the settlement of the vast eastern Pacific, from Sāmoa to Rapa Nui (Easter Island) and from Hawai'i to Aotearoa (New Zealand). The Polynesian peoples located and colonized hundreds of islands, including Sāmoa, Tonga, the Society Islands, the Tuamotus, the Marquesas, the Austral Islands, the Cook Islands, and other small island groups, concluding with the discovery of New Zealand circa 1200 CE.

A replica of a traditional Polynesian voyaging canoe—the *Hōkūle'a*. Transported plants would need to be protected from salt spray and other elements on the long, open-ocean journeys. Photo by Stan Shebs, Wikimedia; CC-BY-SA-3.0.



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With people came essential plants and animals needed to establish new settlements (Kirch 2017). The Polynesians were master voyagers and had perfected the skills not only of sailing and navigation but also the transport of plants and animals aboard their seafaring outriggers. As the Polynesians moved through subsequent islands, they carried fewer and fewer plants with them because only a portion of the plants and people who initially settled, adapted, and developed progeny on each island moved on (or were transported) to the next (Lincoln and Vitousek 2017; Whistler 2009). In particular, there was a reduction of plants propagated by seeds, which were vulnerable during the long, open-ocean voyages. By the time settlers reached Hawai'i, their agricultural introductions mainly consisted of plants that are vegetatively propagated, such as by tubers, root suckers, or cuttings. Great care was needed to protect the plants from rotting, dehydration, and salt toxicity. For instance, root suckers were "wrapped in well-rotted coconut husk fiber . . . the whole thing . . . wrapped in dried leaves . . . then a . . . basket woven around the entire[ty]" (Schattenburg 1976). Hardier than many of the other plants on the voyage, sugarcane was likely always among the first wave of plants introduced to newly settled islands. The agricultural cornucopia in most all the Polynesian islands included sugarcane, except for New Zealand (too cold) and some of the very low-lying islands or atolls (Whistler 2009).

The process of island hopping played an essential role in defining the horticultural assortment of the different Oceanic groups, with systematically less genetic diversity arriving at each successive settlement. Envisioning this process is easy. When departing an island only a few select varieties could be taken along, with fewer still successfully established on a new island home. The surviving varieties would be cultivated and diversified over time, and when departing many generations later, again only a sliver of the genetic diversity could be selected for transportation. This process produced a strong genetic drift by repeatedly constricting the gene pool. Return voyages, multiple colonizations, and trading with other island groups complicate the story, but the basic concept remains true. Although not for sugarcane, the examination of other crops' genetics, such as breadfruit and paper mulberry, have illustrated this process (Chang et al. 2015; González-Lorca et al. 2015; Zerega et al. 2004). As one of the extremes in the Pacific settlement, the crop genetics that reached Hawai'i represent an apex of this process.



Before the development of commercial hybrids, Noble Canes from the Pacific were used in sugar plantations around the world. Photo by A. Nielsen, *National Geographic*, public domain.

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An aerial view of Maui Island after the closure of Hawaiian Commercial & Sugar Company, the last sugar plantation in Hawai'i, in December 2016.



When Europeans finally reached the Pacific through their westward exploration, they noted the incredible diversity of sugarcane within and between island groups (Beaglehole 1967a, 1967b; Bott 1982). Many varieties were collected and returned to the sugar colonies of the New World. Papua New Guinea, New Caledonia, Hawai'i, and Tahiti were all important sources of extraction (Brandes 1956; Daniels and Daniels 1993; Deerr 1949). The influx of new varieties significantly increased productivity in the New World plantations compared to the 'Creole' cane on which they were founded. The most successful varieties were spread far and wide and incorporated into plantations across the world. A prime example is the 'Otaheiti' variety from Tahiti, which spread through Brazil and the

Caribbean, and eventually made it all the way back to Europe, where it was popularly known as 'Bourbon' (Vitrac 2017). 'Otaheiti', known as Lāhaina, was the first foreign sugarcane cultivar introduced to Hawai'i, but instead of being imported from nearby Tahiti, it came through Europe, Louisiana, and Panama in global trade before reaching the archipelago.

Today, sugarcane is still a major global crop, not only used for sugar but also for ethanol production (James 2004; Sharpe 1998). Sugarcane grows between 30 degrees south, in Australia and Argentina, and 37 degrees north, in Spain. Brazil produces some 40 percent of the world's sugar, while many of the colonial-era plantations, including those in Hawai'i, have discontinued production.

Kō in Hawai'i

The Hawaiian archipelago is unique among the Pacific islands. It is the only significant island group north of the equator, has the only peaks higher than 4,000 m, and are the only islands that have current and constant volcanic activity. The substrate ages ranging from fresh lava rock to five million years and vast

gradients of rainfall and temperature create a myriad of soils and habitats that represent virtually every arable climate found on earth: from desert to rainforest and from coastal to alpine (Juvik et al. 1998). As the Hawaiians colonized and cultivated this diverse landscape, they adapted their agriculture to create unique farming methods



The diverse climates of Hawai'i are visible even from space. Photo by NASA, photo ID ISS038-E-32755.

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(Handy 1940; Lincoln and Vitousek 2017). Over time, new crop varieties developed that excelled in different environments and cropping systems (Kagawa-Viviani et al. 2018a). Hawaiian farmers distinguished upward of 50 sugarcane cultivars that differed in their appearance, usage, and environmental tolerance. Some varieties thrived in arid dunes, some in marshy areas, and some in higher, colder elevations. Some were renowned for their striking colors and others for their taste.

When Hawai‘i was settled by the Polynesians, likely in the tenth century CE, kō was one of only about 23 plants that were eventually introduced to form the basis of their agriculture (Kirch 2017; Whistler 2009). Transported in the form of stem cuttings, which is the preferred method for propagation, and protected during the long voyage, sugarcane would proliferate quickly in the Hawaiian environment.

Whether sugarcane traveled on the initial settling voyage or whether subsequent trips were made to gather the desired plant is unclear. Handy et al. (1972) argue that the association of kō with the god Kāne, the first of the four primary deities to come to Hawai‘i, is indicative that it arrived with the first group to settle the islands. In support of this theory, kō appears very early on in the Hawaiian creation chant, the Kumulipo, second only to *kalo* among the crops (Beckwith 1951, 59):

O kane, ia Wai‘ololi, o ka wahine ia Wai‘olola
Hanau ke Ko‘ele‘ele noho i kai
Kia‘i ia e ke ko Punapuna, ko ‘ele‘ele, noho i uka
He po uhe‘e i ka wawa
He nuku, he wai ka ‘ai a ka la‘au
O ke Akua ke komo, ‘a‘oe komo kanaka
Man for the narrow stream, woman for the broad stream
Born was the Ko‘ele seaweed living in the sea
Guarded by the long-jointed sugarcane, the kō ‘ele‘ele, living on land
Darkness slips into light
Earth and water are the food of the plant
The god enters, man cannot enter

The Kumuhonua, an ancient chant that records the traditions of *kahuna hāhā* (medicinal healers who diagnosed by touch and feel), also references kō (Barrère 1969; Judd 1858). The third line of the chant invokes the plant (Judd 1858, translation by Malcolm Chun):

He ko kumu, he ko lau, oo no
A cane stalk, a cane leaf, mature

Several of the following stanzas apply a pattern of invoking Lono and referencing ‘Kea’, the principal medicinal sugarcane variety:

He one kea ke one, he ko kea ke ko,
He ko wai Lono, ka la e Lono
Wekea e Lono, puha e Lono,
O Hawaii ka moku e Lono.
The sand (land) is white, the cane is kea
Sugar cane juice, oh Lono, the daylight, oh Lono
Beginning to break, oh Lono, bursting open, oh Lono
Hawai‘i the island, oh Lono

While later stanzas call upon other well-known varieties of kō:

He kala hale ke one, he maoheohe ke ko
He awawa ke one, he paapaa ke ko
He moana ke one, he palani ke ko.
The land is plaited, the cane is Maoheohe
The land is furrowed, the cane is Paapaa
The land is expansive, the cane is Palani

The importance of kō in Hawaiian society indicates that it was a prized crop, and if it did not make the colonizing voyage, it would soon have been acquired. It is clear that Hawaiians made return voyages to South Pacific islands, sometimes solely to obtain desired plants or animals (Beckwith 1932, 1940). How many varieties of kō might have been introduced is also questionable. Genetic relationships seem to indicate five to eight closely related groups of canes (depending on where one draws the line defining “closely related”) (Schenck et al. 2004). It seems unlikely, though not impossible, that these distinct groupings originated from bud mutations alone. Therefore, these groupings may indicate an equal number of initial introductions. However, sugarcane does produce small amounts of viable seeds, and the groups could also result from a single introduction followed by the occasional propagation from seed. Regardless of how many cultivars were introduced, it is clear that once they arrived Hawaiians developed new varieties unique to Hawai‘i. In their book *Native Planters in Old Hawai‘i*, Handy et al. (1972, 21) explain the process of creating and selecting new cultivars:

In the matter of shrewd observation of varieties and careful, conscious selection of mutants in the creation of subvarieties of their plants, the Hawaiians were truly experimental horticulturalists. New varieties are still consciously created by selecting sports from bud or slip mutation. A variant sport, growing as a banana or taro shoot, or from a potato slip, is termed *keiki* (child). If the mutant produces desirable food, or is liked for its color, leaf form, or vigor, it is replanted and given a name, generally that of a grower or locality; and if it is of real value, it will be shared with friends. Thus, presumably, have the hundreds of varieties of old Hawaiian taro and sweet potato, and the less numerous varieties of banana, sugar cane, and *‘awa* (*kaava*, *Piper methysticum*), been originated.

Exceptional varieties spread across the archipelago through this process of sharing. That the different varieties were prized and collected is well illustrated in *mo‘olelo* (stories). The legend of Wailele o Komali‘u mentions that the *ali‘i wahine* (princess) Komali‘u traveled around the island of Kaua‘i and gathered different varieties of sugarcane for her people, including ‘Pilimai’ and ‘Laukona’ (Wichman 1985). As a variety was spread, it was occasionally renamed (Fornander 1919a). In Hawaiian culture, names are significant and carry *mana*, or spiritual power. A cane’s name may in itself contribute to its vigor, popularity, or powers. Changes in the names could occur for any number of reasons. Some of these reasons include inspiration (that is, a sign from the gods) or to honor individuals or memorialize a significant event. For instance, according to Fornander (1919a) a commoner brought the cane “‘Ōhi‘a’ to the chief Kiwala‘ō during a famous battle at Moku ‘Āweoweo, and Kiwala‘ō told the commoner that this cane should henceforth be known as “‘Āweoweo’ to commemorate the battle and those who died. Additional names were invoked around special ceremonies. ‘Halālī‘i’ may be referred to as “‘Ailolo’ when used in graduation ceremonies or as ‘Ukuhala’ when used in rituals asking forgiveness. It is not uncommon in Hawaiian to have multiple names for an object. Even people will often have a common name, a poetic name, and a secret name used only in exceptional circumstances. The same was true for plants, animals, and places.

The extensive naming of plant varieties exemplifies the horticultural prowess of our ancestors. Over 80 unique Hawaiian names of *kō* are documented, which represent at least 35, and upward of 50, distinct types. These cultivars

appear to be unique to Hawai‘i, developing from the original introductions during a millennium of cultivation. Careful observations of the sugarcanes and their mutations by W. W. G. Moir in the early 1900s suggested that there were at least 11 (and up to 15) “families” of sugarcanes (Moir 1930, 1932a, 1932b, 1938). Each family represents two to five varieties of sugarcane, which are said to mutate into each other, and back again, quite commonly. Moir’s groupings are presented in Appendix I (from Moir 1932b).

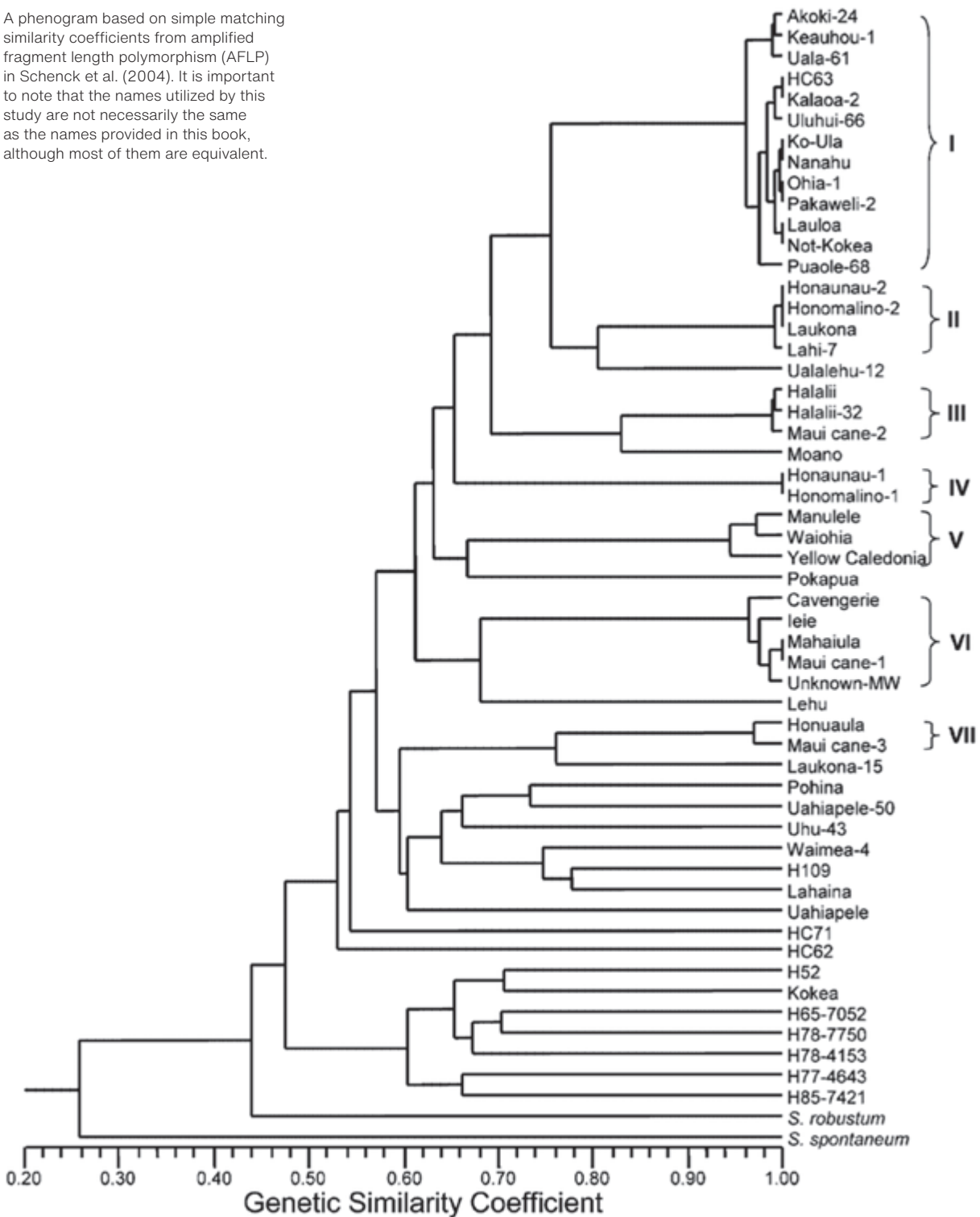
While some of the varieties are strikingly different, others differ very subtly. ‘Opukea’, for example, is reported to be “exactly like Kea but always dwarfed by it,” while ‘Honua‘ula’ and ‘Pāpa‘a’ are said to be “distinguishable only by a small groove beneath the eye [on ‘Honua‘ula’].” Like many crops, detailed observations and descriptions are necessary to distinguish varieties.

Hawaiian Sugarcane Names

The word for sugarcane in *‘ōlelo Hawai‘i* (the Hawaiian language) is *kō*. The varietal names may have the word *kō* placed in front of them, but more often than not *kō* is dropped. References will therefore refer to ‘Kea’, ‘Kō Kea’, and ‘Kōkea’ interchangeably. *Kō* has many meanings that relate to the cultural uses of sugarcane. Hawaiians greatly enjoy wordplay and utilize *kaona* (implied or hidden meanings) extensively. In some ways, it is merely a pun—a play on the multiple interpretations of a word—but holds more significance in Hawaiian communication compared to many languages. The following definitions of *kō* are found in various Hawaiian dictionaries (Andrews 1865; Hitchcock 1887; Pukui and Elbert 1986):

- Sugarcane (*S. officinarum*), a large unbranched grass brought to Hawai‘i by early Polynesians as a source of sugar and fiber.
- Dragged, towed, wind-borne; long, as a vowel sound; drawl; to hold a note for several beats in singing or chanting.
- To drag, push, prolong, tow; to drag, as with a rope; pull, tug, massage.
- To fulfill, come to pass, succeed, do, complete, foreclose; to fulfill, as a threat; to be avenged.
- (*Ho‘o*) Executive; to carry out, as a contract; to enforce, execute, confirm, construe, interpret, decree; to award, as land; to probate, perform, satisfy; to transact, accomplish; to cause a conception;

A phenogram based on simple matching similarity coefficients from amplified fragment length polymorphism (AFLP) in Schenck et al. (2004). It is important to note that the names utilized by this study are not necessarily the same as the names provided in this book, although most of them are equivalent.



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confirmation, award; to perform what has been spoken.

- To obtain; to conquer; to overpower; to obtain what one has sought after; to succeed in a search.
- To put a law in force, that is, cause to fulfill the law.
- To win in dispute; to win in a bet; to prevail, as one party over another.
- To conceive, as a female; to become pregnant; to be fulfilled.
- To proceed from, as a child from a parent; to beget, as a father.
- To break up lumps in *poi* (taro) by pressing against the side of a container.
- Second note in the musical scale, re.
- A call to pigs, fowl.
- Your (of one person; singular possessed object, often with affectionate connotation).
- Of. The sign of possession or property, answering often to the apostrophic s in English, thus: *Kō ia*, of him, his, hers, its; belonging to him or her. *Kō laila*, of that place; belonging to that place, local.

Several associations and uses of sugarcane are embedded in these definitions. The definition of “wind-borne,” for instance, can be evoked in a negative or derogatory way to imply a person of no commitment or consequence. The definitions referring to complete or foreclose are significant to the use of *kō* in the closing of many types of religious and medicinal ceremonies. The need for quick energy after these ceremonies, which are often long and involve fasting, is one possible reason for the relationship. The association with *kō* to conception indicates usage in ceremonies encouraging pregnancy, and also may be why *kō* has a role in marriage ceremonies elsewhere in the Pacific. The many powerful definitions of *kō*, including possession, completion, execution, and probation, indicate the importance and energy of the plant. Much could be implied in the simple act of gifting *kō*.

Most Hawaiian cane varieties share a name with reef fish or ocean flora; it seems likely that for those that do not, the relationship once existed but has been forgotten. These names represent relationships observed between the land and the sea. Often the link appears visual. The mottled



Crops may share the same name when sharing similar traits, such as the ‘Manini’ (a) *kō*, (b) *kalo*, (c) *mai‘a*, which all share the physical striping reminiscent of the (d) the manini fish—*Acanthurus triostegus*. Fish photo by user Brocken Inaglory, Wikimedia; CC-BY-SA-4.0.



pattern of red, green, and yellow on the ‘awela fish (*Thalassoma fuscum*) is the same as seen on the ‘Awela’ cane. Other crops—particularly *kalo*, ‘uala, and *mai‘a*—often share the same names as kō varieties that exhibit similar characteristics. The name ‘Manini’ is applied to several crops that all have white variegation on their stalks and leaves that resemble the *manini*, a small reef tang. Although appearing superficial, these relationships encode knowledge. The subtle variations in the habitat of the fish and the crops are said to vary together. ‘Uahiapele’ is a name applied to varieties of *kalo* and kō. Both have a dark smoky-purple coloration, but both also grow well in cooler, upland climates—a shared trait that is not so obvious.

Agriculture in Ancient Hawai‘i

The Hawaiians were extraordinarily adept farmers, perhaps more so than any other Oceanic peoples. While many assume that our Hawaiian ancestors relied heavily on the ocean for their food, most descriptions of daily life in Hawai‘i indicate that the efforts of farming greatly exceeded those of fishing. As Handy et al. write in *Native Planters in Old Hawai‘i* (1972, vi):

For every fisherman’s house along the coast there were hundreds of homesteads of planters in the valleys and on the slopes and plains between the shore and the forest. The Hawaiians, more than any of the other Polynesians, were a people whose means of livelihood, whose work and interests, were centered around the cultivation of the soil. It was the practice of systematic agriculture more than anything else that produced qualities of character in the Hawaiian common people that differed markedly from those of other Polynesians.

Hawaiian cultivators devised and applied new ways of planting that differed from those found elsewhere in Polynesia. The new techniques were driven, at least in part, by the vastly different environment of Hawai‘i. Before reaching the fertile volcanic slopes of Hawai‘i, the settlers had a long legacy of inhabiting smaller, more ancient islands less capable of supporting vast, intensive agriculture. The ways of cultivation that excelled in the South Pacific were out of context in Hawai‘i. As Hawaiians became increasingly knowledgeable about their new home, they developed farming practices uniquely suited to their environments. Just as Hawai‘i has perhaps the

densest concentration of different habitats and ecosystems, so do the Hawaiians have a dense diversity of farming practices and techniques (Lincoln and Vitousek 2017).

The most salient division of agriculture in Hawai‘i is *lo‘i* (wetland) and *mālo‘o* (dryland) agriculture (Kirch 1994; Lincoln et al. 2018). While the wet/dry division is an oversimplification, even Hawaiian agriculturalists recognized this delineation, as illustrated by a nineteenth-century native farmer’s statement that, “*Elua ano a ka aina, he maloo a he wai*—There are two kinds of lands, there are dry and there are wet” (Fornander 1919a, 160).

Wetland agriculture refers to irrigated or inundated farming plots. Similar forms are found elsewhere in Polynesia. Most commonly, *lo‘i* consist of flooded gardens in lowland river valleys. Here surface water was directed through a series of terraces. Early European observers, such as Cook and King (1784, vi), emphasize the quality of these systems on Kaua‘i:

These plantations were divided by deep and regular ditches; the fences were made with a neatness approaching elegance, and the roads through them would have done credit to any European engineer.

Eventually, moderate slopes of every river valley and flat lowland plain were converted into highly productive terraces. Many testimonies capture the vast alteration of these valley landscapes for agriculture, such as these remarks from Lydgate (1912, 126) describing Wainiha, Kaua‘i:

All . . . along the river, wherever the encroaching [steep mountain slopes] on either side leave the least available space, the land has been terraced and walled up . . . so the whole valley is a slowly ascending stairway of steps, broad in the tread and low in the rise, all the way to [the back of the valley], where the last available space was won.

An essential aspect of *lo‘i* was the ‘auwai—canals that transferred water from the river through the pond-fields and back (Kirch and Lepofsky 1993). ‘Auwai were often simple channels of compacted earth, but more elaborate systems were paved with well-fitted stones and even used carved wooden conduits to pass over short expanses. Some ‘auwai were upward of 3 km long. The sides were sloped inward to prevent erosion and often lined with plantings to stabilize the soil. At critical junctures were

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keystones that could be used to adjust or eliminate the flow of water. The *po‘o wai* (lit. headwater) refers to the diversion point. Here the water would be slowed by *mānowai*—constructions that allowed for sufficient water pooling while employing mechanisms to prevent excess flow during high-water events. For instance, stone dams were built to raise the water level for adequate intake; these dams were constructed so that during flood events they would break away, lowering the water level and preventing the ‘*auwai* from being washed out. A detailed observation of one *lo‘i* in Wailau, Moloka‘i, illustrates some of the precise engineering (Sarah Sykes in ‘Onipā‘a Nā Hui Kalo 2004, 199):

There’s a stone wall edging . . . four feet wide, level with the terraces . . . but nine feet high on the side facing . . . below. Also, there were large *pohaku* (stones), standing like sentinels . . . in the middle of a terrace . . . at seemingly random locations . . . and stonework that gave the odd impression of short walls abruptly left unfinished. [After a terrific storm] . . . the purpose of the stonework was seen . . . all had been engineered to break the force of water, gently move[moving it] through the system of

cleared terraces with such perfection that it was not even discolored. Not a speck of soil was washed out, not a single plant uprooted, and not a single stone dislodged from its place.

Once diverted from the river, water flowed through several *lo‘i*, passing from one to the next via small connections known as *makawai* (lit. water eye). Finally, the water was invariably returned to the river or allowed to seep into the ground. ‘*Auwai* embodied multiple aspects of the communal values that permeated Hawaiian society. Their construction and maintenance required socially organized labor; if a family did not contribute to the building or maintenance of an ‘*auwai*, they risked being excluded from its usage. Similarly, a system of locks allowed for control of water to individual series of terraces; during times of drought, the water was managed so that all users, despite their downstream location, were given a fair share of water as determined by their contribution to the system. The close relationship between the words *wai* (water) and *waiwai* (wealth) exemplifies the Hawaiians’ recognition of water’s supreme importance for personal and social well-being.



Archaeological remains of *lo‘i* can be found in virtually every inch of irrigable land where they have not been destroyed, such as these beautiful walls seen in Mānoa, Kaua‘i. Photo by Tom Dye in Earle (1978): Plate 4. Reproduced with permission from Timothy Earle.

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As the preferred staple, *kalo* was grown extensively everywhere in Hawai'i with adequate water. Photo by Frederick George Eyton-Walker; public domain.



While wetland agriculture is generalized in the system outlined above, there existed a range of forms and styles (see Kirch 1977). In intermittent streams, stone barrages built within the streambed were used to create simple *lo'i* systems. In coastal areas where springs created nearshore pools an adaptation known as *loko wai* was used, where slightly brackish water was used to grow both *kalo* and fish together. In steep areas, cuts were made into the slope to access the groundwater table and create small *lo'i*. Lowland flats, where the water table approached the surface, formed permanently inundated areas. These swampy areas that never dried out, known as *'āina wai*, were extensively transformed into highly productive pondfield systems. Here, rather than build up terraces and *'auwai*, shallow pondfields and connecting canals were dug into the earth to enhance the pooling and flow of water.

The principal crop grown in all wetland agriculture is *kalo*, while along the banks or around a *lo'i*, other plants were cultivated, often *mai'a*, *kō*, and *kī*. The investment into *lo'i* construction was considerable and often a cooperative social venture, but the return was significantly reduced maintenance and increased yields. The flowing water inhibited weeds, kept the plants adequately watered, and delivered a constant source of nutrients. The surrounding crops not only benefitted from the irrigation and

provided more diversified production, but also helped to stabilize the banks and maintain the integrity of the pondfields.

Mālo'o, or rainfed, agriculture occurred in a range of habitats from the ocean up to approximately 2,500 feet in elevation (Ladefoged et al. 2009; Lincoln et al. 2018). While wetland agriculture can be somewhat generalized as a cropping system based on *kalo*, rainfed cultivation utilized a broader range of techniques, practices, and cropping assemblages (Lincoln and Ladefoged 2014; Lincoln and Vitousek 2017; Lincoln et al. 2018). While some forms of rainfed agriculture, such as arboricultural systems, are found elsewhere in the Pacific, others are uniquely Hawaiian. The methods of cultivation were adjusted to every circumstance of climate, altitude, weather, substrate, and exposure (Handy 1940). Despite lacking draft animals or metal, Hawaiian agriculture is highly advanced, relying on ingenuity and knowledge intensity to create highly productive systems sustained for several hundred years. The first Europeans to visit the islands made it clear that they were deeply impressed with the expertise shown by the Hawaiians in manipulating their crops, the meticulous care they took of plantations, the intensity of agricultural development, and the significant bounty brought forth from the land (Menzies 1920).



The use of *lo‘i* is still commonplace today, although the scope and scale of application is only a fraction of what it was in the past. Photo by Joel Bradshaw; public domain.

The most intensive form of rainfed agriculture were vast systems that can be characterized by relatively uniform infrastructure. The dominant surface features were long walls or embankments referred to as *kuaiwi*, literally meaning “backbone.” [Several similar names describe the agricultural walls, including *kuaiwi*, *kuamo‘o*, *kua‘āina*, *iwi‘āina*, *iwikiuamo‘o*, and *mo‘o‘āina*. All the terms evoke the meaning backbone or ridge, using the terms *iwi* (bones), *kua* (back), *‘āina* (land), and *mo‘o* (ridge or narrow strip of land).] The name *kuaiwi* is significant, referring not only to the walls’ appearance on the landscape but also to their critical role in supporting Hawaiian society (Lincoln et al. 2018). The *kuaiwi*, made of earth or stone or both, were typically 1–2 m wide and 0.5–1 m high; they could extend continuously, in a kinked manner, for over 1 km. The *kuaiwi* were spaced to encompass cleared fields, typically 12–20 m wide, though as narrow as 8 and as wide as 60 m. Generally, the walls were planted with taller secondary crops such as *kō*, *mai‘a*, and *kī*, while the cleared fields between them were used to cultivate the primary crops of *‘uala* and *kalo*. Archibald Menzies (1920, 75–76), one of the first European botanists to view Hawai‘i, describes the perfection of one such system:

For several miles round us there was not a spot that would admit of it but what was with great labor and industry cleared of the loose stones and planted with esculent roots or some useful vegetable or other. . . . As we advanced beyond the bread-fruit plantations, the country became more and more fertile, being in a high

state of cultivation . . . seeing now these upper regions so industriously cultivated and teeming with productive crops, we could no longer remain ignorant of their vast resources . . . they thus avail themselves of Nature’s bounty in the conformation of their country by extending their cultivation to different regions of the air, they secure a continued succession of crops and therefore can never be destitute of supply. . . . Every step we advanced through these plantations became more and more interesting as we could not help admiring the manner in which the little fields on both sides of us were laid out to the greatest advantage and the perseverance and great attention of the natives in adapting every vegetable they cultivate as far as lays in their power, its proper soil and natural situation by which their fields in general are productive of good crops that far exceed in point of perfection the produce of any civilized country within the tropics.

The perfection of these systems is even more impressive when considering their extent and intensity. T. S. Newman (1974), one of the first archaeologists to study the dryland systems, states, “The Kona field system is without equal in Hawaii, and probably the nation, in terms of pre-historic modifications to the land . . . comparable in terms of complexity and size to the well-known field systems of Central and South America” (in Kelly 1983, 73). That Hawaiians built continental-scale agriculture on small islands in the Pacific is an achievement that cannot be overstated. The expansion of rainfed agriculture coincides with the late crop introduction of *‘uala*, and possibly *ipu*.

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Both crops are associated with Lono, one of the four supreme deities whose principal affiliation is to rain and clouds—critical for nonirrigated agriculture. Lono’s arrival is placed after the time of Kāne and Kanaloa, suggesting a later arrival for these crops.

The younger islands primarily support the intensive dryland systems, with extensive development occurring in Kohala, Waimea, Kona, and Ka‘u on Hawai‘i Island; Kula and Kaupō on Maui Island; and Kalaupapa on Moloka‘i Island (Ladefoged et al. 2009). In each area adaptations to the local environment were made. For instance, in Kohala, Hawai‘i, where the prevailing trade winds are exceptionally strong and mist-laden, the *kuaiwi* run perpendicular to the slope and the winds. Here the walls functioned as a windbreak and mist trap to concentrate water resources and improve productivity (Lincoln et al. 2017). In contrast, the walls in Kona, Hawai‘i, are parallel to both slope and wind; the author believes this facilitates the management of solar radiation and evaporation (the walls run on a WSW orientation, aligning with the sunset in the winter while providing shade to the fields during the summer). While the infrastructure is similar in form among the field systems, the application and purpose of the infrastructure appear to be unique at each location.

The dense concentration of diverse microhabitats in Hawai‘i necessitated different types of cropping systems and temporal uses of dryland areas. The ecology of dryland

agriculture is variable due to the wide range of elevation, temperature, rainfall, wind speed, and soil nutrients encompassed by these systems. Hawaiians exploited each of these zones according to their social needs and the ecological requirements of their crops. In Kona, Hawai‘i, well-defined bands of planting occupied the mountain slope. Each zone consisted of different assemblages and techniques. Traveling upslope, these zones in Kona were (Kelly 1983; Lincoln and Ladefoged 2014):

- *kula*—dry lowland plains used primarily for resource crops such as *hala* (*Pandanus tectorius*), *pili* (*Heteropogon contortus*), and *ipu* (*Lagenaria siceraria*);
- *kalu‘ulu*—an arboricultural system with a canopy of breadfruit (*Artocarpus altilis*) and *kukui* (*Aleurites moluccanus*) and diverse understory including ‘*awa* (*Piper methysticum*), *mai‘a* (*Musa* spp.), and *wauke* (*Broussonetia papyrifera*);
- *‘āpa‘a*—dense concentration of *kuaiwi* infrastructure where *kalo* (*Colocasia esculenta*) and ‘*uala* (*Ipomea batatas*) grew in cleared fields with *kō*, *mai‘a*, and *kī* (*Cordyline fruticosa*) grown along the walls; and
- *‘ama‘u*—modified native forest in which crops such as *mai‘a* and *uhi* (*Dioscorea alata*) and native resource plants such as *mamaki* (*Pipturus albidus*) and *olonā* (*Touchardia latifolia*) grew under an ‘*hi‘a* (*Metrosideros polymorpha*) canopy.

An elevated perspective of the Kohala Field System on Hawai‘i Island gives a sense of the vast extent of lands converted to intensive dryland agriculture.



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An 1836 drawing depicts the different farming zones behind Kona, Hawai‘i Island, with the *kula* lands in the foreground, the *kalu'ulu* arboriculture appearing as a distinct band across the landscape, followed by the intensive *āpa'a* planting zone and the native forest canopy occurring above. Drawing by Lucy Goodale Thurston (1882) *Life and Times of Mrs. Lucy G. Thurston*, reprinted by Kessinger Publishing.

In contrast, the *mālo'o* system in Kohala, Hawai‘i, did not use these same planting zones, but was instead temporally segregated, in which a single cropping system based on *'uala* and *kō* dominated the region, but lower elevation areas produced during the wetter, colder winters, and higher areas during the drier, warmer summers (Kagawa and Vitousek 2012, Kagawa-Viviani et al. 2018b).

As seen throughout much of Polynesia, arboriculture played a significant role in Hawaiian agriculture. Many of the introduced crops do well in forest conditions, including *'ulu*, *noni*, *kukui*, *wauke*, *ōhi'a 'ai*, *niu*, *'awa*, *mai'a*, *'awapuhi*, *kī*, *uhi*, *hoi*, and *hala*. Endemic plants used for resources and medicine, such as *mamaki* and *olonā*, also thrive. Diversified arboriculture was particularly prevalent in areas that were too steep, too rocky, too infertile, or too salty for *kalo* and *'uala* production, and was therefore common on colluvial slopes, areas with very young soils, near the coast, and in older or wetter areas that were relatively infertile (Handy 1940; Lincoln and Vitousek 2017). The valley walls provide an example of places that were often too infertile or steep to support intensive rainfed agriculture.

If fertile, colluvial soils were sometimes worked to form rudimentary terraces, but more often were established with semiwild tree and shrub plantings that would provide resources, seasonal products, and unmanaged reserves against disasters. The planting of breadfruit, in particular, on the valley slopes is evidenced by dozens of historical and prehistorical references, as well as remnant plantings visible today (Lincoln, forthcoming). These valley plantings accounted for the bulk of the agricultural production in some areas and was a key component to resilience and production throughout the islands (Kurashima and Kirch 2011). In some regions, it is clear that Hawaiians planted trees specifically to accumulate fertility. In these systems, known as *pā*, fast-growing woody plants that decomposed quickly such as *kukui*, *hau*, and *hala* were cultivated (Handy et al. 1972; Lincoln, forthcoming). The trees provided resource products for several years, after which they were cut down and composted to support multiple years of *kalo* cultivation. Hawaiians also made use of the enhanced fertility of natural forests for various forms of agriculture. Maps of homesteads submitted at the time of the Māhele



(above) Mixed agroforestry systems, such as this restored breadfruit system seen at Māla Kalu'ulu Farm, were typical in many environments in Hawai'i, chiefly in areas that were not suitable to more intensively cropped systems.



(left) In marginal locations, small pockets of soil were gathered, captured, or built using compost to create small, farmable areas, such as this small planting pit in the young lava flows in Kalaemanō, Hawai'i Island.

show multiple variations of this. (Māhele was the political act that ended the traditional land tenure system and established fee-simple landownership. The Monarchy of Hawai‘i enacted the Māhele in 1848, with two follow-up provisions that allowed for land claims to be submitted by Hawaiian nationals.) Often areas of *‘ōhi‘a*, the dominant canopy tree in most native Hawaiian environments, were maintained with dense understory plantings of useful ferns and shrubs. This practice capitalized on increased nutrient cycles associated with forests, and increased moisture due to cloud and mist interception. Specific methods appear to be regional, utilizing crops and infrastructure as the local environment required. For instance, in Hana, *hau* (*Hibiscus tiliaceus*) was planted in the uplands to choke out plants in preparation for agroforestry, but in Puna, *hau* was grown as mulch for composting their planting pits.

Over time, increasingly marginal areas were cultivated out of necessity. In some cases, most notably in Kaupō, Maui, and Kona, Hawai‘i, vast areas were utilized that scarcely seem able to have supported agriculture (Schilt 1984; Lincoln and Vitousek 2017). Here, alternative methods were used such as soil capture or creation. Swales were commonly used to concentrate water and soil resources. These could be simple dams constructed in highly intermittent streams or u-shaped enclosures that captured water-borne or wind-blown dust. Where the use of soil capture techniques was not an option, Hawaiian farmers created soil. Pocket agriculture was the process of leveraging natural formations or simple human-made infrastructure to deposit soil and other organic and inorganic amendments into “pockets.” Natural “blisters,” or air pockets in the lava, were particularly useful for this technique because their thick sides kept the soil cool and their low porosity helped to preserve water. The types of plants grown in pocket agriculture varied depending on the specific local conditions. This method was well-known for the production of *‘uala* and *ipu*—both species are vines that would root in the pockets of dirt and crawl out across the surrounding rocks. A large area of spaced pockets could form a contiguous patch of gourds that grew together, effectively bringing the entire area into cultivation despite having only a small percentage of land with adequate soil.

Similarly, rock mounds were common in soil-scarce or dry regions. While mounds were also used extensively in fertile areas, their application was much more widespread



The use of mounds is commonplace in Hawaiian agriculture, but in particular dry, marginal areas, where they were used to help reduce evaporation and conserve water.

in marginal habitats (Horrocks and Rechtman 2009; Quintus and Lincoln 2018). Several acres could be blanketed in heaps of stones approximately 1 m in diameter, which increases yields primarily by helping to preserve moisture and regulate heat. The rock piles enclosed soil or organic matter and were planted mainly with *‘uala*. William Ellis (1963, 187), in his 1820 tour of Hawai‘i Island, presents:

We thought the people generally industrious; for in several less fertile parts of the district we saw small pieces of lava thrown up in heaps, and potato vines growing very well in the midst of them, though we could scarcely perceive a particle of soil.

The diversity of techniques used by Hawaiian farmers allowed them to cultivate a wide range of habitats across the islands successfully. Crops, cropping systems, agricultural infrastructure, planting methods, timing, and management were all adjusted according to the local climate and the macro- and microtopography (Kagawa-Viviani et al. 2018a, 2018b; Lincoln and Ladefoged 2014; Lincoln and Vitousek 2016, 2017; Quintus and Lincoln 2018). Often planting styles could be found in close proximity to each other, making the most of available resources.

Hawaiians thoroughly intertwined their agriculture and religious beliefs. These beliefs govern everything in Hawaiian culture, including relationships to land, water, plants, and animals (Abbott 1992; Beckwith 1932, 1940; Fornander 1916, 1919a, 1919b; Handy 1940; Handy and Pukui 1998; Handy et al. 1972; Ii 1959; Kamakau et al. 1964;

Malo 1898). The *kalo* plant provides a prime example. *Kalo* emerged in association with Wākea (a progenitor of the Hawaiian people, and regarded both as a man and a deity in different *mo‘olelo*), known in deity form as the sky-father. A stillborn child, produced from relations between Wākea and his daughter, was buried behind their house, from which emerged the first *kalo* plant; Wākea had many other children, from whom stem the Hawaiian people. *Kalo* is, therefore, the elder sibling of the Hawaiian people, and this endows upon it a paramount place from the perspective of familial relationships. The elder sibling is to be respected, while assuming the responsibility to care for the younger relatives. Thus, a central value of the Hawaiian people is expressed through agriculture—kinship with our environment, to the same degree as kinship among a family, both of which require reciprocity and respect to function properly.

Environmental cycles played an essential role in Hawaiian agriculture. Hawaiians adhered to a lunar calendar that designated certain days as *kapu* (forbidden) for planting due to religious observances (Handy et al. 1972; Tāwhai 2013). The *kapu* days are also the days said to be worst for planting, illustrating the intertwining of religion and agricultural knowledge. The annual calendar was not strict in the Julian sense but depended on appropriate environmental cues. For instance, the Makahiki (holiday period of peace and planting) commenced with the observation of the Makali‘i star constellation (the Pleiades) at sunset, an indicator that can be affected by weather patterns and shifts in its onset from year to year. This relationship between the environment, religion, and daily practice was a core foundation of agronomy in Hawai‘i.



Wild *kalo*, often called ‘āweu, was respected and left as food for the gods.

Many practices were local in their development, derived from the diverse environmental habitats and patterns. The Makahiki holiday, for instance, evolved around the *mālo‘o* systems (Handy et al. 1972). These dryland systems are dependent on winter storms essential for planting. When the rains came, communities needed to mobilize for planting quickly. *Lo‘i* agriculture, which has a steady supply of fresh water and does not require the quick labor response, is very different. In Kaua‘i, where most of the farming was *lo‘i*, the fishing seasons dictated much of the religious observances and planting schedules. While this is a large-scale example, there are countless examples of small, local customs and beliefs that adapted the religious and agricultural practices. The diversity of traditions across the archipelago makes it difficult, dangerous, and disrespectful to generalize about Hawaiian agriculture.

Hawaiian Sugarcane Farming

Ancient Hawaiians grew sugarcane using several different methods that reflected the opportunities and limitations of the various growing climates (Handy 1940; Lincoln et al. 2017). *Kō* could be found growing lushly along the banks of flooded terraces with *mai‘a* and other moisture-loving crops, where they played a role in stabilizing the banks and shading the water in ‘auwai to keep it cool; in backyard gardens, where the canes were meticulously manicured and cared for; in intensive rainfed systems, where they formed thick hedges extending for several miles, acting as windbreaks or shade hedges; in the harsh conditions of young lava flows, where they were grown in excavated pits, heavily mulched; in boggy lowlands, where they might even persist in brackish waters; and in other conditions. An article in *Ke Au Okoa* by Kamakau (1869, 3) exemplifies some of these diverse growing conditions (author’s translation):

Kō grows on pretty much every type of land, and there’s hardly anywhere it does not grow. *Kō* ke‘oke‘o grows well on arid lands, on ridges that have no water, and in the mountains. The varieties *kō ‘ula*, *kō lahi*, and *opukea* do not grow well on arid lands. *Kō ‘ula* and *kō ‘ōni‘oni‘o* are famed for being planted in gardens (*kīhāpai*). *Kō* was planted in sweet potato patches, dryland taro farms, paper mulberry plantings, and *lo‘i* walls. *Kō* was planted on the borders/banks of every garden so that the plants in the middle would be dignified (*hanohano*).

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In Hawai'i, sugarcane grows best near sea level but will grow well up to about 2,500 feet on the leeward side. While the methods of planting and care differed with the location and type of farming, there are many commonalities that are described here. Sugarcane propagation is done using *pulapula*, or sections of cut stalk referred to as setts or seed-pieces in English. Setts are typically 18 inches long and contain several nodes, where both the roots and the shoots originate. Hawaiians consider the selection of vigorous stock material to be of the utmost importance. The best seed-pieces are taken from the *'ēlau* (top portion of the stalk) of immature canes 8 to 12 months old. Here the buds are younger, healthier, and less likely to dry out. Often buds on the lower portion are already dead and will not sprout, while buds from the *'ēlau* will sprout and grow much faster. That the upper portion of the stalk makes for

the best *pulapula* is also convenient because it is the part of the cane with the least amount of sugar and so not as valued for food. The Kamakau (1869, 3) article cited above continues (author's translation):

The way it was planted was a person would go out and get a bunch of *kō*, bring it back to the house and cut it into forearm-length (*ha'ilima*) portions, and tend (*mālama*) the knuckles (*'ōpu'upu'u*) because that is where it grows from. Really smooth *kō* will not grow, the *kō 'ōpu'upu'u* will grow quickly. July and August are the months that are good for planting because when the *kō* flowers/clumps (*i ka wa pua o ke ko*), the shoots grow vigorously. When planting, dig a hole until the dirt is soft and mixed, and then put down two stalks, then cover with dirt. When the shoots pop up, weed and make mounds (*pu'e*).



Pulapula about 18 inches long taken from the *'ēlau* (upper portion of the stalk) are best for planting, such as these planting setts at Ulu Mau Puanui in Kohala, Hawai'i Island.

Setts are planted at a 45-degree angle and lightly covered with soil. A careful farmer will dig a large hole and mulch it with compost and topsoil before planting, but in fertile areas, seed-pieces can be simply pushed into the bare ground. Care should be taken to plant the seed-piece facing upright so that the buds are above the node. Planting the *pulapula* at an angle is said to yield better over the long run and to firmly anchor the plant so that the stalks will grow more erect and be less prone to falling over. The seed-pieces can be expected to sprout within two to three weeks when kept moist. The sharp buds can push through several inches of soil, but it is best to gently cover the seed-pieces then to continually mulch and heap soil as the sprouts emerge until a *pu'u* (mound) exists over the entire planting.

Sugarcane can be planted on two different time schedules (Handy et al. 1972). One is seasonal, with planting governed by the onset of the local rainy season,



Emerging shoots from a fresh sugarcane planting.

providing maximum water to the young plant, which grows best when kept wet. In ancient times some *kahuna* made their fame in advising the proper time to plant by observing the weather patterns and using divination to predict the timing of the rains. Two main times are best for planting: the months of 'Iki'iki and Ka'aona, which correspond to May/June/July, and the months of 'Ikuwā and Welehu, which correspond to September/November/December. (The names of months from Kona, Hawai'i, are used; different islands and regions often applied different names to the months that reflected their local annual weather.) Which of these times depends upon whether the grower is on the windward or leeward side of the island. For windward areas with abundant moisture, the early summer will offer luxurious growth with the summer sun; for leeward regions that are typically very dry in the summer, planting in the fall at the onset of the southerly winter storms will give the plant the best head start before the dry summer arrives. However, there are always exceptions to the rules! Kona, for instance, is a leeward area with plenty of summer rain, making May/June an excellent time to plant.

The second schedule used by Hawaiian farmers is the lunar calendar; each phase of the moon correlates to a particular type of growth (Handy et al. 1972; Tāwhai 2013). For instance, Hua (the 13th day of the lunar calendar, the waning three-quarter moon) means "fruit," and plantings on this day will bear abundant fruit, but they will be small. Mahealani (the 16th day, the third full moon) is a good day for planting all crops, while the days called 'Ole, meaning unproductive (the 7th, 8th, 9th, 10th, 21st, 22nd, and 23rd days) are a terrible time for planting anything. For sugarcane, the night of Akua (the 14th day, the first full moon) is the very best and will yield considerable growth of stalks and leaves. The three days dedicated to Kanaloa, known as Kāloa (the 24th, 25th, and 26th days, the waning quarter moon), are also exceptional for sugarcane as the plants will grow long joints, be sweet, and make quality medicines. Muku (the 30th day, the new moon) is also a good night for kō. The days dedicated to Kū (the 3rd, 4th, 5th, and 6th days, the waning crescent moons) are considered weak for sugarcane, for they will be upright and tall but spindly and thin. If planted at the right times, sugarcane grown in the right conditions can be producing mature stalks in as little as ten months.

Clumps of sugarcane are best planted 2–3 m apart, so each clump can be individually managed to reap the sweetest cane possible. The spacing allows for the sun to reach

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Hawaiian agriculturalists pay close attention to the moon phases and govern planting accordingly. Photo by user Jun, Flickr; CC-SA-NC-2.0.

the entire plant better, which cycles more water and increases the amount of sugar. Traditionally, leaves were stripped as they first began to yellow but today most people will wait until the leaves are entirely senesced (brown) before removing and mulching them. The ground around the cane should be continuously mulched, both to conserve moisture and to provide nutrients. Sugarcane has been shown to harbor many beneficial bacteria; mulching the leaves back around the canes enriches the soil with these bacteria. Stalks that are spindly or have very short joints should be removed immediately. These stalks do not produce good juice, and are simply a waste of energy for the plant; removing them will focus growth on the healthier stalks. The stalks should not be mulched near the plantings as they can increase disease transmission and also may sprout a new clump where it is not wanted.

Clumps of sugarcane are *pūā* (tied up together) to prevent stalks from leaning too far or falling over. An upright stem produces sweeter and purer juice than a fallen one. Gravity pulls the heavy sugars down, concentrating the sweetness in the lower half of an erect shoot; in a leaning stalk the sugars are diluted, making the juice impure and bitter. Clumps can be tied up once they are a few feet tall, typically around six months old. As the cane grows, soil should continue to be mounded around the base to provided additional stability. This whole tending process is called *momona ke kō*, or “fattening of the cane.” For small-scale production, stalks are best harvested individually as they mature or as they are needed. Always harvest before flowering or lodging; the plant will burn its sugar to produce a flower or shoots, reducing the sweetness of the juice.

A clump of sugarcane can grow for decades, but each year the crop will weaken. The first crop, nowadays called the plant crop, produces the fattest and sweetest growth. Successive crops, known as ratoon crops, make more stalks that mature quicker but are successively smaller and less sugary. Therefore, it is good practice to replant *kō* every 5 to 12 years. Interplanting different cultivars provides multiple benefits. Each cultivar thrives under different environmental conditions; planting several varieties provides a buffer against variability in the weather. Similarly, each cultivar exhibits varying degrees of disease and pest resistance; a diverse planting reduces the chance of devastating outbreaks. Finally, each cultivar differs in its patterns of maturity and ratooning; multiple varieties will spread out the harvest season and the need to replant.

In ancient rainfed systems, sugarcane appears to have been grown in large quantities—at first glance even in excess supply. This sentiment is captured in ethnohistorical descriptions of rainfed field systems, and with an *‘ōlelo no’eau* that depicts the *kuaiwi* walls dense with *kō*—“*I ‘ike ‘ia no o Kohala i ka pae kō*—One can recognize Kohala by her rows of sugarcane” (Pukui 1983, 127). I suggest that sugarcane was an integral part of the cropping systems—that is, Hawaiians may have established so much sugarcane because it allowed them to grow staple crops bigger, better, or more consistently (Lincoln and Vitousek 2016; Lincoln et al. 2017).

In Kohala, for example, restoration of lines of *kō* along the *kuaiwi* have demonstrated how the cane functions as windbreaks, disrupting the fierce trade winds and capturing mist from the moisture-laden air (Lincoln et al. 2017). The rows of *kō* decrease wind to the lee, protecting

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crops from physical damage and lowering evapotranspiration. We have frequently observed leaf-wetting, whether morning dew in sugarcane intercanopy or interception of wind-blown mist or rain on the leaves and stalks. Days of light mist that would barely touch the ground instead turn into a constant drip of water droplets off the tips of the sugarcane leaves. In Kona, where wind and mist are not typical, the tall sugarcane planted on and along the *kuaiwi* provide morning and afternoon shade to the crops in the fields. Preliminary measurements over time show that kō elevates the soil moisture maintained throughout the day by reducing evaporation.

In *mālo‘o* agriculture, kō was a vital source of mulch, as observed by early Europeans, who noted “a thick layer of

hay” covering the fields (Menzies 1920, 76), as well as captured in traditional sayings such as “*kahilipulu Kohala na ka makani*—Kohala is swept, mulch and all, by the wind” (Pukui 1983, 143). Robust examination of mulching rates in Kona indicates an optimal level of mulch to increase soil moisture consistently (Lincoln, unpublished data). Below the optimal level, soil moisture increases as the mulch guards against evaporation; above the optimal level, soil moisture declines rapidly as excessive mulch prevents precipitation from ever reaching the soil.

In addition to increasing plant available moisture, sugarcane helps manage nutrient cycles, affecting nutrient inputs, storage, and redistribution (Lincoln and Vitousek 2016). During the decomposition of sugarcane leaves and pressed stalks, high levels of asymbiotic nitrogen fixation occur; to date, this is the most substantial source of nitrogen identified in traditional Hawaiian *mālo‘o* systems of agriculture. This is in addition to the nutrients in the mulch itself. Traditional practice is that sugarcane leaves were stripped from the plant and mulched at “the first signs of yellowing,” which equates to a peak nutrient concentration in the leaves. Through detailed knowledge and practices, kō leaves acted as a natural fertilizer, accumulating nutrients from the *kuaiwi* walls and transferring it to the fields of *kalo* and *‘uala*.



Lines of sugarcane at Ulu Mau Puanui, an organization restoring parts of the Leeward Kohala Field System, have demonstrated how kō can increase and concentrate soil moisture to enhance the growth of *‘uala*.



Sugarcane mulch harbors many beneficial microorganisms, including nitrogen-fixing bacteria. Proper management of cane mulch can significantly increase soil moisture and health.

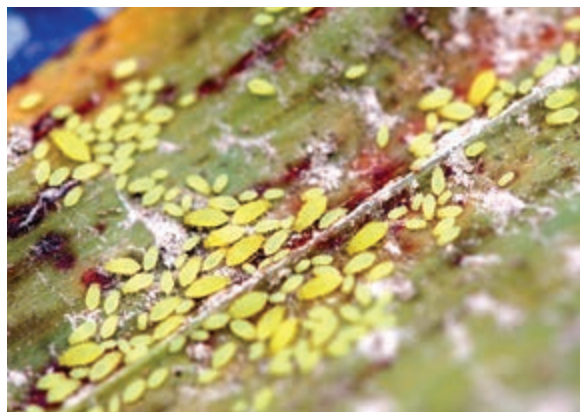
The traditional Hawaiian methods for growing cane were productive. In addition to cultivating kō in a wide variety of environments, there is evidence that yields were high and growth was exceptional. A description stemming from aboard Captain Cook’s boat *Discovery* in 1778 states, “The sugarcanes of the islands grow to an extraordinary size. One of them was brought to us at Atooi (Kaua‘i) whose circumference was eleven inches and a quarter, and it had fourteen feet eatable” (Beaglehole 1967b). From *Ka Nupepa Kuokoa*, a contributor nonchalantly testifies, “We saw kō Pua‘ole . . . that was grown at Halaaniani . . . that was 21 feet” (“I Nehinei Ike Makou” 1866).

Disease and Pests

Sugarcane can become diseased or infested, more so today than in the past because of the introduced diseases and pests (Hitchcock and Chase 1951; James 2004; Purseglove 1968). In the past, when an infested plant was identified, the whole plant was destroyed (Handy et al. 1972). Fire was used to sterilize the soil and prevent the spread of the disease, or the area was abandoned for a couple of years to allow the infection to dissipate.

Two primary pests are prevalent in Hawai‘i today. The yellow sugarcane aphid (*Sipha flava*) is a small yellow insect that will cluster on the underside of the leaves near the midrib. They drain the plant of nutrients, causing the leaves to brown and die. These pests leave behind a honeydew deposit that often causes the growth of sooty mold fungi. Natural enemies to these pests, such as earwigs (*Doru* spp.), ladybugs (*Diomus* spp.), predacious ants, and young spiders can help to reduce populations. Although damage to leaves from the aphids can reach up to 50 percent, sugar yields from infested plants are not impacted heavily, only 5–10 percent. Borer insects, such as the lesser cornstalk borer (*Elasmopalpus lignosellus*) and the sugarcane borer (*Diatraea saccharalis*) are moth larvae that may tunnel into the stems of sugarcane, causing loss of weight; in extreme cases, entire stalks can wilt and die. These pests can be an issue in the Hawaiian sugarcanes, which in general are soft fleshed. Such pests are much more problematic in already unhealthy plants, and the impacts are minimized by replanting often and keeping clumps well cared for.

A range of diseases can affect sugarcane in Hawai‘i (Hitchcock and Chase 1951; James 2004; Purseglove 1968). Perhaps the most common is the eyespot disease, which



The yellow sugarcane aphid in itself is not exceptionally problematic but can be a vector for pathogens and disease. Photo by Scott Stewart, University of Tennessee. Reproduced with permission.

is caused by a fungus (*Bipolaris sacchari*). The airborne spores land on the plant leaves and cause damage that starts as tiny brown spots but will grow into elliptical reddish-brown lesions and streaks. This disease will not kill a plant but does reduce yields, and unfortunately no efficient methods of control are known. The rust disease of sugarcane is caused by *Puccinia melanocephala*. The earliest symptoms are small, elongated yellowish spots visible on both sides of the leaf, which eventually increase in size and turn red-brown to brown with a thin, pale halo around the lesions. When severe, numerous lesions give the blade an overall rusty appearance. The spores of the rust fungus are transmitted by wind and water splash. Removing and burning infested material or the application of specific fungicides can control the spread. Similarly, brown and orange sugarcane rust, caused by fungus in the genus *Puccinia*, are moderately common in Hawai‘i. The fungus is a prolific spore producer, and in dense plantings an infestation can spread quickly, causing losses of up to 20 percent. The best control is to use resistant varieties and to have well-ventilated plantings. Yellow leaf syndrome, another common disease, can cause losses of yield up to 25 percent. The leaf midrib becoming bright yellow is a clear indication. There are no known treatments, but aphids are the primary vector and therefore controlling pest populations can efficiently reduce spread. Also very common in Hawai‘i is the red rot disease, caused by the fungus *Glomerella tucumanensis*. Most people will notice the deep red contamination of the flesh during harvest. However, outward signs, such as deep red

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legions on the midrib or sheaths, are noticeable. In addition to causing reduced yields and quality of flesh, red rot can cause excessive lodging (bud sprouting prior to stalk maturity) and general decline of plant health. The spores rely heavily on water for transportation, and most of the disease transmission comes from the use of infected seed-pieces. Smut disease, also caused by a fungus (*Sporisorium scitamineum*), can cause stunting and death. It is easily noticeable when new leaves emerge as withered black or gray growth. These stalks should be removed immediately when noticed, as a couple of months later the spores will be released and the disease can spread. While previously widespread, smut disease is rare today. Also uncommon is the sugarcane mosaic disease, caused by a virus in the Potyviridae family. The mosaic disease tends to occur in sporadic outbreaks when conditions are favorable for the aphid vectors and susceptible varieties are grown, and can cause losses up to 30 percent in yields.

To combat diseases, using healthy, disinfected planting material is the first step. A hot water treatment is commonly used to neutralize several diseases before planting. Keep plants nourished so they are healthy and resistant,

and prevent the introduction of disease by cleaning equipment and other materials. Use a range of cultivars to ensure increased resilience against pests, diseases, and environmental extremes. Keep plantings well spaced and ventilated, and control pest pressure to prevent the spread of diseases. Finally, observe plants often and remove any infected or infested clumps.

Uses of Sugarcane in Hawai‘i

FOOD

In the past sugar was enjoyed much as it is today, and the chief purpose was as a food or food additive (Handy et al. 1972). Cuttings were convenient to carry on a journey and chew for quick energy or could be prepared from the plant instantly for an easy snack while working in the fields. Of course, children especially enjoyed this treat, and the behavior was encouraged, as chewing the tough fibers and pulp was said to strengthen the gums and teeth. While sugarcane hardly qualifies as an important food from a nutritional standpoint, it has been considered a lifesaver in



The eyespot disease is widespread in Hawai‘i, and heirloom canes typically exhibit at least minor symptoms.



Yellow leaf syndrome, indicated by bright yellow midribs, may not look like a disease but cause a significant loss in productivity.



The red rot disease is commonly noticed only when harvesting by the deep red coloration of the flesh, but topical symptoms occur. This pathogen is prevalent in Hawaiian canes and is best avoided by choosing healthy seed-pieces for planting.



The Noble Canes are often called the Chewing Canes, precisely because the soft flesh can be chewed to extract the sweet juice, unlike the rock-hard flesh of the commercial hybrids. Photo by Herbert Smith, public domain; digitized by Bonhams, Bournemouth News & Picture Service.

times of famine. In Hawai‘i the extracted juice can be used to sweeten foods such as *haupia*, a coconut pudding, and *kūlolo*, a taro-based dessert. The sugar water was cooked over an open fire and fed to nursing babies, sometimes considered the only solution for an ill child (Chun 1986). Some types of food require specific varieties. For instance, only the canes with the darkest flesh should be used to stir and sweeten *‘awa*, such as ‘Halāli‘i, which was used by Kaumua‘ali‘i of Kaua‘i to mix the *pūpū* *‘awa* upon meeting with Kamehameha (Fornander 1919b). Traditionally, the liquid was extracted by pounding the pith to soften the fibers, then wringing out the juice into a vessel (Chun 1998). The most popular method of eating cane, though, was simply to chew on the raw stalk, extracting the juice by crushing the fibers with one’s teeth.

MEDICINE

The most widely applied medicinal use of sugarcane is to sweeten bitter-tasting medication (Chun 1986, 1994a, 1994b, 1998, 2003; Gutmanis 1976, 1983; Kaaiakamanu and

Akina 1922; Krauss 1981; McBride 1975; Nagata 1971; Norton 1998; Whistler 1992). Many say that for this purpose only ‘Kea’ or ‘Opukea’ was traditionally used. Perhaps this is because these canes have the whitest flesh and therefore the purest juice (although ‘Kea’ is also considered the most



The pressed juice of kō displays a range of colors, dependent on both the flesh and the stalk colors.

ancient of the Hawaiian canes and may relate to this usage). For instance, the fruit of the *noni* is used to expel the placenta after birth, and ‘Kea’ is used to wash it down. ‘Kea’ can be used to sweeten a range of medicines, such as the *‘apu kowali* (morning glory potion) or *‘apu la‘au ho‘onahā* (purgative potion) used as purgatives or the *‘apu ho‘omomona* (fattening potion) used to combat thinness and lack of energy.

In addition to sweetening bitter-tasting medicines, cane juice is an active ingredient in curative formulas. The most popular application was for deep cuts: the sugar crystals dry out a wound and prevent the growth of infection-causing bacteria. A short story is related by Fornander (1919a, 584) about using sugarcane as a mixture to form a salve or ointment:

This cane was discovered by Kulua and Paiaalani. While Kulua was lying very sick with chills and with sores covering his body, Paiaalani came to him and asked, “Why are you lying in the house these days and not going out? . . . That disease is easily cured if you will get that cane called Uleohiu; boil it in hot water, drink some, rub some on your skin, and you will be cured.

Sugarcane varieties are said to vary in their therapeutic properties. *Kahuna hāhā*, who diagnose and treat sicknesses and pain, considered ‘Kea’, ‘Honua‘ula’, ‘Lahi’, and ‘‘Ainakea’ the best for medicinal purposes. ‘Lahi’ is the primary variety used in diagnostics, in which ritualistic practices and movements utilizing the cane are used to divine the ailment of patients and the potential outcome of treatments. One text indicates one such protocol:

The sugar cane [stalk] was pulled apart (‘ume) by the kahuna and examined. If the overripe part (kō pala) of the sugar cane was in the left hand and the healthier part (kō maika‘i) in the right, then the kahuna deemed the patient to be “alive.” However, if the opposite occurred, then the patient was deemed “dead.” (Chun 1986, 54)

All kō varieties are used by various practitioners, with some favored over others in particular lineages of practice or specific districts. For instance, some *lapa‘au* (medical experts) practitioners use ‘Manulele’, although *kahuna hāhā* (diagnostic experts) will not. Other times, distinct varieties of cane are necessitated, often for their religious significance. ‘‘Ele‘ele’ or ‘Māikoiko’ were the only cane



Kāhuna were experts in various fields; *kāhuna hāhā* and *kāhuna lapa‘au* were medical experts who used kō as part of their medical repertoire. Photo by Unknown photographer, from Hawai‘i State Archives Digital Collection.

varieties used for treatments of tuberculosis. Most say that it is okay to substitute a similar variety if the cane of choice cannot be found, such as using ‘Pāpa‘a’ in place of ‘Honau‘ula’. Canes are used in mixtures to treat asthma, deep lacerations, sprains, pain/shock, illness of a weak heart, running sores, thrush, and gonorrhea, in addition to native illnesses such as *make uila wale* and *pā‘ao‘ao*. Concoctions will utilize specific parts of the cane plant. The very young buds of sugarcane are the most common ingredient, but occasionally a tincture will call for the juice, the leaves, or even the roots.

Many treatments require purgatives. An “opening,” or a total purging (emetic, purgative, and enema), is often administered to prepare a patient for the positive effects of medicines to follow (Chun 1986, 1994b; Gutmanis 1976). Purgatives are used to treat cramps, stomach ailments, and other more severe diseases. A typical purgative mixture includes the pounded *kowali* (*Ipomoea indica*) root, raw eggs, mashed *kukui* nuts, *noni* fruit, and the juice of the sugarcane. Kō can be used alone as an emetic in large quantities; however, it is typically combined with other ingredients.

The very young buds are a good medicine for pouring on deep cuts and wounds. One such recipe calls for four young kō buds, two *kowali pehu* vines, and one-quarter *‘apu* (coconut-shell cup) of *pa‘akai* (sea salt). The ingredients are pounded into a fine mash and bundled up inside *kī* leaves and broiled until cooked. The resultant salve can be applied to wounds, fractures, and internal injuries as

KŌ IN HAWAI‘I



The *kowali* vine was commonly mixed with kō to form salves and other medicines.



The slimy sap of the *hau* tree was mixed with kō juice to aid in childbirth.

well. This medicine is used to hasten the healing process but also to reduce the formation of scars.

The stalks of the sugarcane are used to treat a range of infections. A medicine concocted for the treatment of *hilo* or *waikī* uses four segments of ‘Ainakea’ and the meat from one ripe coconut. These are mashed, strained, and mixed with the slimy sap of the *hau ka‘eka‘e* (*Hibiscus tiliaceus*) and applied to the genitalia before and after urination. A similar concoction was made with ‘Pale ‘Ōpua’ to cure the female version of the sickness, *kohepopo*.

Sugarcane was often used in pregnancy, both in topically applied salves and lubricants and in ingested concoctions. ‘Māikoiko’ is the most commonly used cane in childbirth. Sugarcane juice can be used to keep the mother energized and is mixed with other concoctions to induce labor. Sugarcane juice is also a key ingredient, along with the slimy sap of the *hau ka‘eka‘e* and other plants, in the lubricating liquids made to help with delivery. Kō was often used in postnatal treatments, such as to increase mothers’ supply of milk. One such treatment is ‘*apu ho‘opa‘a*, which uses juice from aerial roots of the *hala*, juice from the stalks of the sugarcane, and several drops of sap from the flower of ‘Iholena’ banana all mixed with mashed ‘*uala*.

Wai kō (sugarcane juice) was particularly prevalent in treating infants. Warm, toasted *wai kō* was said to be the saving grace of young babies when nothing else would work. The warmed juice of ‘Honua‘ula’ is supposed to be the only cure for infants who have contracted the native disease *make uila wale*.

RELIGIOUS CEREMONIES

Medicine in Hawaiian culture is spiritual as well as physical. Many physical ailments are believed to be manifestations of poor mental or spiritual health. For instance, the psychological stress of a sinful act, such as theft, could lead to physical sickness. Sugarcane is one of the central representative plants of the *kahuna hāhā*, or diagnostic professionals, involved with several ritualistic ceremonies for diagnosing and healing sick individuals. Similarly, kō is used as the *pani*, or closing food, to most healing rituals.

Many ceremonies, religious offerings, and formal events make use of kō. Offerings of kō to *akua* were commonplace, with specific varieties favored. Fishermen typically offer ‘Halālī‘i’ on *ko‘a* shrines. On the days of each month set aside for the worship of Kāne, offerings of ‘Halālī‘i’ along with two fish, *aku* (*Katsuwonus pelamis*) and ‘*ōpelu*’ (*Decapterus pinnulatus*), are made on stone altars outside the home (Handy et al. 1972). The famed bird catchers of Hawai‘i, who acquired the feathers used to make the royal cloaks and insignia, similarly used this sugarcane as an offering to Kū upon snaring their first bird of each season. ‘Honua‘ula’ is also used when offering ‘*awa* to patron sharks or other ancestral deities. Other ceremonies were flexible in the required variety. For example, for the dedication of lesser *heiau* (temples), any red-colored cane would suffice.

When used in ceremonial ways, the sugarcane variety may take on the name of the ceremony. The onset of



Kō was a common offering to Kāne and Kū, presented on *ahu*, such as this modern altar built by the author at Kealakekua, Hawai‘i Island.

special training involves a tradition known as Pailolo, in which students “rouse the brains,” and the graduation is known as ‘Ailolo, called so because the students had “eaten the brains” to feed their minds (Gutmanis 1983). This reference is both figurative to the learning accomplished, but also literal; during the ceremony, participants eat the head, particularly the brains, of a fish offered to the gods. Ukuhala refers to a penalty for wrongdoings and services conducted in the remissions of sins, and Wehehala means “to remove a personal transgression by prayer.” Kō varieties such as ‘Halāli‘i and ‘Pakaweli’ are used in these ceremonies, both as a central spiritual tool and as food to seal the event. The names of these services are often referenced as synonyms to the cane varieties, meaning ‘Pailolo’ may be referenced as an alternative name to ‘Pakaweli’.

Sugarcane was traditionally present in some of the most *kapu* (forbidden) ceremonies, such as ceremonies to adorn images of *akua* with feathers or *kapa* cloth. For these rituals, ‘Kauila’ was often used. Sugarcane is also the preferred tool for mixing ceremonial *‘awa*, for which the

dark-fleshed varieties such as ‘Pāpa‘a, ‘‘Ula’, ‘Āwela’, and ‘‘Uala’ are required. For this purpose, the rind is removed, except for one end that is left as a handle to grasp the cane.

LOVE MAGIC

A distinctive and unique use of some kō varieties is for *hana aloha*, in which a *kahuna hana aloha* influences love affairs (Gutmanis 1983; Kamakea 1930; Wise 1911). A person desiring to gain the heart of another can request the ritual. The person desirous of love eats sugarcane after the *kahuna* has dedicated the cane to Makakanikeoe, the love god. Then the person blows in the direction of the desired person. The god, in his wind form, bears the prayer’s *mana* along on the breeze, and when it touches the one desired, he or she becomes very much in love with the sender. Fornander (1919a, 584) relates this concept in his description of ‘Manulele’:

The reason for calling it Manulele is because of a man with a woman. They lived peaceably as husband and wife, but after some time there grew up in one of them the desire to go astray, thus bringing about discord, and the husband, or perhaps the wife, is taken by another. The one remaining would still be very much in love, trying various ways to occupy his mind, thinking this addiction would soon pass away, but no—it would not cease. Then after a while someone who knows how to intensify love is heard of and is sent for, and upon his arrival the kahuna would ask, “What ails you?” The man would respond, “the love of wife, that is why I am ailing, I do not desire food, I was fond of food and fish when living with my wife, but at this time we are contending together, I do not care for food.” The kahuna would say, “that is a sickness easily cured if I should treat you.” The sick man would say, “suppose then you treat me.” “All right,” the kahuna would say. Then he would get his cane and would explain, “this cane is Manulele (flying bird); her love will fly to you, she will cease her wanderings until the two of you are parted by death.”

As indicated by this story, ‘Manulele’ was the most prevalent cane used in the practice of *hana aloha*. This cane is used specifically to induce a distant person to fall in love. The “flying bird” gives wings to the prayer laden with the power to induce love or yearning in a distant victim (Kamakea 1930; Wise 1911). When the cane is prayed over,



The delicate blossoms of the ‘ilima were used to determine if it was appropriate to conduct a *hana aloha* ceremony.

it is referred to as ‘Kā‘awe’ or ‘Kā‘awe ‘ā‘ī’. The desire for specific types of affairs warrants the usage of different canes: ‘Pāpa‘a’, meaning to “hold fast,” is used to strengthen existing relationships or to create a lifelong bond; ‘Pilimai’, meaning “come this way,” is used for short, temporary affairs; and ‘Lahi’, of which little is known. Other sources also indicate that ‘Honua‘ula’ is rarely used, with its specific application being similar to that of ‘Manulele’, perhaps because the canes are reported to be mutants of each other. Some of the spells involve a love potion taken to the desired person, while others are conducted purely through ritual. Mary Kawena Pukui relates how one such ceremony was done (Hawaiian Sugar Planters’ Association 1953, 6):

While no potion was actually brewed, the charm could be successful only if three specific kinds of cane were used: the Manulele, or flying bird, which would make the love of the recipient fly out to the sender; the Pilimai, or the clinging together; and the Papaa, securely walled, which held the love closely. The kahuna’s prayers and incantations converted the cane into carriers of the spell, or mana, and guaranteed that the recipient would fall passionately in love with the sender. The petitioner brought a piece of each of the three canes to a kahuna hana aloha, who possessed the ability to cast the proper spell. Before starting the charm, a good kahuna would consult the gods to see if they approved. This was done by filling a calabash with water, giving the water a quick stir and then

dropping on its surface two ilima blossoms—all to the accompaniment of incantations. If the blossoms remained separated, the gods did not approve. If the blossoms came together, but later separated, the effects of the charm would be temporary. But if the flowers came together and remained together, the gods were favorable. Of course, not all kahuna were conscientious; some did not bother with the ilima flowers, but would invoke the mana without any assurance that the gods would approve.

Three *pule hana aloha* compiled in Gutmanis (1983, 44) are presented here. The first two are to capture a new love, such as that blown to the wind by ‘Manulele’. The third is to reinvigorate a weak love, which may be accompanied by ‘Papa‘a’ or ‘Pilimai’.

Makanikeoe
 Hono a lele
 Lele ke aloha
 Pili ia (inoa)
 ‘Ilaila ‘e pili ai
 ‘A moe ‘ole kona po
Makanikeoe
The joining flies
The love flies
This pertains to (name)
There it will be in contact
And sleepless are his/her nights

Lele ‘oe a loa‘a o (inoa)
 Ma kona wahi e noho ai
 Ho‘okomo ‘oe i ke aloha iloko ona
 Ka hali‘a, ke kuko, ka makalahia
 Moe ‘ole ai kona po
 Ho‘iho‘i mai a pili a pa‘a me ia‘u
 E pili a pa‘a, mau a mau
 A mau loa
 A kau i ka pua aneane
You fly until you get (name)
At his/her place at which s/he lives
You put love into him/her
The fond recollection, the strong desire
That his/her nights may be without sleep
Return and join firmly with me
Come together, fixedly, continually
And ever after
Till the last offspring is born

Uli iluna, Uli ilalo
 Uli 'ai, Uli noho
 E ku 'oukou i ka wahine/kane
 Ho'ihō'i mai 'e pili me a'u kana kane/wahine aloha
*Uli above, Uli below
 Uli that eats, Uli that dwells
 Get the woman/man, all four of you
 Bring him/her back to join me, his/her loving
 man/woman*

Those who suspect that they have been affected by a love spell can approach a different *kahuna* to attempt to undo the work of the first in a ceremony called *pale hana aloha* (literally “the warding off of hana aloha”). While many *kō* are used in *hana aloha*, ‘Laukōna’ is the only cane referenced for use in *pale hana aloha*. If performed properly, another ceremony and the eating of ‘Laukōna’ can free an individual from the spell, causing a man to dislike (*konākonā*) a woman or vice versa. *Laukōna* refers to the gusty southerly winds. As the prayer is recited, the inflicted victim eats the cane to blast away the unwanted infatuation with the fury of the Kona wind. A final *pule* evokes this desire:

E ho'okonakona, e wehe, e kala
 Kiola hoohele'i i ka mana'o
 Ho'opalaka, ho'opoina
 Ho'opoina loa i ku'u aloha ho'owahawaha aloha
 Ho'opauloa, me ka hi'a
 'Amama, ua noa, lele wale aku la
*Hold in contempt, undo, release
 Throw away, scatter the thought
 Indifferent, forgotten
 Entirely forgotten my love utterly despised
 Bring entirely to an end the rubbing back and forth
 'Amama, it is free of taboo, simply flown away*

While *hana aloha* often has the connotation of being for sexual or even manipulative relationships, it is commonly used to cause love and affection more broadly. ‘Pili-mai’ in particular was used to create more familial relationships in situations that called for this. The best example is when a child was *hānai* (adopted) at a very late age and then *hana aloha* was used to help build a strong bond of love between the child and the foster parents.

SORCERY

On the opposite end of *hana aloha*, some canes are used for more evil purposes, and even in ‘*apu kōheoheo*—poisons. The addition of sugarcane juice was said to accelerate the poison, and also to disguise the taste from the drinker, such as the bitter-tasting drink made from the ‘*akia* (*Wikstroemia uva-ursi*). Very few canes were used in these types of applications, the most well recorded of them being ‘Pāpa’a’ and ‘Pale ‘Opua’.

TATTOOS

The primary ink used for *kākau*, or tattoos, uses sugarcane juice. Charcoal from charred *kukui* shells, or the soot of burning *kukui* nuts, was mixed with sugarcane juice to create the ink. For this purpose the cane ‘Nānahu’, which literally means “charcoal,” was used. Just as *wai kō* was used to aid the healing of cuts and lacerations, it is likely that the *kō* juice helps the tattoo heal. Other plants, such as the sap of the ‘*ilie’e* (*Plumbago zeylanica*) were used after the tattooing to help the ink set and darken in the skin.



The sap of the ‘*ilie’e* was used to help darken tattoo ink made from *wai kō*.

RESOURCES

Sugarcane also has several uses as a physical resource (Abbott 1992; Brigham 1899; Buck 1964; Whistler 2009). The leaves are used to thatch the inside wall of *hale* (houses), providing a neat, finished look to the walls and a sweet scent to the house. *Lauhala* provided a longer-lasting finish but no scent. *Kō* leaves were not used to thatch the outside of the house in Hawai‘i, where *pili* (*Heteropogon contortus*) was preferred, but in other parts of Polynesia, such as Sāmoa, sugarcane was used extensively. In temporary dwellings in the upland, *kō* might have been fashioned into a quick, easy roof by using the entire sugarcane top, typically with 20 to 30 leaves attached, rather than thatching with bundles of stripped leaves.

The flowers are put to use in *lei* making, particularly in *lei haku* (McDonald 1985; McDonald and Weissich 2003). *Lei kō* provides a beautiful silver crown, prized because of the delicacy needed to work with the flowers, which readily disperse if not handled carefully. In this style of *lei*, the short flower stems are woven together so that no other materials are needed. A beautiful *oli* by Pualani Kanaka‘ole Kanahale captures the delicate beauty of the *lei kō* (McDonald and Weissich 2003, 40):

Kō a ke kō kehau
Ka lihilihi luhi i ka ‘ehu
‘O ka ‘ehu kai ho‘okāhiko mai
Ku‘u lei ‘ōlinolino i ka lā

*Sugarcane tassels supporting the dew
Its tassels drooping in the morning
It is the morning mist that bedazzles
My lei glittering in the sun*

The flowers, besides being harvested for decoration, were used to line the *hōlua* (land-sledding) tracks to make them suitably slippery and fast. The flowers also served as the “feathers” of Hawaiian arrows that were used primarily for hunting rats and birds. The flowers could be wrapped in *kapa* to create a soft and sweetly scented pillow. Embalming of the deceased can be done using the *pua kō* (flowers), by soaking them in *pa‘akai* and wrapping the body with the salted flowers, as well as inserting them into the body’s orifices to quickly dry out the corpse.

The long flower stalks can be trimmed to make *lei* needles, or sharpened whole to create a natural dart. The tips of the darts are typically dipped in mud to provide the correct weight balance. Both adults and children used these darts in several games. One such game is *ke‘a pua*, in



Hale were thatched externally most often with *pili* grass, but *kō* was used as an internal thatch to provide a finished look and sweet smell.



An example of the delicate and beautiful forms of *lei kō*. Photo by Paul Weissich. Reproduced with permission from the Friends of Honolulu Botanical Gardens.



Sugarcane's large flower tassels are attractive and had many uses.

which a sugarcane dart is ricocheted off a ramp and judged on distance or accuracy. The dried stems of the flower are split and used for plaiting, being prized for their smooth surface and silvery sheen when prepared correctly. The stems may be prepared by soaking in hot or boiling water for 10–15 minutes, then dipped in cold water and, when dried, scraped clean to make the shiny ribbons. This usage of the flower stalks can be seen in old woven hats.

‘Ōlelo Nō‘eau

There are many *‘ōlelo nō‘eau* regarding *kō*, often with both a literal and a metaphorical meaning. In addition to encoding direct knowledge, these sayings also hint at how *kō* is perceived and referenced in Hawaiian thinking. Several *‘ōlelo nō‘eau* are presented here, clustered into similar categories. The common sayings are often presented with slight variations, and the author has given the version he is most familiar with from personal teachings, occasionally differing from previously recorded versions. Where direct

transcription from publications occurred, the citation is provided. For collections of *‘ōlelo nō‘eau* on *kō* see Forlander (1919a), Judd (1930), Kamakea (1930), Pukui (1983), and Wise (1911).

The most common and straightforward types of *‘ōlelo nō‘eau* involve seasonal timing, often relating processes on land to those in the ocean. Processes are more accessible to observe on the land and can be informative as to what is happening in the sea. This form of coupled relationship is stronger than seasonal information captured in hard dates. The yearly variations in rainfall and temperature mean biological occurrences happen at slightly different times each year, such as coral spawning or a fruiting season. However, if the correct biological events are coupled, they may vary in concert each year, effectively capturing the “yearly” events in a more meaningful way. These two sayings both involve the *pua kō*, or the time of year that sugarcane flowers. This is typically November and December in Hawai‘i but may change from year to year by several weeks or more.

KŌ IN HAWAII



The white sugarcane inflorescence is used to symbolize old age and wisdom.

Pua ke kō, ku ka he'e

When the sugarcane blooms the squid are plentiful

Pua ke kō, kūkini ka 'āholehole

When the cane blooms the 'āholehole are running

The silver tassels of the sugarcane are often likened to white hair, and may be used as a polite way to reference an elderly person. Two similar sayings use this metaphor. The first is said of one who lives until his hair whitens, indicating living a long life. The second uses the same symbolism more subtly. Both these sayings refer specifically to *kō* 'Kea', a play on the meaning of *kea* (white).

Ola a kau kō kea

Living until the kō Kea tassels

Ua heu ka kō kea

The white sugarcane has grown

Specific parts of the cane are referred to as a way to hint at individuals' disposition. Here the first saying applies to the flowers of the sugarcane, which are silver/

gray upon emerging. This saying can be used to refer to a *keiki* who shows wisdom and potential, indicating that they have characteristics beyond their years—that they have “gray hair” even in their youth. The second saying is meant to refer to the buds of the sugarcane, which are hidden under the leaf sheaths until they begin to grow and emerge. A person likened to the buds of the cane are those who are humble or shy but can accomplish great tasks.

Hanau ia, kuakea nā hulu

When it is born, its hairs are gray (Judd 1930)

He manu, nā maka i lalo ka 'ēheu

A bird, with eyes under the wing (ibid.)

Not all the expressions involving *kō* are positive. Here three sayings are used in derogatory ways. The first is rather straightforward and likens a person to the discarded pith of sugarcane. The pith is chewed for the juice and then thrown aside like trash, implying a person of no consequence. The second saying, stating, “No amount of sugar will sweeten,” implies a difficult person whose anger cannot be mollified. The third saying, which refers to the

KŌ IN HAWAI‘I



The waste from sugarcane, called *'aina kō* or bagasse, symbolized someone who was worthless. Photo by user Harsha K R, Wikimedia; CC-BY-SA-3.0.

“lack of sweet cane,” was used as a cynical allegory for the residents of Kohala, implying that they are difficult and stubborn.

'Aina kō kiola wale 'ia i ka nahele
Sugarcane trash thrown in the wilderness (Pukui 1983)

He 'oi kēlā 'o ke kanaka huhū
'a'ohē pū kō momona iāia
He's a very angry man
no clump of sugarcane will sweeten him up
(Fornander 1919a)

'A'ohē opu kō momona i Kohala
There are no sweet clusters of cane in Kohala

Pupukea, an *ali'i* from Hawai'i Island, coined an exceptionally famous saying. It was said in retort when the Maui chief Makakuikalani made fun of his small stature. Many slightly different versions and explanations of this renowned line exist. The obvious interpretation is that just because something or someone seems one thing, it can, in reality, be something very different—akin to the English idiom “Don't judge a book by its cover.” This saying was later used in praise of the warriors of Kohala, who were known for their courage and were said to be small in stature but fierce and strong. It was also used as an insult to



Kohala, a region known for its long rows of cane and fierce warriors, made famous the “hard, white cane” in the most famous *'ōlelo nō'eau* regarding kō. Photo by Adam Cohn; CC-BY-SA-3.0.

Kohala farmers, where the harsh conditions of their *mālo'o* made farming difficult. More poetically, it has been interpreted to mean that something might look easy but is hard to do.

He li'ili'i pā'ā kōkea no Kohala
e kole ai ka waha ke 'ai
Like the little, hard white cane of Kohala
it will hurt your mouth when eaten

Several sayings refer to the unique usage of sugarcane for *hana aloha*. The first is a derogatory reference to the use of love magic. As part of the prayers and ceremonies associated with *hana aloha* the participant blew in the direction of his or her desired person, literally “blowing the medicine.” When used with evil intent, such as for revenge or to humiliate, the sender is spoken of as an ugly person. This is meant in the literal sense, as the sender has no charm and cannot find love, and also in the figurative sense, as resorting to manipulative sorcery. The other three sayings specifically reference kō varieties used in *hana aloha*, referring to their specific uses. 'Pāpa'a' “holds fast to love,” referring to its inducing longstanding relationships. 'Pilimai' is used for short-term infatuations, and the saying doubly refers to *hana aloha* as love magic, and making love. 'Laukona' is used when “love is despised” in order to reverse the effects of an unwanted infatuation.

KŌ IN HAWAII

Puhipuhi lā'au kahuna
ka maunu loa'a aka pupuka
*By blowing the medicine given by a kahuna
can the ugly gain his desire (Pukui 1983)*

No ka lele o ke aloha
ke pili mai, ke hana aloha
*The sending of love
Pilimai, the love magic (or come hither, make love)
(June Gutmanis, personal notes)*

He pāpa'a ke kō, pa'a ke aloha
*Pāpa'a is the cane that holds fast to love (Pukui
1983)*

He Laukona ke kō
konākonā ke aloha
*Laukona is the sugarcane
love is despised (ibid.)*

Another saying refers to the usage of the kō flowers in *hōlua*, or mountain sledding. The flowers of the canes are added to the course on top of *kī* leaves, making the course more slippery and faster.

Pua ke kō, ne'e i ka he'e hōlua
*When the kō tassels, move to the sledding course
(ibid.)*

Some sayings refer specifically to how cane was planted in different areas. The first saying below mentions the long lines of cane in Kohala on Hawai'i Island. This refers specifically to the vast field system in Kohala, where field walls planted with sugarcane extended for miles across the landscape. Here the "rows of sugarcane" acted as windbreaks in the harsh landscape. The second saying refers to Halāli'i on Ni'ihau Island, where the cane stalks famously were said to grow in the dry dunes. The sand would blow and shift, burying the stalks and leaving only the leaves protruding. This would help to preserve the moisture of the cane, and allow kō to be grown in the dry Ni'ihau landscape, but harvest would require digging in the soft sand.

I 'ike 'ia no o Kohala i ka pae kō
Kohala is recognized by her rows of sugarcane

Ke kō 'eli lima a Halāli'i
Hand dug sugarcane of Halāli'i



The *hōlua* slides were layered with kō flowers to increase the speed of the sled. Photo by Ruben Carillo. Reproduced with permission from Kamehameha Schools.

Hawaiian Terminology for Kō Plant Anatomy

Pulapula

*piece of stalk used
for planting*

Wai kō

sugar juice

‘Aina kō

fibers, pith, waste after pressing

Okaoka kō

fine broken particles of fiber

Pu ko‘o

cane held up with sticks

Lalani kō

a row of growing cane

Pae kō / Kō a palena

cane bordering a kalo patch

Māla ko

a field of cane



Pu‘upu‘u

node

Puna kō

internode

Maka kō

bud, eyes

Pūkō / Ōpū kō
a clump of cane

Kīlepalepa
tassel

Mū'okole
a cane after tasseling
when the head dies back

Mu'ō kō
leaf shoot

Lau'ō
green leaf

Ha kō
leaf sheath, midrib

Elau
upper portion of stalk
best for planting

Heu
hairs on sheath

Lā'ō
dry leaf

Pua Kō
individual flower

Kumu kō
stalk

Puna pekepeke
short internode

Puna loloa
long internode

Huluhulu
rootlet

A'a kō
root

Hawaiian terminology for the plant parts and growth of kō. Illustration from USDA-NRCS PLANTS Database / Hitchcock, Albert Spear. (rev. Agnes Chase). 1950. *Manual of the Grasses of the United States*. USDA Miscellaneous Publication No. 200. Washington, DC.



Identification and Naming



TH. H. F. L. S. del. et lith.

SACCHARUM OFFICINARUM, Linn.

M. N. K. K. K. K. K.

Identification Guide

HOW TO IDENTIFY SUGARCANE VARIETIES

Morphological Descriptors for Identification

Many characteristics are used to identify sugarcane varieties, but only by using all of them together can an accurate identification be made. Many features are not consistent but change with the environment, particularly sun exposure. This section covers a range of identification features, how to observe them, and common mistakes made (Artschwager 1938, 1939, 1940; Artschwager and Brandes 1958; Moir 1930; 1938; Purseglove 1968).

In approaching a clump of sugarcane, the first thing to notice is the stature of the plant. Is the plant very erect, or does it prefer to lean outward? Are the stalks very straight, or do they like to curve? Do the shoots come out very close together, or does the clump like to spread? Is it tall and spindly, or short and stocky? These aspects of the growth habit can help in determining the cultivar. However, these features do vary! A well-spread clump may merely be an old planting that has ratooned many times, a leaning clump may have just been poorly planted, and a spindly clump may be the result of having grown in the shade. While the entire stature of the plant should be considered, the curvature of the stalks is the most telling feature. A very erect cane will not bend much, even if the stalks are leaning outward; conversely, the stems of a recumbent cane will curve near the base even if the clump as a whole is very upright.

Also observe the leaves from afar. In general, they may be stiff and erect, they may droop toward the middle of the blade, or they may droop just at the tips. They may also grow densely or more openly. The stature of the leaves is more consistent than the stalks but may be unreliable in windy areas, where even very erect leaves may appear drooped. Also see if there is any hint of color to the leaves. Often the reddish or bluish tinge is only apparent from the

right distance as the sunlight reflects off the leaves, and this trait may be overlooked if only observing the cane up close.

Getting closer, the most noticeable feature will be the colors of the stalk. It may be tempting to identify a cane by the coloration alone, but this is not advisable. Different cultivars may be virtually identical in color. More important, a single cane variety will vary in coloration depending on soil conditions, moisture, sun exposure, age, and natural variability. Along the length of a single stalk, the colors will differ from the top to the bottom or where shade has been cast. Many factors other than sun exposure may also affect the appearance of the stalk. The best way to observe the color is on a healthy, mid-aged stalk near the top, just a few nodes below the last healthy leaf.

All sugarcanes are covered with wax to varying degrees. Often the Hawaiian sugarcanes have a sparse, shiny wax bloom that is not really noticeable, but others are so thickly coated with white wax as to obscure the color of the cane altogether. On old stalks, the wax may have washed off, but even on young, healthy shoots there may be more or less wax. Because of the variability in the appearance of the stalks, the limitations must be recognized—the stalks are a useful feature to narrow down the possibilities but not sufficient to make an accurate identification.

Although we think of sugarcane stalks as being cylindrical, the internodes take several different shapes, from concave to extremely barreled. Each cultivar favors a particular form but will differ based on the growth of the plant. The shapes can be challenging to clarify on most stalks, especially when leaning. The differences are often subtle, but observation of many internodes does reveal a shape preference. To assess the shape, look at healthy, mature, erect shoots near the center of a clump. In cases where the stalk shape is exceptionally expressive, such as the highly

The overall growth pattern of cane varieties differs, such as (a) a very erect cane with erect leaves, (b) a semi-erect cane with leaves that droop at the tips, (c) a semi-recumbent cane with leaves that droop near the leaf center, and (d) a recumbent cane with leaves that droop near the leaf center.





The coloration of cane stalks may vary considerably with exposure to the sun, such as (a) in "Ōhi'a", which typically appears deep reddish purple and olive green, but may appear bright yellow and light green where it receives less sun, or (b) in 'Uluhui', where the south side of a stalk in winter is considerably darker than the north side.



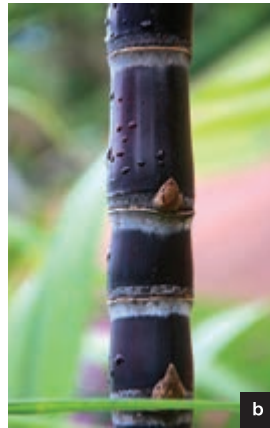
Individual varieties may vary significantly in their coloration, patterning, and growth depending on environmental factors other than sunlight exposure, such as the many forms exhibited by 'Hālāli'i' shown here. In addition to the color, notice that the thickness, prevalence, and transparency of the banding differ considerably.





Canes vary in the amount of wax bloom of the stalk. Most Hawaiian canes produce an extremely light wax bloom that is not noticeable. Canes are described by their maximum waxiness because the wax may be stripped off by the weather. The canes are described here as having (a) very light, (b) light, (c) moderate, or (d) heavy wax bloom, as seen here on 'Uahiapele'. Photo of heavy wax by Mahi'ai o Ka'onohi, Kalauao, Ewa, O'ahu. Reproduced with permission from Anthony DeLuze.

The differences in internode shapes are often subtle, but are expressed as (a) concave or bobbin shaped—both sides curving inward, (b) conoidal—bottom of internode bulging with constricted top, (c) obconoidal or shouldered—top of internode bulging with constricted bottom, (d) cylindrical—both sides straight, (e) concave-convex—one side curved in, other side bulging, and (f) barrelled—both sides bulging outward.





a



b



c

Some standard features of the internode are (a) the bud furrow, such as the deep and long expression seen on 'Pokapua', (b) corky cracks, as evident on the red patches of this 'Tolo Mauga', and (c) growth cracks, as seen here on 'Lahi'.



a



b



c

Features of the node, while small, are essential aspects to cane identification. Features seen here are described as (a) triangular bud with long hairs at tip, tumescent growth ring, and only two rows of root eyes, (b) round, fat bud with reddish wings and darker growth ring that curves to avoid bud, (c) round, flat bud with broad triangular wings, light-colored root band and colored root eyes, (d) squarish bud, darker-colored root band, and five rows of root eyes, (e) large, triangular bud with rounded base that extends well beyond tumescent, dark-colored growth ring, and (f) small round bud with small wings with colored growth ring and colored root eyes.



d



e



f

IDENTIFICATION GUIDE

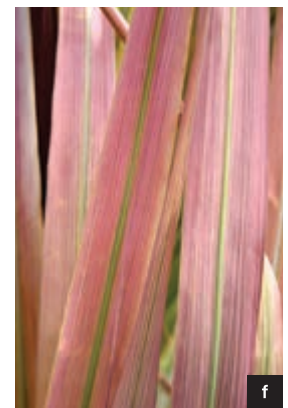
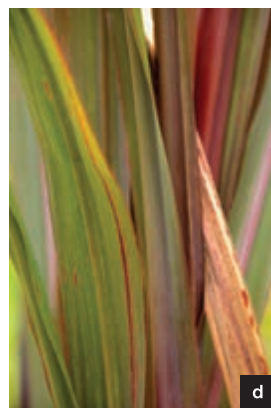
barreled ‘Hāpai’ cane, it can be a useful giveaway to quickly identify or narrow down the variety.

Zooming in further, more detailed features along the stalks are noticeable. A significant feature of the internode is the bud furrow, a depression that starts behind the bud and extends upward. The groove may be nonexistent (absent), shallow (inconspicuous), or deep (strongly marked), and may continue the whole length of the internode or stop partway up. Unlike most of the characteristics mentioned so far, the expression of the bud furrow is very consistent and is generally reliable except on very short-jointed stalks (in which case the groove tends to disappear on all varieties). A less noticeable feature is corky cracks—small fissures in the rind of the cane. This feature is typically absent on Hawaiian cultivars, and so their conspicuous presence usually indicates a non-Hawaiian variety. Finally, stalks may be more or less prone to producing large splits, known as growth cracks. These are more a

function of environment and growth but they certainly occur more or less prevalently depending on the variety.

At the node, many morphological features occur. These elements include the leaf scar, wax band, root band, growth ring, and bud. At the center of the node is the leaf scar, a lipped protrusion where the leaves attach. The leaf scar may be either straight or inclined, and while each variety favors one or the other, it is a variable feature. For kō, the most valuable observation is to note if there are protruding hairs on the leaf scar, which immediately indicates one of two kō varieties. Directly below the leaf scar is the wax band. The wax band will be indistinguishable from the bloom on a heavily waxy cultivar, but the dense ring of wax is clearly visible on most sugarcanes. While not particularly noticeable, the wax band ranges in width and may tend toward being tumescent (swollen) or depressed. Immediately above the leaf scar is the root band, where the root eyes, or primordia (earliest structural stage of the

The leaf color of sugarcane varies across (a) light green, (b) dark green, (c) dark green with a tinge of color, (d) very dark green with strong coloration, (e) darkly colored new growth, and (f) brightly colored.



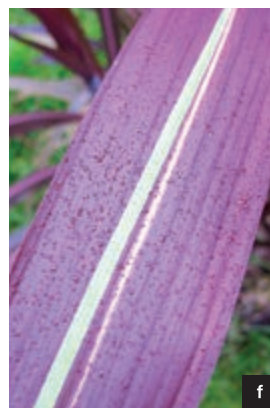
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roots), are located. This section will consistently vary in height and shape. While often similar in color to the stalk, the root band is occasionally quite expressive in hue. Notably, for banded (striped) varieties, the stripes may extend through, truncate in, or stop short of the band. The number of primordia is variable, ranging from two sparse rows to six densely packed rows. While most cultivars have three or four rows of root eyes, the presence of only two or more than five rows is useful for narrowing down identification. Along the upper edge of the root band is the growth ring. This narrow line is often distinctly colored, but with high sun exposure tends to be the same color as the internode. Depending on the cultivar, the growth ring may be tumescent or not, and may curve to accommodate the bud.

The bud, located within the root band, exhibits a diversity of forms. These shapes may then be large or small, long or short, and flat or plump. The bud growth may extend above the growth ring or stop short of it. While

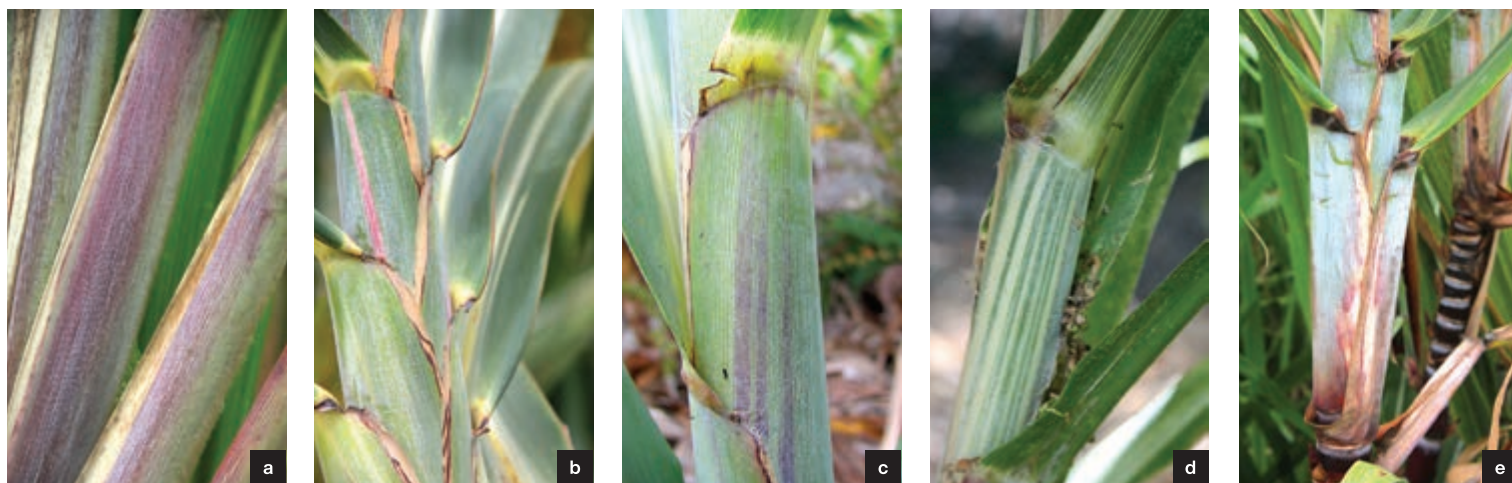
all very young buds are green, flat, and flush against the stalk, at the proper stage of maturity, they exhibit a range of colors, sizes, and angles of projection from the stem. Along either edge of the bud there is a membranaceous growth called the wings. The wings vary in color and width, but the trait most often noted is whether they start in the upper or lower half of the bud. Both the bud and the wings may be pubescent, and over 30 distinct hair groups are described along the front and back sides. In this guide, we focus only on a couple of the most prominent and noticeable hair groups that help in quick identification.

Moving further up the plant we reach the leaf and leaf sheath. The leaves themselves are not particularly revealing. The most noticeable trait will be any coloration or variegation present. The color may be strikingly apparent or just a slight tinge of color seen in the reflecting glare. Variegation occurs in many varieties and is described by its intensity (how densely a single leaf is variegated),



Sugarcane often expresses leaf variegation, seen here in (a) very light, (b) moderate, (c) heavy, (d) dominant, (e) colored, and (f) green forms. Photo of green variegation by Isaac Kaiana Runnels. Reproduced with permission.

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Some examples of sheath variation: (a) moderately waxy and very hairy with a purple flush, (b) moderately waxy and lightly variegated with pink, (c) lightly waxy and moderately variegated with purple, (d) heavily waxy and heavily variegated, (e) very heavily waxy.

frequency (how many leaves are variegated), and color. The size of the leaves will vary considerably depending on the environment, but the length and width vary in concert. Therefore, the length-to-width ratio, called the leaf module, consistently falls within a small range for each variety and is a reliable characteristic.

The leaf sheath is more expressive than the leaves and is essential for identification. Some varieties are *only* distinguishable by the sheath. The sheaths show a broader range of colors than the leaves, often flushing with red or purple, and also express variegation much more strongly, typically with white, pink, or purple. The sheath's level of waxiness is another useful description, ranging from virtually wax-free to heavily coated with wax. Less visually apparent, but fundamental for identification, is the pubescence; these are the irritating hairs that lodge in your skin when working with sugarcane. In some clones, the sheaths are entirely smooth, while in others they are densely pubescent. The hairs are concentrated into distinct areas, mainly down the middle and on the upper sides of the sheath. The hairs can be washed off in heavy rains or rubbed off in windy areas, so be careful when assessing pubescence. Other smaller characteristics of the sheath are how persistently it clings to the stalk and if the sheath cracks open to allow the emergence of the bud. In general, the prevalence and location of the hairs, and the color and intensity of the variegation are the most essential features of the sheath.



The sheaths on some varieties crack open to allow the emergence of the bud, while other varieties do not.

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Examples of dewlap colors and shapes: (a) purple broad squarish, (b) purple squarish deltoid, (c) olive green broad deltoid, (d) deep olive ascending double crescent, (e) light green narrow ligulate, and (f) yellow intermediate ringed in light purple.



Where the leaf sheath meets the leaf, two critical identifying features are found: the dewlaps and the auricles. The dewlaps are the hinge of the blade joint, which occurs at the juncture of the leaf and the sheath and consist of two symmetrical patches (one on each side), which will differ in color and structure from either the sheath or the leaf. The dewlaps vary in color from yellow to dark purple, and in some varieties are ringed with bright pink or purple. There are four basic shapes—rectangular (called squarish), deltoid (triangular), double crescent (curved), and ligular (undulating, tongue-shaped). Descriptions of orientation, such as ascending or descending, and size, such as narrow or broad, are often added. Many intermediate forms exist and are recognized but knowing the basic shapes can help considerably in identifying a specific variety. Dewlaps are best observed on fat stalks with large, healthy leaves. It is best to look at a moderately young

blade, maybe stripping off a couple of older leaves first because the color will deepen over time to olive or olive-brown in many varieties.

The auricles are appendages on the leaf sheath, emerging from either side of the sheath just below the dewlap on the margin of dead leaf tissue. The auricles are usually asymmetrical and weakly developed, particularly with the Hawaiian canes, but well-developed auricles are a conspicuous feature and can be found within any mature clump with a probing search. The auricles take many shapes—from complete absence to long sharp protrusions. When the auricles are absent or transitional, a tuft of hair is often present that varies in length and density. When using the auricle for identification, remember that the two sides will differ, and so it is important to inspect them both. Also, remember that well-formed auricles are rare, so check many different stalks and leaves to find a well-developed example.

Examples of auricles:
(a) absent with tuft of hairs, (b) nub well below dewlap, (c) calcarate slightly below dewlap, (d) deltoid, (e) lanceolate (pointed), and (f) view of differing inner and outer auricles.



IDENTIFICATION GUIDE



Flesh color exists on a spectrum across (a) white, (b) yellow, (c) light brown, (d) orange-brown, (e) dark brown.



Finally, the cross section of a sugarcane stalk allows the observation of the flesh, which varies in color from white to dark brown, and the rind. Some cultivars have a green, yellow, or orange tinge to the flesh, while others transition from being very dark near the skin to perfectly white at the core. In some varieties, distinct radial fibers are present.

Identifying Hawaiian Sugarcanes

The Hawaiian cane varieties are distinctly different from most other cane varieties around the world. Of the important island centers of sugarcane diversity, including Papua New Guinea, Hawai'i, Java, and New Caledonia, the Hawaiian canes are considered the most homogeneous. This means they are both relatively easy to distinguish from foreign cultivars and challenging to tell apart from one another. One outstanding and consistent feature of Hawaiian varieties is a long, sloping transitional auricle that often consists of a poorly developed nub occurring an inch or more below the dewlap. The opposite auricle is typically heavily fringed with hairs, often with the fringe descending beyond the insertion point of the auricle. Therefore, any canes with well-developed pointed auricles or having both inner and outer auricles developed are most likely not native Hawaiian cultivars.

In general, kō varieties have minimal stalk wax and strongly marked bud furrows, but these are only generalizations and not necessarily indicative. All the other features of appearance, pubescence, stature, and so on are highly variable.

Sources of Information

The varietal descriptions are a compilation of the author's original research and a number of historical resources. All contemporary observations come from the author's notes. Historical descriptions are compiled from a large range of sources, occasionally including unattributable notes and observations from a range of sources. Most notable is research published previously by William Whitmore Goodale Moir, Edward Leonard Caum, and the USDA (Ernst Artschwager and Elmer Walker Brandes), as cited in the bibliography. Secondary sources include loose notes and documentation from plantation records such as by Charles Nichols Spencer and Hermann A. Widemann, Hawaiian scholars including David Kaaiakamanu, Mary Kawena Pukui, and David K. Kamakea, text translated and compiled in Abraham Fornander, passing references in publications by the Hawaiian Sugar Planters' Association, and the occasional notes from modern ethnobotanists such as Beatrice Krauss and June Gutmanis.



Notes on Naming

This book does not mean to tell anyone that the name they use is incorrect. It attempts to create a standard for communication so that when we talk with others and say a name, we can be sure that we are talking about the same cane. This book has used a wide range of modern and historical sources of information and thousands of detailed observations of sugarcane varieties to triangulate the most popular name, presented as the primary name, for each variety and crossmatch all synonyms. All other names associated with a cane variety as referred to as “alternative names.”

Sorting through the varied and often contradicting cane names is difficult. These are some of the reasons why kō names have evolved over time:

- Before European contact, the same variety of kō was often known by different names in different locales. Conversely, the same name was occasionally applied to separate sugarcanes.
- With new cultures, practices, and varieties arriving with Europeans, more names arose. Introduced canes were often given Hawaiian names, and sometimes native cultivars were given English names. As germplasms were established, sometimes no traditional name was recorded, and so new, generic names were created. Often these were place-names, which adds a layer of confusion because many traditional names also utilize place-names.
- To simplify management, codes such as H.O. (Hawaiian Officinarum) and H.C. (Hawaiian Cane) were applied to unknown varieties, which appear to have been applied to both native and introduced cultivars.
- Over time, collections became mixed up within the plots, which is easy enough to do. When germplasms were shared or copied, these naming errors propagated through the different users.
- The canes mutate into different varieties, and these changes can be propagated if care is not taken.
- When mistakes are noticed in the collections, the variety is often renamed with ‘Not’. For instance, a cane held as ‘Ko Kea’ was deemed to be incorrect and renamed to ‘Not Kokea’. Reestablishing the correct name to the correct cane, often based on conflicting historical information, is not a straightforward process.



Botanical Key to Hawai'i's Sugarcane Varieties

To use this key, for the cane in question, first select I for banded/striped canes or II for solid-colored canes. Then select which of the two choices at the next level down, 1, applies. If a variety name appears next to your choice, the cane has been identified. If no variety appears, the key will instead direct you to the number of the next trait pair to examine. Continue the process, moving down through the paired trait levels until you succeed in establishing the identity of the cane. Note that you may be directed to skip numbered levels to find the next set of paired traits to examine. Care is needed to ensure you choose the correct trait at each pairing and that you proceed to the pair level indicated by your choice.

I. CANE BANDED

1. Stalks noticeably waxy: 2
1. Stalks virtually waxless: 3

2. Sheaths highly pubescent — **'NOT UHU'** (*Stalks heavily to moderately waxy and purple striped with deep yellow that may redden, sheaths heavily pubescent, auricle short to moderate deltoid*)
2. Sheaths smooth/sparsely pubescent — **'HAWAIIAN OFFICINARUM'** (*Red to reddish brown striped, often finely, with bright yellow or yellow-green and moderately to lightly wax coated, sheaths smooth or lightly pubescent and heavily waxy, dewlap double crescent, buds small and round*)

3. Sheaths smooth/virtually hairless: 4
3. Sheaths noticeably hairy: 10

4. Internodes extremely barrel-/egg-shaped — **'HĀPAI'** (*Yellow to green striped with dark red to purple, internodes extremely barreled, bud furrow deep, dewlap dark green to purple and narrow ligulate, auricle rounded or calcarate*)
4. Internodes not extremely barrel-/egg-shaped: 5

BOTANICAL KEY

5. Bud furrow absent — **'TOLO MAUGA'** (*Green-bronze to purple striped with yellow to bronze, bud furrow shallow, leaves with distinct veins and faint purple cast, sheaths waxy and smooth, dewlap dark green to purple and ligulate, auricle transitional*)
5. Bud furrow present: 6
-
6. Sheath variegated with white — **'HC 71'** (*Yellow to yellow-green striped with light to dark green, heavy pink flush in sun, sheaths smooth and variegated, dewlap narrow ligulate, auricle transitional, leaves lightly variegated*)
6. Sheath variegated with pink or purple: 7
-
7. Auricle is poorly formed nub or absent — **'ŌHI'A'** (*Yellow to dark green striped with bronze to purple, bud furrow deep, sheath pink variegated, dewlap light to dark green and subcrescent, auricle transitional*)
7. Auricle is large and rounded or calcarate: 8
-
8. Leaves with slight variegation — **'PAKAWELI'** (*Orange to green striped with pink to purple, sheaths smooth and purple variegated, dewlap yellow to dark green and ligulate, auricle calcarate and transitional*)
8. Leaves with no variegation: 9
-
9. Stalks green to purple striped purple to dark purple — **'HONOMALINO 2'** (*Green-bronze to purple striped with light to dark purple, bud furrow deep, sheath variegated with purple, dewlap yellow to yellow-green and double crescent, dewlap ringed in pink, auricle calcarate and transitional, slight purple tinge to leaves and midrib*)
9. Stalks yellow to dark green striped brown-red to purple — **'LAULO'A'** (*Light to dark green striped with red to purple, bud furrow deep, sheaths smooth and pink variegated, dewlap light to dark green, auricle calcarate and transitional*)
-
10. Sheaths not variegated — **'NOT LAUKONA'** (*Yellow to green striped with light red to dark purple, sheaths moderately waxy and hairy, dewlap yellow to green and narrow deltoid, auricle small rounded*)
10. Sheaths variegated: 11
-
11. Leaves not variegated: 12
11. Leaves slightly or heavily variegated: 14
-
12. Sheaths variegated with pink or purple — **'KEAUHOU'** (*Yellow to green striped with light red to dark purple, bud furrow deep, sheaths smooth and variegated with purple, dewlap deltoid, auricle small pointed*)
12. Sheaths variegated with white: 13
-
13. Auricle calcarate, located at or just below dewlap — **'LAUKONA'** (*Light yellow to orange striped with light green to green, sheath variegated, dewlap light to dark green and double crescent, auricle round or calcarate, leaves heavily variegated*)

BANDED CANES

13. Auricle round, located at dewlap — **'STRIPED BAMBOO'** (*Yellow to light red striped with dark green to dark purple, sheath heavily waxy and hairy, dewlap light to dark green and squarish deltoid, auricle small rounded*)
-
14. Auricle located at or just below dewlap: 15
14. Auricle located well below dewlap or transitional: 18
-
15. Auricle is poorly formed nub or absent — **'IE'IE'** (*Bronze to light purple striped with dark green to dark purple, sheaths hairy and variegated, dewlap yellow-green to purple-green and deltoid, auricle poorly formed and transitional*)
15. Auricle is large rounded or calcarate: 16
-
16. Sheaths variegated with pink or purple — **'AKOKI'** (*Yellow to green striped with red to purple, bud furrow deep, sheath purple variegated, dewlap yellow to dark green and deltoid, auricle calcarate*)
16. Sheaths variegated with white: 17
-
17. Leaves held very erect — **'HALALI'** (*Yellow to orange striped with yellow-green to green, sheath white variegated, dewlap yellow to dark green and squarish deltoid, auricle calcarate*)
17. Leaves heavily drooped near middle — **'NOT HINAHINA'** (*Light to dark yellow striped with light to dark green, pink flush in sun, five or six rows of eyes, sheath lightly waxy and white variegated, dewlap squarish deltoid, auricle calcarate*)
-
18. Stalks light red to purple striped with green or dark purple — **'MAHAI'ULA'** (*Light red to purple striped with dark purple, sheath with dense brown hairs and white variegated, dewlap squarish deltoid, auricle transitional*)
18. Stalks light yellow to light green striped with green — **'PUA'OLA'/'KALAOA'** (*Light yellow to yellow striped with yellow-green to green-bronze, pink flush in sun, sheaths moderately hairy and variegated, dewlap light to dark green and subcrescent, auricle round and transitional*)

II. CANE SOLID COLORED

1. Stalks hairy — **'LEHU'** (*Greenish yellow to bronze often flushed with pink, moderate sheath hair down center and upper edges, dewlap dark green to purple and squarish deltoid, leaves drooped, pith greenish white*)
1. Stalks hairless: 2
-
2. Hairs on leaf scar: 3
2. No hairs on leaf scar: 4
-

BOTANICAL KEY

3. Stalks virtually waxless — **'MĀIKOIKO'** (Dark purple to black stalks, hairs on leaf scar, only two rows of eyes, wax band green, internodes exceptionally short, sheaths moderately covered with brown pubescence, dewlap purple and squarish deltoid, auricle long deltoid)
3. Stalks noticeably waxy — **'UAHIAPELE'** (Light to dark purple stalks, moderate to heavy wax bloom, sheath heavily coated with hairs down center and sides, dewlaps green to light purple and broad double crescent, auricle is small rounded and transitional)
-
4. Stalks virtually waxless: 5
4. Stalks noticeably waxy: 20
-
5. Sheaths smooth/virtually hairless: 6
5. Sheaths hairy: 13
-
6. Dewlap always purple — **'HONU'ULA'** (Light to dark purple stalks, no wax bloom, leaves purple, sheaths purple, smooth and heavily wax coated, dewlap purple and ligulate, auricle pointed occurring at dewlap)
6. Dewlap not always purple: 7
-
7. Bud furrow absent — **'WAILUA HOMESTEAD'** (Yellow-orange to purple stalks rarely sparsely banded with yellow or purple, no wax bloom and thick wax bands, sheaths smooth and waxy, dewlap squarish deltoid or ligulate, auricle poorly formed and transitional)
7. Bud furrow present: 8
-
8. Sheath variegated with pink/purple — **'NĀNAHU'** (Light red to purple stalks that appear solid but are weakly banded with light purple, sheaths smooth, variegated with purple and heavily wax coated, dewlap light-colored, often ringed in pink and squarish deltoid, auricle calcarate)
8. Sheath not variegated with purple: 9
-
9. Auricle located at or just below dewlap: 10
9. Auricle located well below dewlap: 11
-
10. Auricle is poorly formed nub or absent — **'UHU'** (Green to purple stalks, sparse wax bloom, sheaths moderately waxy and very sparsely hairy, dewlap yellow to dark green, ringed in pink and squarish deltoid, auricle small rounded)
10. Auricle is large rounded or calcarate — **'ULA'ULA'** (Bronze to purple stalks, sparse wax bloom, bud furrow very deep, sheaths waxy and smooth, dewlap light green, ringed in pink and squarish deltoid, auricle large rounded or calcarate, decided purple cast to leaves and midrib)
-

SOLID COLORED CANES

11. Auricle is large rounded or calcarate — **'HC62'** (*Stalks highly variable in color from yellow to purple—often two-toned, sheath lightly hairy and lightly waxy, dewlap light green and double crescent, auricle calcarate and well below dewlap*)
11. Auricle is poorly formed nub or absent: 12
-
12. Stalks yellow to green — **'ULUHUI'** (*Yellow to green stalks, heavy purple flush on exposure, sparse wax bloom, sheaths moderately waxy and sparsely hairy, dewlap yellow and squarish deltoid, auricle poorly formed or transitional*)
12. Stalks green to purple — **'UALA'** (*Green-bronze to purple stalks with sparse wax bloom, sheaths moderately waxy and virtually smooth, dewlap yellow and subcrescent, auricle small rounded and well below dewlap*)
-
13. Auricle located well below dewlap — **'NOT HALĀLI'** (*Light purple to purple stalks, bud furrow absent or shallow, sheath moderately waxy and moderately hairy, dewlap green or dark green and ascending ligulate, auricle nub or transitional*)
13. Auricle located at or just below dewlap: 14
-
14. Primary stalk color is red or purple — **'MOANO'** (*Light red to dark purple stalks with sparse wax bloom, bud furrow very strongly marked, sheaths heavily waxy and coated in hairs, dewlap is dark green to purple and squarish deltoid, auricle calcarate*)
14. Primary stalk color is green or yellow: 15
-
15. Maximum of three rows of eyes: 16
15. Maximum of more than three rows of eyes: 17
-
16. Internodes decidedly barreled — **'PAKĒ'** (*Light yellow to yellow-green stalks with sparse wax bloom, sheaths sparsely waxy and hairy, dewlap light green or green and squarish deltoid, auricle small rounded occurring just below dewlap*)
16. Internodes cylindrical or slightly conical — **'LĀHAINĀ'** (*Light yellow to yellow-green stalks with sparse wax bloom, sheaths moderately waxy and moderately hairy, dewlap yellow to dark green and squarish deltoid, auricle small rounded*)
-
17. Auricle calcarate: 18
17. Auricle rounded: 19
-
18. Dewlap squarish deltoid — **'HONAUNAU #2'** (*Yellow to green stalks, sparse wax bloom, pink flush in the sun, sheaths moderately waxy and sparsely hairy, dewlap light to dark green and squarish deltoid, auricle calcarate*)
18. Dewlap ligulate — **'UALALEHU'** (*Yellow to green stalks with sparse wax bloom, sheaths lightly waxy and heavily hairy, dewlap yellow to dark green and ligulate, auricle calcarate occurring at the dewlap*)
-

BOTANICAL KEY

19. Dewlap squarish deltoid — **'LAHI #7'** (*Yellow to green stalks, pink flush on exposure, bud furrow shallow, sheaths lightly waxy and heavily hairy, dewlap yellow or light green and squarish deltoid, auricle small rounded*)
19. Dewlap ligulate — **'LAHI'** (*Yellow to green stalks with pink flush on exposure, bud furrow deep, sheaths lightly waxy and heavily hairy down center and sides, dewlaps variably colored and ligulate to narrow ligulate, auricle small rounded located at dewlap*)
-
20. Sheaths smooth, auricle rounded — **'H50-7209'** (*Yellow-green to purple stalks, heavy wax bloom, large depressed wax bands, long straight internodes, sheaths smooth, dewlap dark green and deltoid, auricle small rounded*)
20. Sheaths noticeably hairy: 21
-
21. Dewlap always purple — **'BRASH'** (*Olive green to purple stalks, heavy wax bloom, bud furrow absent, sheath waxy and moderately hairy, dewlap dark purple and squarish deltoid, auricle long pointed*)
21. Dewlap not always purple: 22
-
22. Stalks green to purple: 23
22. Stalks yellow to green: 25
-
23. Bud furrow absent or very shallow: 24
23. Bud furrow strongly marked — **'PŌHINA'** (*Green-bronze to purple stalks, moderate to heavy wax bloom, bud furrow deep, sheaths very hairy, dewlap narrow deltoid, auricle small rounded*)
-
24. Dewlap dark green to purple, stalks purple — **'HC52'** (*Light to dark purple stalks, heavy wax bloom, sheaths very hairy, dewlap dark green to purple and squarish deltoid, auricle small pointed, long hairs on edge of leaf*)
24. Dewlap yellow to green, stalks green to light purple — **'H109'** (*Green-bronze to purple stalks, heavy wax bloom, bud furrow absent, sheaths very waxy and hairy, dewlap light to dark green, auricle small pointed*)
-
25. Dewlap subrescent to ligulate — **'POKAPUA'** (*Yellow to green stalks, light to moderate wax bloom, bud furrow deep, sheath very waxy and extremely hairy, auricle calcarate, leaves hairy on surface, midrib, and edge*)
25. Dewlap narrow ligulate — **'WAIMEA'/'WAIMEA #4'** (*Yellow to green stalks, moderate wax bloom, sheaths very hairy, dewlap narrow ligulate, auricle small calcarate*)
-

Varietal Descriptions

Native Hawaiian Varieties

BANDED • DARK COLORED

'AINAKEA

('AINAKEA MAOLI, LEANIHI, PŪKEA)

Status: no known specimens

Background Information: *Ainakea* literally means “white [kea] pith/bagasse [‘aina]” or “white land [‘aina].” According to Fornander, this name refers to a particular episode in Hawaiian mythology: Kū‘ula and Kāne, two powerful *akua*,

practiced their sorcery on the people of Honua‘ula, Maui, and left the bodies of the dead strewn about and exposed. The duo added further insult by snacking on sugarcane grown by the victims to quench their thirst; since this time the cane has been called “Ainakea’, referencing the white bones left bleaching in the sun—the leftover waste (‘aina) from the event. However, *lā‘au lapa‘au* sources indicate that



(above) Laenihi, an alternative name for ‘Ainakea’, refers to razorfish, several nearshore fish species that are often whitish in coloration. Photo by Andrew Green, iNaturalist, CC-BY-NC-3.0.

(left) One story relating to ‘Ainakea’ refers to bones being left baking in the sun. Photo by Christopher T Cooper, Wikimedia, CC-BY-3.0.

VARIETAL DESCRIPTIONS

the name refers to the flesh of the cane, which is said to be the whitest of all Hawaiian canes—a particularly rare trait for a dark-skinned variety. An alternative name, 'Laenihi', generally refers to high-headed labroid fish of the genera *Hemipteronotus* and *Iniistius*. Another name, 'Pūkea', is a quantifying term applied to 'Laenihi' that refers to a whitish coloration and was used to denote a specific species of fish. 'Ainakea' was one of the few canes used in medicinal concoctions by the *kahuna hāhā*, and was important in the treatments for *pā'ao'ao*, *ea*, *hilo*, and *waikī*.

Historical Description: 'Ainakea' is said to be one of the prettiest Hawaiian canes, similar in appearance to "Ōhi'a" when it is young but lightening in color as it grows. It was one of the best-producing kō varieties and was a popular cultivar in home gardens, particularly in dry and lowland areas.

Stalk Color: The stalks are described by Moir as "maroon-red and striped with apple green when young, and changing to purplish red and yellow when mature"; by Fornander as "red with long white stripes"; and by Spencer as "a ribbon cane, green and purple." Alternatively, Kaaiakamanu compares it to 'Manulele', and states that the stalks were "dark reddish as the pōpolo liquid."

Leaf: The sheaths are distinctly variegated with white, the leaves occasionally slightly variegated, and the midribs pale or yellowish white (Moir).

Flesh: Moir reports that a distinguishing characteristic is that the flesh in cross section is segmented into brown and white sections that reflect the banding on the outside of the stalk (the pith being white where the stalk is red), although Kaaiakamanu gives a conflicting description indicating that the flesh is white throughout. The flesh is described as soft and brittle, rich in juice, and good eating due to its sweetness. The rind of the cane is said to be slightly tough.

Growth: Moir states that the growth is erect and of moderate height, and ratoons poorly.

'AKILOLO

Status: no known specimens

Background Information: 'Akilolo' literally means "brain biting" or "brain nibbling." The name typically is associated with *hīnālea 'akilolo*, the bird wrasse fish (*Gomphosus varius*) although a few sources also equate the name to the rainbow wrasse (*Julis pulcherrima*). The colorations of the bird wrasse are drastically different for the male, who is bright blue and green, and the female, who is black and white with a red nose. *Kāhuna* use the bird wrasse as the *pani* (closing medicine) for ceremonies to cure head diseases and the cane is used in the same way. 'Akilolo' also refers to a variety of *kalo*, which may be substituted for the fish or the cane during rituals. One source states that this name is a ceremonial synonym for 'Akoki', although this is contradictory to most, which indicate it is a unique, albeit similar, cane.

Historical Description: 'Akilolo' is virtually identical to 'Akoki', but less vigorous and with smaller leaves. 'Akilolo' is said to be almost identical with 'Pakaweli', except that in 'Pakaweli' the leaves are somewhat variegated and the stripes of the sheath are underlaid with white, giving a pink or red appearance in contrast to the deep purple stripes of 'Akilolo'.

Stalk Color: The stalks are described by Moir as "striped green and deep purplish-red when young, and turning to yellow and deep red on older exposed stalks"; by Artschwager and Brandes as "green and red striped becoming yellow and red striped"; and by Caum as "striped deep purple and yellow." Artschwager and Brandes report a very sparse wax bloom.

Internode: The wax bands are of medium thickness; internodes tend to be cylindrical; growth ring striped and narrow; bud furrow strongly marked; root band is also

The (a) male and (b) female *hīnālea 'akilolo*. The males exhibit greens and purples similar to the stalks of "Akilolo". Photos respectively by Norbert Potensky, reefapp, CC-BY-SA-3.0 and Toby Hudson, Wikimedia, CC-BY-SA-3.0.



striped, cylindrical, and with 2–3 rows of eyes (Artschwager and Brandes).

Bud: The buds are green, somewhat hairy, narrow-ovate with round-pointed tip, occur at the leaf scar, extend above the growth ring, and have medium-broad wings that begin below the middle of the bud (Artschwager and Brandes).

Leaf: The leaves are short, broad and not variegated; sheaths are variegated with purple or dark purple and tend to be smooth (Moir); the primary auricle is small, fringed, and calcarate; and secondary auricle is transitional with a short hair group (Artschwager and Brandes).

Flesh: The flesh is soft and dark brown (Moir) or dark orangish (Caum).

Growth: The general form is said to be like ‘Badila’—growing very erect, reaching medium heights, and having thick stalks under standard conditions (Moir).



“Akoki” has very erect leaves and mostly erect stature.

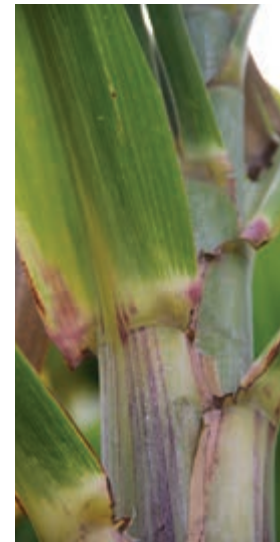
‘AKOKI

Status: held in collections

Background Information: “Akoki” is mentioned in historical documents but never receives more than a passing reference. Little information other than the physical description is recorded, and no meaning or origin could be attached to the name. Two canes are currently held in collections, named “Akoki #22” and “Akoki #24” by the HSPA. No morphological distinctions between the two accessions could be identified, and they are treated as a single variety here.



The “Akoki” stalk color ranges from dark green to yellow with sun exposure, with stripes turning from dark purple to red.



“Akoki” is the only Hawaiian cane that always has purple, rather than pink, variegation on the sheath.



“Akoki” buds are large and triangular, with an extended hair group from behind the tip.



A small, calcarate auricle is usually found just below the dewlap of the “Akoki”.

VARIETAL DESCRIPTIONS

Identifying Characteristics: The stalks are typically bright apple green and purple. The sheaths are one of the few varieties that are consistently variegated with purple rather than pink. The sheaths are moderately to heavily waxy, and smooth or very sparsely pubescent. Leaves are well spaced, erect, and easily shed. “Akoki” may be confused with ‘Pakaweli’, but is easily distinguished by lack of leaf variegation, purple rather than pink stripes on the sheath, and lack of long hairs extending from the bud tip.

Stalk Color: apple green dominantly striped with purple when young, turning first to yellow-green and eventually to orange or bronze striped with reddish purple or dirty maroon; wax bloom very sparse.

Internode: long, very straight, cylindrical or very slightly obconoidal; bud furrow deep and extending entire internode; wax band prominent and slightly constricted; growth ring striped, decidedly greener than stalk, slightly tumescent; root band striped or stripes truncating in the band, typically yellower or lighter than stalk, with 2–3 rows of eyes

Bud: green, large, ovate or narrowly ovate with a pointed tip, inserted at leaf scar and extending above growth ring; moderately pubescent with prominent short hairs along the base and long hairs extending from behind the tip; bud wings olive green, attached near the base and evenly outlining the bud

Leaf: erect, occasionally slightly variegated, medium length, medium width, module 18:1–22:1; sheath light green, often yellowish tinge, variegated with purple or light purple, moderate to heavy wax, smooth or sparsely covered with long, white hairs down center and very lightly along upper side; dewlap yellowish green, rarely tinged pink or purplish, rarely ringed with pink, generally squarish sub-crescent; outer auricle transitional with moderate long

white hairs at insertion point; inner auricle transitional but developed, small nub to moderate calcarate growth, occurs an inch or more below insertion point

Flesh: dark brown with orangish tinge; very dark brown ring near rind; sweet but distinctly sulfuric in taste

Tassel: sparse, broad and short, open, silverish; held well aloft; tassels freely

Growth: top heavy, average, moderately recumbent, stalks tend to fall easily

HAU

(KĀNI’O, LELE, ‘ŌNI’ONI’O)

Status: no known specimens

Background Information: *Hau* in this instance refers not to the common lowland hibiscus tree (*Hibiscus tiliaceus*) but to mother-of-pearl shells. Kaaiakamanu states the quivering juice of this *kō* is reminiscent of the shimmering colors seen in the smooth inner surface of the shells. This cane was commonly used in divination, reading the patterns in the shifting colors. *Kāni’o* and *’ōni’oni’o* literally mean “striped” or “streaked,” usually crosswise rather than lengthwise, or “spotted.” This name is aptly applied to the *’ō’opu nōpili* (*Sicyopterus stimpsoni*) a native stream fish with distinct white stripes down its side. ‘Hau’ is said to be/have been a hardy cane with a dark red stalk with green stripes that boasted a “many-colored pattern” or “streaked with many colors.” A single reference equates this cane to ‘Lele’, contradicting several sources that equate ‘Lele’ to ‘Manulele’. *Lele* refers to an unknown type of fish, and a tall variety of wild banana that was formerly offered to the gods (at *ahu lele*) and also used for love magic, which would “fly” (*lele*) to the gods.



The ‘ō’opu nōpili is also called *kāni’o*, referencing its light stripes. Photo by Gordon Smith, United States Fish and Wildlife Service.



Hau refers to the shimmering colors seen in the mother-of-pearl shells, such as *Pinctada margaritifera* seen here. Photo by Didier Descouens, Wikimedia, CC-BY-SA-4.0.

HONOMALINO #2

Status: held in collections

Background Information: This name refers to an unknown cane collected in the Honomalino area. It is believed to be an indigenous cane variety, which is supported by genetic tests. Schenck et al. (2004) indicate that this cane is genetically identical to 'Hōnaunau #2', but the two cultivars are morphologically very different. One explanation is the two varieties are closely related mutants. However, without clear documentation, error in cane identification cannot be ruled out.

Identifying Characteristics: Stalks are uniquely light purple striped with dark purple, changing to orange-red striped with light purple with high sun exposure. Sheaths have a purple flush that often extends into leaf, ringing the dewlap in light purple or pink and providing a purplish hue to the leaf midribs.

Stalk Color: light reddish purple to purple striped with darker purple; turns to orange-bronze striped with purple with exposure; wax bloom very sparse to light

Internode: conical or slightly barreled; bud furrow deep and long; wax band moderately thick, prominent, often washes away on older stalks; growth ring purple or dark purple, slightly tumescent; root band striped like stalk, darker, slightly constricted, with 3 rows of eyes

Bud: green turning to red, large, ovate; prominently pubescent particularly with long hairs; bud wings purple, broad, inserted well below the center of the bud



'Honomalino #2' has relatively short stalks of moderate thickness.



'Honomalino #2' stalks are uniquely light purple striped with dark purple; banding is occasionally subtle and difficult to notice.



'Honomalino #2' sheaths often flush with a dark purple, with dewlaps ringed in light purple or pink.



On 'Honomalino #2', a very prominent bud furrow extends above the small deltoid buds with broad wings.

VARIETAL DESCRIPTIONS

Leaf: erect, moderate/short length, broad width, module 15:1–19:1, moderately hairy along edges, tend to be crinkled, slight purple tinge, serration small and moderately spaced; upper midrib distinctly pinkish, particularly near base; sheath green flushing to purple, variegated with pink or light purple, moderately to heavily waxy, very sparsely hairy; dewlap yellow or yellow-green, often ringed with pink, squarish subsescent or broad double crescent; outer auricle transitional with a light short hair group just below insertion point; inner auricle medium to large, pointed, can be curving, occurs just below dewlap

Flesh: light brown with an orangish tint to it, becoming whiter near the core, soft, moderately juicy and moderately sweet

Tassel: sparse, open tassel, silverish, broad and short, held shortly aloft

Growth: erect, moderately thick, short stalks



'Keauhou' is a sparse cane but produces tall, broad, erect stalks.

KEAUHOU

Status: held in collections

Background Information: This is a generic name referring to an unknown cane collected in Keauhou on Hawai'i Island. Previously there existed accessions 'Keauhou' #1–9, this cane being 'Keauhou #2'. The other cultivars were identified over time, leaving this variety as the sole unknown cane from the Keauhou collection. This accession was equated to 'Wai'ōhi'a' by HSPA in 1993, but 'Keauhou' does not remotely match the historical descriptions of 'Wai'ōhi'a'. As such, the name 'Keauhou' is retained, and 'Wai'ōhi'a' is treated as a separate variety.

Identifying Characteristics: Stalks yellow-green striped with purple; stripes often not clean and may truncate in the internode or the root band. Thick-lipped leaf scar, deep and long bud furrow, and large deltoid buds. Usually has



The color of 'Keauhou' is typically lighter than the other green and purple banded canes, often being more yellowish.



The 'Keauhou' sheath is very lightly variegated with a light purple, and dewlaps occasionally ringed with color.



The 'Keauhou' has a large deltoid bud with a rounded bottom that extends well beyond the tumescent growth ring.



On 'Keauhou', the well-formed deltoid or calcarate auricle is located moderately below the dewlap.

well-formed deltoid auricle that occurs about an inch below the dewlap. Distinctly colored when young, but older stalks may be confused with 'Pakaweli' or 'Akoki', as all three change to reddish yellow striped with purplish red.

Stalk Color: reddish purple, purple, or muddy purple striped with yellow, light green, or green; wax bloom very sparse to light

Internode: cylindrical or slightly concave-convex, conspicuous leaf scar with thick rim; bud furrow deep and long; wax band moderately wide, prominent; growth ring greenish and striped like stalk; root band same color as stalk, slightly greener or darker, 2–3 rows of eyes

Bud: greenish, deltoid with ovate bottom; moderately to heavily pubescent, long hair group from behind tip; bud wing reddish, broad, inserted near the center of the bud

Leaf: erect, moderate length, moderate/broad width, module 17:1–21:1, rarely slightly variegated with purple, discernible purple tinge, serration is medium sized and closely packed; upper and lower midrib usually with pink tinge; sheath green, variegated with purple stripes, moderately coated in wax, sparsely hairy; dewlap yellow-green, occasionally flushing with purple, ascending crescent or squarish crescent; outer auricle transitional with light

to moderate growth of short hairs; inner auricle small rounded, occurring well below the dewlap

Flesh: light brown

Tassel: large, open, silver, held well aloft

Growth: very erect, relatively thick stalks

LAULOA

Status: held in collections

Background Information: *Lauloa* literally means “long leaf” and is a name applied to other crop varieties such as *kalo* and *'uala*. Traditional accounts indicate that the leaves were long and broad, as expected from the name. The 'Lauloa' variety today matches the historical descriptions with one glaring exception: the leaves are not only small, but they are the smallest of all cultivars examined. Regardless of this discrepancy, this cane is described as 'Lauloa' because it appears this is the same cane that was initially collected by Moir and locally identified.

Identifying Characteristics: Stalks are yellow-green to green striped with light purple to purple. Sheaths are typically not variegated, or only slightly variegated with purple. Leaves are very short, broad, and erect. 'Lauloa' may be confused

VARIETAL DESCRIPTIONS



'Lauloa' has a dense growth, producing many short stalks.

with several other green and purple banded canes, including 'Pakaweli', 'Akoki', and 'Keauhou' but is distinguishable by the lack of variegation on the sheath and very short leaves.

Stalk Color: yellow-green with reddish-brown stripes, turning deep olive striped with dark brownish red when exposed to the sun; wax bloom very sparse to light

Internode: cylindrical or slightly barreled; bud furrow typically deep and long; wax band prominent, slightly constricted, occasionally merging into bloom; growth ring striped like the stalk; root band striped like the stalk, stripes extending through root band, 3–4 rows of eyes

Bud: ovate, rounded, light green, extends to growth ring; lightly coated with short and long hairs, distinct long hair group extending from behind the tip; bud wings pink or purple, broad, inserted near the middle of the bud

Leaf: very erect, short length, medium width, module 14:1–18:1, moderately hairy along edge; sheath light green, lightly coated in wax, very lightly hairy, slightly variegated with purple; dewlap lighter green than the leaf, deltoid; outer auricle transitional; inner auricle calcarate growth

Flesh: light brown

Tassel: not observed

Growth: very erect, short



Healthy 'Lauloa' stalks often have a brilliant apple green color.



The 'Lauloa' sheath is often not variegated so much as partially streaked.



The buds of 'Lauloa' are smaller and rounder than other purple and green canes.



'Mahai'ula' produces many thick, semi-erect stalks.

MAHAI'ULA

Status: held in collections

Background Information: The name literally means “red trevally” (*Pseudocaranx* or *Gnathanodon* spp.), which is said to be a rare giant trevally with a reddish hue to its reflection. The name, however, refers not necessarily to the fish, but to a coastal location on the western coast of Hawai'i Island. Traditional references conflictingly equate this variety with 'Pakaweli', with 'Wai'ōhi'a', or describe it as different than either. It is likely then that this cane, if it is a traditional cultivar, was known by different names on different islands. Unfortunately, no physical descriptions of 'Mahai'ula' were identified, and verification of its authenticity was not possible. This cane, called 'Mahai'ula' today, closely matches the historical descriptions of 'Wai'ōhi'a' and is physically and genetically very similar to "Ie'ie"/'Cavengerie'. Due to the unaligned references, this cane is treated as a unique variety.



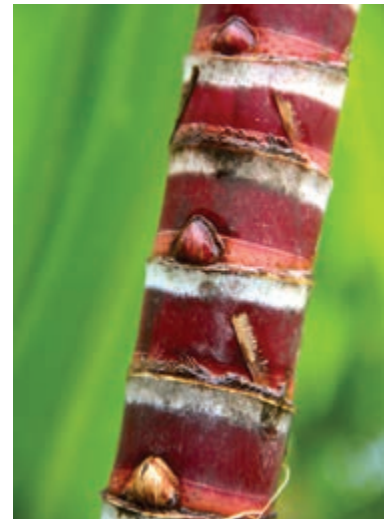
Juvenile *Pseudocaranx*.
Photo by Richard Ling,
Wikimedia, CC-SA-BY-3.0.



'Mahai'ula' stalks are purple, with dark purple striping, which is often sparse.



'Mahai'ula' sheaths are lightly variegated with white, with absent auricles that exhibit large, long tufts of hair.



Mahai'ula' buds are fat, broad, and triangular, occurring within a root band that is typically very lightly colored.

VARIETAL DESCRIPTIONS

Identifying Characteristics: Stalks are purple striped with dark purple. Sheaths are long and variegated. The transitional auricle is fringed with an extended area of long, dense hairs. Nearly identical to “‘Ie’ie” but more robust, with thicker stalks and better ratooning, and darker in color.

Stalk Color: deep red or light purple with dark purple stripes, rarely light red with olive green stripes; wax bloom very sparse

Internode: straight or slightly conical; bud furrow variable, often poorly expressed; wax band medium thickness, prominent; growth ring dark red or dark orange; root band orange, reddish brown, or salmon colored, 2–3 rows of well-spaced eyes

Bud: ovate, light green changing to purple, very sparsely pubescent with short hairs; bud wing reddish and inserted below the center of the bud

Leaf: drooped from the middle, medium/long length, medium width, module 22:1–26:1, rarely sparsely variegated with white or light purple, closely packed, numerous, very sparsely hairy along the edges, sparsely hairy behind the dewlap, serration is moderately sized and closely spaced; upper midrib creamy white or pale yellow; sheath green, variegated with white, moderately to heavily waxy, moderately to heavily hairy down the center, sparsely hairy along upper edges; dewlap green or olive green, often with purple patches, heavily coated with wax, somewhat nondescript shape, distinctly squared, ascending squarish or ascending squarish deltoid; outer auricle transitional with a very dense and long hair group; inner auricle deltoid nub, occurs at the dewlap

Flesh: light brown, very hard, juicy but not exceedingly so, very sweet, sulfuric aftertaste, rind very hard

Tassel: large, open, rosy, held well aloft

Growth: semi-erect, many thick stalks

MĀIKOIKO KAHAKAHA

Status: no known specimens

Background Information: This is a postcontact name that means “striped *Māikoiko*,” applied to this banded mutation of ‘*Māikoiko*’. Because this mutation is said to occur often, it is likely there is an unknown Hawaiian name for this variety. Moir indicates that he noticed and isolated this variety from the HSPA germplasm, rather than collecting it like most other Hawaiian cultivars.

Historical Description: Moir reports this to be buff-brown striped with maroon when young, becoming olive brown



Māikoiko refers to the black surgeonfish, a common reef fish. Photo by Derek Keats, Wikimedia, CC-BY-SA-3.0.

and very deep purple on exposure to the sun. The stalks are of medium size, and the cane is a vigorous stooler and grower. The leaves are light green, the sheaths deep red, and the root band and growth ring only visible when young leaves are stripped. The cane seldom tassels but shows an open purple tassel held well above the cane when it does.

MANULELE

(KĀ’AWE, LELE)

Status: no known specimens

Background Information: *Manulele* translates to “flying bird.” The word *kā’awe* literally means “to tie anything tightly around the neck, to choke, to strangle, hang,” and was a name invoked in the *hana aloha* ceremonies. *Lele* literally means “to fly or jump” and is reported by Pukui to apply to an unknown fish. ‘*Manulele*’ is the most referenced cane in *hana aloha*, a ceremony intended to cause love in a distant person. In this sense, the “flying bird”



Manulele means “flying bird,” which relates to its usage in *hana aloha* (love magic), during which the prayers fly like a bird to the desired person.

carries the prayers to the targeted lover. While a variety is held in collections today as ‘Manulele’ (see ‘Tolo Mauga’), it does not match the historical descriptions.

Historical Description: This is a storied cane with multiple accounts written about its usages, but few historical descriptions are found. Generally, the accounts run contrary to ‘Not Manulele’, the exception being Kaaiakamanu’s.

Stalk Color: Kamakea records that the stalk is “maroon and purple striped”; Moir reports it to be “yellow-brown with red-brown stripes overlaid with green in newly exposed portions, changing to buff-brown with maroon stripes in old stalk with a very fine strip of canary yellow”; Artschwager and Brandes record that it is “reddish-brown with purple stripes”; Hilea Plantation reports it is “purple and brown striped.” Kaaiakamanu’s description in 1917 conflicts with the others, reporting that it is “reddish and has tall greenish stripes.”

Internode: The internodes are conical or concave, have a sparse wax bloom and heavy, but narrow wax bands. The growth rings are striped, narrow, and raised and the root band, 8 mm high, is striped with 3–4 rows of eyes. The

buds are green, 14×12 mm, generally pubescent and ovate with a round pointed tip and olive wings inserted below the middle (Artschwager and Brandes).

Leaf: The leaf sheaths are green with a purplish cast and striped with white, and are long and smooth. The leaves are somewhat variegated and have a decided purple cast (Moir). The dewlap is steeply ascending flaring ligulate, and both auricles are transitional (Artschwager and Brandes).

Flesh: The cane has dark brown pith (Moir).

Growth: Growth is that of ‘Badila’ type, producing large stalks of medium height (Moir).

NOT LAUKONA

Status: held in collections

Background Information: No information is attached to this cane. It is held in multiple collections, either unnamed or under the name ‘Laukona’, but the features do not match the historical descriptions of that name. The features of this cane are consistent with Noble Canes in general, and Hawaiian varieties in particular. While included in the



‘Not Laukona’ cane produces many dense stalks that are thin and semi-erect.

VARIETAL DESCRIPTIONS



'Not Laukona' stalks are often clearly bobbin shaped, with heavy, but occasionally truncated or incomplete, stripes.



The 'Not Laukona' dewlap is lighter than the sheath or leaves, occasionally with some slight pink coloration.



'Not Laukona' buds are small and narrowly deltoid with moderate wings.

Hawaiian section of this book, there is little evidence, for or against, this cane's origin.

Identifying Characteristics: Stalks green striped with light purple. Internodes very bobbin (obconoidal) shaped. Sheaths smooth, lightly waxy, and not variegated. Small deltoid buds. 'Not Laukona' may be confused with other green and purple banded canes, but sheaths are not striped; may be confused with 'Lauloa', but is always lighter in color and has a distinctive internode shape.

Stalk Color: yellow or green striped with light muddy red or purple; wax bloom very sparse

Internode: distinctly concave or bobbin shaped; bud furrow very strongly expressed, deep and extending the length of the internode; wax band medium broad, often inconspicuous; growth ring striped like stalk, slightly yellower or greener; root band light green or green, 2–3 rows of eyes

Bud: green, deltoid; pubescence very sparse; bud wings reddish, thin, inserted near the middle of the bud

Leaf: erect, moderately short; sheath green without purpling or variegation, lightly to moderately waxy, lightly hairy, small split to allow bud growth; dewlap light green, double-crescent deltoid; outer auricle transitional with small tuft of long hairs; inner auricle small rounded, occurring at dewlap

Flesh: light brown with a distinct dark brown ring near the rind

Tassel: not observed

Growth: semi-erect, relatively small stalks, thin, short

‘ŌHI‘A

(‘ĀWEOWEO, MĀ‘OHE‘OHE)

Status: held in collections

Background Information: ‘Ōhi‘a was named for the mountain apple (*Syzygium malaccense*) known as ‘ōhi‘a ‘ai (literally “edible ‘ōhi‘a”). The cane’s deep red and green colors are said to match the growth and flowers of the mountain apple. *Mā‘ohe‘ohe* means “tall, straight, spindly, as trees in a dense forest that reach up for light” and refers to bamboo or being bamboo-like. ‘Āweoweo refers to a red reef fish in Hawai‘i commonly called bigeye (*Priacanthus* spp.) and to a native plant in the Amaranth family (*Chenopodium oahuense*) Although many sugarcanes share names with fish, Fornander tells that this name is that of a famous place: “This cane was discovered during the battle between Kamehameha and Kiwalao at Mokuaweoweo. On account of the great number of people and the many who were dying they were hungry and thirsty; so when Pohina appeared with a bundle of cane Kiwalao inquired,



“Ōhi'a” is a moderately dense and erect cane with very erect leaves.

‘What is the name of the cane?’ Pohina replied, ‘This cane is called the Ohia.’ Kiwalao said, ‘You had better call that cane the Aweoweo.’”

Identifying Characteristics: Stalks are reddish purple striped with olive green. Very strong bud furrow that is deep and extends the length of the stalk. Short and broad leaves with a low leaf module ratio. Leaves occasionally very slightly variegated, with midrib often flushed with pink.

Stalk Color: dark red to dark purple with olive-green stripes, fades to lighter red striped with yellow-green or orange; wax bloom very sparse

Internode: cylindrical or slightly conoidal; bud furrow noticeable, deep, extends length of internode; wax band medium width, slightly depressed; growth ring green,



Pristigaster blochii.
Photo by Albert Kok,
Wikimedia, CC-BY-
SA-3.0.



“Ōhi'a” is often called one of the most beautiful canes, with a fuchsia color striped with a deep green.



“Ōhi'a” sheaths are always variegated with white, and often with pink.



“Ōhi'a” buds are ovate and quickly turn dark red with sun exposure.
Fig. 13.03.

VARIETAL DESCRIPTIONS

orange, or red, tumescent; root band greenish purple, olive green, or orange, obconoidal, 3–4 rows of eyes

Bud: ovate, long, green, turns red on exposure, moderately pubescent with short hairs; bud wings olive, turn red on exposure, broad, fringed, inserted below the middle of the bud

Leaf: erect, medium/short length, broad width, module 15:1–19:1, occasionally very slightly variegated with white or rarely pink, devoid of hairs except sparsely on edges, serration small and well spaced; upper midrib white or pink; sheath yellow-green, nearly always flushed with pink, variegated with pink or white, light to moderate wax coating, sparse hair group down the center, thick margin of dead tissue; dewlap light green or yellow-green, occasionally ringed in pink, ascending ligulate or ascending squarish deltoid; outer auricle transitional with a light tuft of medium-length hairs; inner auricle rounded nub, occurs well below the dewlap

Flesh: very dark brown or dark orange-brown, mildly juicy, mildly sweet, distinct flavors, rind is very hard and tough

Tassel: large, open, rosy, held moderately aloft

Growth: very erect, moderately dense, produces thick stalks of moderate height

PAKAWELI

(PAILOLO, HOU)

Status: held in collections

Background Information: *Pakaweli* is said to refer to a fish, though no information about what fish or why is given. Some sources indicate that this name is synonymous with ‘Mahai’ula’, though there are conflicting accounts on this subject (see ‘Mahai’ula’). *Pailolo* refers to a ceremony in which this variety is used, conducted for the onset of learning because one encouraged or roused (*pai*) the brains (*lolo*). *Hou* refers to various varieties of wrasses (*Thalassoma* spp.) that are colorful shallow-water reef fish. *Hou* is the adult stage of these fish, while another cane name (‘‘Āwela’, synonymous with ‘Pua’ole’) refers to the young stage of the fish.

Thalassoma trilineatum. Photo by Di Isusuki, Wikimedia, CC-BY-SA-3.0.



Like many of the purple and green canes, ‘Pakaweli’ exhibits erect growth and leaves.

Identifying Characteristics: Stalks are bright apple green striped with light purple. Leaves are lightly variegated with white and rarely with bright pink. Greater auricle is often well developed, small pointed or hooking growth that occurs well below the dewlap. ‘Pakaweli’ may be confused with ‘Akoki’, but can be distinguished by the lightly pubescent sheaths compared to the smooth or virtually hairless sheaths of ‘Akoki’, and the sheaths of the former being variegated with pink rather than purple.

Stalk Color: bright green or yellow-green striped with dark rose, red, or light purple, may turn orange or bronze with sun exposure; wax bloom very sparse



'Pakaweli' stalks are often slightly kinked compared to the growth of similar canes.



'Pakaweli' sheaths are consistently variegated with white or bright pink.



The 'Pakaweli' leaf is sparsely variegated with white, but occasionally heavily variegated with pink.

Internode: cylindrical or conoidal; bud furrow variably expressed, can be deep and long; wax band moderately wide, often inconspicuous, fades with age; growth ring bright green or yellow-green, tumescent; root band striped like the stalk, decidedly greener, 3–4 rows of eyes

Bud: green turning to red or purple with exposure, narrow ovate, round pointed tip; moderately hairy with both short and long hairs; wings olive green turning reddish, broad, heavily fringed, inserted near the middle of the bud

Leaf: erect, short length, medium width, module 14:1–18:1, often crinkled at the tips, void of hairs except sparsely along edge, slightly variegated with white or less commonly pink, rarely heavily variegated, serration medium sized and moderately spaced; upper midrib is white or pale yellow hue; sheath light green, often flushed with purple, variegated with white, pink, or both, light to moderate coating of wax, hairs very sparse in narrow strip down center, thick margin of dead tissue; dewlap yellow-green or light green, flaring ligulate; outer auricle transitional with a dense growth of medium-length hairs; inner auricle small to medium pointed growth, occasionally hooking, occurs an inch or more below the dewlap

Flesh: light brown, distinct white core, outward color transition from white to brown, very soft, very juicy, mildly sweet



The 'Pakaweli' bud is narrow, rounded, and moderately hairy, extending just beyond a highly tumescent growth ring.

Tassel: squat, broad, open, very rosy, held well aloft, does not tassel freely

Growth: erect to semi-erect, stalks of moderate size and height

VARIETAL DESCRIPTIONS

WAI'ŌHI'A

Status: no known specimens

Background Information: Although *wai'ōhi'a* literally refers to the juice of the mountain apple (*Syzygium malaccense*) some instead say the cane is named for the coloration of the mountain apple tree. Some Big Island sources indicate that this cane is synonymous to 'Mahai'ula', and HSPA equated this to the name 'Makaiula' (likely a misnomer for 'Mahai'ula'). While a variety is held in collections today as 'Wai'ōhi'a' (see 'Not Wai'ōhi'a'), it does not match the historical descriptions.

Historical Description: The stalks are said to have been deep olive-brown striped with dull red. The sheaths and leaves had no stripes or purple cast. The flesh was dark. The general growth is said to have been erect and compact, being a vigorous grower but with small stalks.

'Wai'ōhi'a' cane references the 'ōhi'a 'ai (mountain apple). Photo by Forest & Kim Starr, biolib.cz, CC-BY-3.0.



WEKE

Status: no known specimens

Background Information: *Weke* literally means “crack or narrow opening; to open a crack, as a door; to separate, loosen, free” and refers to certain red and white goatfish (*Mullidae* spp.) that have large scales and are found in near-shore sand flats. *Weke* fish are a favorite offering to the gods to turn away curses, and the cane was used for the same purpose.

Historical Description: The stalks are bronze-red to light brown striped with red to light purple. The leaf sheaths are hairy and attached to raised nodes, and the buds medium-sized, pointed, and winged. The growth is semi-erect and the stalks small to medium in diameter.



Goatfish commonly have reddish coloration similar to the description of the 'Weke' cane. Photos respectively by Richard Ling, Wikimedia, CC-BY-SA-3.0, and Barry Peters, Wikimedia, CC-BY-SA-3.0.



BANDED • LIGHT COLORED

'APE'APE

Status: no known specimens

Background Information: *'Ape'ape* refers to native plants of the genus *Gunnera*, which are a large-leaved species of flowering plants with large, reddish-brown flowers. *'Ape'ape* have long stalks akin to sugarcane that are green and covered with fine white hairs and bumps that make them appear speckled with white. This cane is sparsely referred to by the early plantations in Hawai'i, which indicate *'Ape'ape* had light green stalks with dark green stripes and was of fair production quality.



The (a) large, light green leaves and (b) the speckled petioles of the *'Ape'ape* from Wailua, Kaua'i.

HALĀLI'I

(AILOLO, MALOLO, MAPULEHU, PAKAIEA, PUAHALA, PŪHALA, UKUHALA, WEHEHALA)

Status: held in collections

Background Information: This cane has more associated names than any other kō variety, indicating its widespread cultivation and importance. Halāli'i is a location on Ni'ihau Island where this sugarcane was famous for growing. As a play on words, the name can suggest "little [*li'i*] *Pandanus* tree [*hala*]." This pun refers to the cane growing in sandy areas of Ni'ihau, where the blowing wind would bury the stalks and leave only the protruding tops visible, reminiscent of a baby hala tree. The sand dunes help retain moisture, allowing the cane to grow in the dry Ni'ihau environment. This image is captured in the saying *Kō 'eli lima a 'o Halāli'i* (the hand-dug cane of Halāli'i)—hinting at digging in the soft sand to harvest the buried stalks. The names *'Ailolo*, *Ukuhala*, and *Wehehala* refer to the use of this cane in ceremonies of the same name.

Fornander provides the name *malolo*, literally meaning "to rest, pause, adjourn, or the low tide," stating the name originated from a religious observance of a woman placing her placenta under a hala tree. *Pakaiea* is synonymous with *lipahapaha*—common green seaweeds called sea lettuce (*Ulva fasciata* and *Monostroma oxyspermum*). These seaweeds have delicate blades that are translucent, much like the green stripes on the stalks that allow the underlying color to show through. *'Pakaiea* is also a *kalo* variety. *Puahala* refers to the brightly colored base of the hala fruits, which are yellow or red color, while *pūhala* refers to the *hala* tree itself, typically the male tree. The male *hala* tree often grows a single erect trunk and blossoms with the *hīmano* flower, which is famed for its sweet scent and use as an aphrodisiac. These are poetic names relying on the pun between *halā* and *hala*.

Identifying Characteristics: The stalk often appears three-colored, with a yellow background that flushes easily to pink and striped with a translucent green. The leaves are consistently, but weakly, variegated with white. The sheaths are heavily variegated with white, heavily or moderately waxy, and show little pubescence concentrated in a narrow strip down the center. This cane is nearly identical to 'HC71' but is distinguishable because 'HC71' has no sheath pubescence and an auricle that occurs well below the dewlap. *'Halāli'i* may be confused with *'Pua'ole* and *'Kalaoa*, but can be distinguished by having slightly stronger leaf variegation and an auricle that occurs at or just below the dewlap.

Stalk Color: yellow or light orange striped with green, flushes dominantly pink or dark pink with exposure, often all three colors are present giving a red-, yellow-, and green-striped appearance to the whole; wax bloom very sparse

Internode: barrel-shaped or obconoidal, slightly shouldered; bud furrow may be deep or shallow but always long; wax band moderately broad; growth ring colored like stalk but distinctly darker; root band thick, darker, striped like stalk with stripes occasionally truncating, 4–5 rows of eyes

Bud: green and purple, narrowly ovate with a rounded bottom, extending above growth ring; moderately pubescent, mainly pubescent at the base, distinct tuft of long hairs extending from behind the tip; bud wings attached slightly below the middle of the bud, rounding off and narrowing near the tip

VARIETAL DESCRIPTIONS

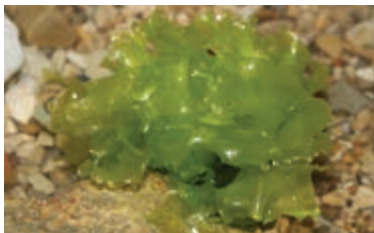
Leaf: erect, medium length, medium/broad width, module 18:1–22:1, consistently but sparsely variegated, typically crinkled surfaces, large serration; upper midrib often has yellowish hue; sheath light green, sometimes a yellowish green, always variegated with white, moderate to heavy wax, little to no hair, concentrated in a narrow strip down the center; dewlap yellow, dark yellow, or rarely greenish, heavily coated with wax, thick and curved, squarish crescent or broad double crescent; outer auricle transitional with a tuft of moderately long brownish hairs; inner auricle often appears to be transitional, but is small calcarate when well developed, occurs just below insertion point

Flesh: white or faint brown, occasionally slightly green, flesh next to the rind is patterned like the outside, soft, juicy, very sweet

Tassel: does not tassel freely

Growth: semi-erect, top-heavy, densely packed leaves, good stooler, exceptional growth in many climates

Ulva spp. Photo by H. Krisp, Wikimedia, CC-BY-SA-3.0.



'Halāli'i' grows semi-erect with densely spaced leaves.



The banding on the 'Halāli'i' stalk varies from dense to sparse, and from translucent to opaque.



The 'Halāli'i' sheaths are always variegated, moderately waxy, and virtually void of hairs.



The 'Halāli'i' buds are narrow ovate with an extended hair group extending from behind the tip.

HAWAIIAN OFFICINARUM

(HAWAII OFFICINARUM, HAWAII ORIGINAL)

Status: held in collections

Background Information: This cane name appears early in the HSPA collection; however, no source data accompanies its collection. The USDA uses the name 'Hawaii Original' for all unnamed canes sent from Hawai'i, but a number always accompanies each variety. It is unclear why this is the only cane in the collections that is referenced as 'Hawaii Officinarum' or 'Hawaii Original' when dozens of other canes were originally held under these names. The features of this cane are in line with Nobel Canes in general and Hawaiian varieties in particular.

Identifying Characteristics: Stalks banded and has noticeable wax bloom. Stalk coloration distinct with bright canary-yellow stripes over red or purplish red. Sheaths are smooth or lightly pubescent and heavily waxy. This cane may be confused with 'Not Uhu' but is distinguished by the lighter coloration, lighter wax bloom, and lack of deltoid auricle.

Stalk Color: bright red or purplish red striped with canary yellow or yellow-green; wax bloom light to moderate

Internode: slightly obconoidal, nodes often slightly kinked; bud furrow deep and long; wax band prominent and broad, often blending into wax bloom; growth ring yellowish or whitish, indistinct from root band; root band yellow or



'Hawaiian Officinarum' is a short-statured cane with large, long, droopy leaves.



The 'Hawaiian Officinarum' stalks are lightly to moderately waxy, and internodes slightly obconoidal or concave.



The 'Hawaiian Officinarum' sheaths are very waxy, and dewlaps a dark olive green.



The 'Hawaiian Officinarum' root band is lightly colored with the yellow stripes often truncating within the root band or simply unnoticeable.

VARIETAL DESCRIPTIONS

pink, banding typically not extending into band, 3–5 rows of eyes

Bud: yellow to light green, deltoid, moderately pubescent around base; bud wing yellowish, medium broad, wings inserted low on bud

Leaf: erect; sheath green, slight variegation with pink or purple near base but not extending through entire sheath, moderate to heavy wax, smooth or very sparse hairs; dewlap greenish, often heavily wax-coated so as to appear gray, ascending deltoid; outer auricle transitional with sparse group of long hairs at point of insertion; inner auricle small rounded or transitional

Flesh: white

Tassel: not observed

Growth: semi-erect, thick stalks, short stature, good stooler

HC71

(HO71)

Status: held in collections

Background Information: 'HC71' was originally collected as an indigenous Hawaiian cane with no ethnographic information attached to it. It was subsequently described by the USDA in 1948 with identical descriptions under the code 'HO71', standing for 'Hawaii Original #71'. This cane is morphologically very similar to the variety 'Halālī'i'.



'HC71' is a very erect cane with short, erect leaves.



The 'HC71' stalk coloration is virtually identical to 'Halālī'i'.



On 'HC71', the heavy sheath variegation rarely extends into the leaves.



The growth ring of 'HC71' is slightly tumescent and always more lightly colored than the stalk.

Identifying Characteristics: The leaves are always variegated with white, but variegation is typically weakly expressed. The sheaths are also variegated with white and heavily or at least moderately waxy; they show little pubescence, which is concentrated in a narrow strip down the center. The stalk often appears three-colored, with the yellow background flushing easily to pink and striped with translucent green. This cane is nearly identical to ‘Halāl’i’ but is distinguished by having less sheath pubescence and an auricle that occurs well below the dewlap.

Stalk Color: yellow or yellow-orange striped with partially transparent green, strong rose flush with exposure; wax bloom very sparse

Internode: cylindrical or slightly shouldered; bud furrow deep and extends the length of the internode; wax band medium broad, prominent; growth ring striped, yellow than stalk; root band striped like stalk, 3–4 rows of eyes

Bud: green to purplish, ovate deltoid, moderate pubescence, prominent hair group extending from behind tip; bud wing reddish or purplish, medium broad, inserted near the center of the bud

Leaf: very erect, moderate/short length, moderate/broad width, module 13:1–16:1, moderately variegated, smooth, medium-sized serration; sheath light green, variegated with white, moderately waxy, virtually void of hairs; dewlap light green to green, strongly ascending ligulate; outer auricle transitional with a very sparse hair group; inner auricle small rounded, occurs well below the dewlap

Flesh: white or faint brown, occasionally slightly green, soft, juicy, very sweet

Tassel: not observed

Growth: very erect; moderate thickness

KALAOA

Status: held in collections

Background Information: This name refers to the Kalaoa area on Hawai‘i Island, where this cane was collected by HSPA. Literally, the name means “the choker,” and refers to a forked stick for catching eels. It is unclear whether this is a traditional name, as canes were often named after their locales, or if this is a name applied by HSPA when they collected the cane. ‘Kalaoa’ appears physically identical to ‘Pua’ole’, but initial genetic work examining the chromosome length suggests they are distinct canes.

Identifying Characteristics: Stalks brightly colored, being yellow striped with green and quickly turning pink.

Internodes slightly barreled, and wax bands constricted. Sheaths very lightly or not pubescent and moderately to heavily waxy. Leaves often variegated with sparse off-white stripes. Growth is stocky and dense with very erect leaves. ‘Kalaoa’ is morphologically identical to ‘Pua’ole’, and may be confused with ‘Halāl’i’ but is distinguished by slightly weaker variegation and auricle occurring an inch or more below the dewlap.

Stalk Color: banded yellow and light green, rapidly changes with sun exposure to pink, dark rose, or rarely purple banded with yellow-green or green; often pink, yellow, and green can be seen on a single internode; wax bloom very sparse



The short stalks of ‘Kalaoa’ support very erect, well-spaced leaves.

VARIETAL DESCRIPTIONS



The green stripes of 'Kalaoa' are typically less translucent than those found on 'Halālii'.



The 'Kalaoa' sheath is heavily waxy and lightly variegated in white or pink.



The 'Kalaoa's' auricle is small calcarate and found an inch or more below the dewlap.



On 'Kalaoa', very sparse leaf variegation can usually be easily found.

Internode: slightly barreled, barreled, or cylindrical; bud furrow variably expressed, often deep and extending the length of the internode; wax band thick, depressed; growth ring striped like stalk but greener, tumescent; root band striped like stalk, stripes occasionally truncating in root band, 3–4 rows of crowded eyes

Bud: green changing rapidly to pink, ovate, round pointed or truncated tip, rather pubescent with long hairs at the tip and short hairs near the base; bud wings red, moderate, inserted near center of bud

Leaf: erect, medium length, broad width, module 15:1–19:1, mildly variegated with white; sheath green or yellow-green, always variegated with white, off-white, or pink, heavily

coated in wax, light to moderate group of hairs down center; dewlap yellow-green or green, occasionally with some pink or purple hues, broad double crescent or ascending squarish deltoid; outer auricle transitional with a light to moderate tuft of medium length hairs; inner auricle poorly formed rounded nub that occurs an inch or more below the dewlap

Flesh: dark brown, very dark brown ring near the rind transitioning to a lighter brown core, soft, very sweet, very juicy; rind moderately hard, tends to bend instead of snap

Tassel: not observed

Growth: very erect, compact, short, moderately thick stalks

LAHI KAHAKAHA 'ĀKALA

Status: no known specimens

Background Information: This cane is the pink-striped mutant of 'Lahi' recorded by early plantations and studies.



A clump of 'Lahi' cane, which the 'Pink-striped Lahi' looks identical to other than the addition of pink banding.

The name is a postcontact name, literally meaning “pink-striped ‘Lahi’.” Assuming that this is an actual mutant of ‘Lahi’, this would have been a naturally occurring cultivar in Hawaiian agriculture, even though no ancient name or description was identified. It is possible that this mutant was not favored by traditional agriculturalists and was not deserving of a unique title.

Historical Description: There are said to be very few morphological differences between this cane and ‘Lahi’ other than the pink striping, which is faint and tends to fade with sun exposure. Indeed, it is said one can have a mutant stalk in a clump of ‘Lahi’ and not notice it. The internodes are long and conical and have dark brown pith. This cane throws long tassels that are open and lightly colored. This mutant is said to be a vigorous grower and heavy stooler of medium size.

LAUKONA

(KĀKONAKONA, MANINI, PŪMAI’A)

Status: held in collections

Background Information: This name references the southerly winter storms that occur in Hawai‘i, and carries the connotation of the word *laukōnā*, which literally means “many dislikes” and is interpreted as “hardhearted, merciless, or implacable.” These two definitions are sometimes applied together to imply “gusty anger,” as captured in the chant lines *Eia mai au o ke Kona, ka makani hele ‘ulu‘ulu* (Here I come, the southerly storm, the wind that blows furiously). Kākonakona, a name shared with a variety of ‘uala, refers to a native grass (*Panicum torridum*) with silky white hairs and small, canelike plumes that only appears after heavy rains in small patches. *Manini*, literally meaning “stingy; to pour, or spill,” refers to the adult stage of the convict *tang* (*Acanthurus triostegus*). This name is applied to other variegated crop varieties, including *kalo*, ‘uala, and *mai’a*. *Pūmai’a* literally means “stalk of the banana.” Forlander (1919a: 582) relates the following story about the naming of this cane: “There were two men, Piikea and Aulii. Piikea asked Aulii: ‘What is the name of this cane?’ Aulii gave his name: ‘The name of this cane is Laukona; its leaf has long white stripes; that is why it is called Laukona.’ Piikea disagreed with him on that name. He said the name was Pumaia. They quarreled a great deal over the name of this cane, and Aulii won.”

Identifying Characteristics: Leaves heavily variegated with white or off-white. Stalks pale yellow or yellow striped



‘Laukona’ produces many stalks that grow densely together.

with green. Sheaths variegated with white and moderately pubescent. Buds round, fat, noticeably pubescent, and with distinct pink or purple wings. ‘Laukona’ may be confused with ‘Not Hinahina’ but is distinguishable by being smaller and less robust, having round buds as opposed to triangular, and having fewer rows of root eyes.

Stalk Color: white or pale pink striped with light green when unexposed, changing to yellow or orange striped with pea green to green with exposure, green stripes somewhat translucent, yellow color gains rose flush with sun; wax bloom very sparse

Internode: slightly conoidal or concave-convex, often kinked growth with slanted leaf scar; bud furrow always present but variably expressed, often small; wax band thick, slightly depressed, often fades on older stalks; growth ring large, bright yellow or orange, rarely green, striped like the

VARIETAL DESCRIPTIONS



The green banding of 'Laukona' may often be irregular, sometimes truncating in the middle of the internode or even occurring in splotches.



On 'Laukona', the heavy sheath variegation often continues into the heavily variegated leaf.



The 'Laukona' root band often widens to accommodate the short, fat buds.

stalk; root band yellow or yellowish, stripes often truncating in root band, 3–4 rows of eyes

Bud: short, ovate, fat, green tinged with pink or purple; moderately covered in short hairs; bud wings green fading to pink or purple, inserted at the middle of the bud

Leaf: erect or droops at tips, medium length, medium/broad width, module 18:1–22:1, heavily variegated with



The heavy leaf variegation of 'Laukona' may take on different degrees of whiteness.

white, numerous, smooth, serration is small and closely packed; sheath variegated with white, moderately waxy, lightly hairy; dewlap light green or green, typically heavily coated with wax, descending deltoid or flaring ligulate; outer auricle transitional with a short, thick hair group; inner auricle calcarate and occasionally fringed

Flesh: brown or orangish, rarely reddish, very juicy, moderately sweet

Tassel: open, long, lightly colored, silverish, held well aloft

Growth: semi-erect to recumbent, many stalks, vigorous grower, top-heavy

MAKA'Ā

Status: no known specimens

Background Information: *Maka'ā* literally means “glowing eye” and figuratively refers to wide, staring eyes and curiosity. The name is applied to the flagtail tilefish (*Malacanthus brevirostris*), which has a distinct, bright blue eye. The fish has faint grayish-green stripes like the stripes described on the cane stalk. 'Maka'ā' is a mutant of 'Uala' and is sometimes referred to as the “olive-striped 'Uala'.”

Historical Description: This cane has faint olive-green stripes over the same yellow or bronze coloration seen on 'Uala', a dark brown pith, large stalks; it is top-heavy



Kō 'Maka'ā is named for (a) the stripes found on the *maka'ā* fish, (b) known for its bright, "staring" eye. Photos by Jean-Lou Justine, Wikimedia, CC-BY-SA-3.0.



and thrives in wetter climates. While there are no known specimens of this variety, "Uala" is still common, and this mutant should be recoverable.

NOT HINAHINA

Status: held in collections

Background Information: This cane is held in many collections today under the name 'Hinahina', but it does not match the historical descriptions.

Identifying Characteristics: Leaves heavily variegated with white or off-white. Stalks pale yellow or yellow striped with green. Sheaths variegated with white and moderately pubescent. Buds round, noticeably pubescent and with distinct pink or purple wings. This cane may be confused with 'Laukona' but is distinguishable by being larger and more robust, having triangular buds as opposed to round and fat, and having more rows of crowded eyes in the root band.

Stalk Color: yellow or yellow-green with light-green or green stripes, flushes rose with sun; wax bloom very sparse

Internode: straight or slightly shouldered, leaf scars very prominent with a significant lip and often at a sharp angle; bud furrow shallow, extending length of the internode; wax band wide, thinly coated; growth ring striped, more yellow or orange than stalk; root band striped like the stalk, 4–6 rows of crowded eyes

Bud: green, ovate, short, extending only to the growth ring, sprouts rapidly, heavy pubescence, short and long hairs; bud wings narrow, purple, inserted midway on the bud

Leaf: long, broad, drooping near tip, heavily variegated with white, sparsely hairy on edge, very small serration, module



The dense growth exhibits many semirecumbent stalks in 'Not Hinahina'.



The 'Not Hinahina' leaf scar often kinks to accommodate the bud, leading to a crooked-looking stalk.

VARIETAL DESCRIPTIONS

(right) The 'Not Hinahina' dewlap is squarish deltoid and lighter green than the leaf once the wax is removed.



(above) The 'Not Hinahina' buds are very round and fat, with narrow purplish wings.

(right) Only 'Laukona' exhibits as much leaf variegation as 'Not Hinahina', shown here.



22:1–25:1; upper midrib sparsely pubescent; sheath green or light green, always variegated with white, lightly waxy, moderately to heavily hairy down the center and the upper sides; dewlap lighter green than the leaves, squarish deltoid; outer auricle transitional with a light tuft of moderate-length hairs; inner auricle medium calcarate

Flesh: light brown, darker orange-brown ring near the rind, soft, very juicy, mildly sweet

Tassel: open, broad, silvery held moderately aloft

Growth: semi-erect to recumbent, tall, lush broad and plentiful leaves, good stooler, produces many closely packed stalks

PILIKO'A

Status: no known specimens

Background Information: This name literally means “coral clinging” and refers to several reef hawkfish (*Paracirrhites fosteri*, *Cirrhitops fasciatus*, and *Amblycirrhites bimaculata*) that are red or light pink. 'Piliko'a' also indicates a stiff, pink seaweed (*Galaxaura lapidescens*) also sometimes called *pākalakala*.

Historical Description: The stalks of this cane are reported by Moir to be yellow-green with pale brown-red stripes when young, changing to deep bronze yellow with dark brown-red stripes. The sheaths and leaves were green and the flesh was colored in segments to match the outer rind.



The blackside hawkfish (*Paracirrhites fosteri*), one of several fish referred to as *piliko'a*, may reflect the red and yellow colorings used to describe the 'Piliko'a' cane. Photo by Bernard Dupont, Wikimedia, CC-BY-SA-3.0.

Galaxaura rugosa. Photo by Derek Keats, Wikimedia, CC-BY-SA-3.0.

PUA'OLE

(ĀWELA, HALE'IWA)

Status: held in collections

Background Information: This is a famous and beloved cane noted for being flowerless, indicated in the name *pua'ole* (lit. “without flower”). The natural indisposition to flowering allows this cane to acquire exceptional growth and sweetness. *Āwela* refers to the young stage of the *hou*, or Christmas wrasse (*Thalassoma fuscum*) The juvenile wrasses are brightly colored, with distinctly different hues and patterns than the adults. This cane is said to grow well in any environment and is especially adapted for cultivation at high altitudes, as the rapidity and size of growth are less affected than other varieties. A cane collected in Hale'iwa and given the name of that locale appears morphologically identical.

Identifying Characteristics: Stalks brightly colored, being yellow striped with green and quickly turning pink. Internodes slightly barreled. Sheaths very lightly or not pubescent and moderately to heavily waxy. Leaves often sparsely



The growth of 'Pua'ole' is erect and compact.

variegated with sparse off-white stripes. Growth is stocky and dense with very erect leaves.

Stalk Color: banded yellow and light green, rapidly changes with sun exposure to pink, dark rose, or rarely purple banded with yellow-green or green, often pink, yellow, and green can be seen on a single internode; wax bloom very sparse

Internode: slightly barreled, barreled, or cylindrical; bud furrow variably expressed, often deep and extending the length of the internode; wax band thick, noticeable, depressed; growth ring striped like stalk but greener, tumescent; root band striped like stalk, stripes occasionally truncating in root band, 3–4 rows of crowded eyes

Bud: green changing rapidly to pink, ovate, round pointed or truncated tip; moderately to pubescent with both long hairs at the tip and short hairs near the base; bud wings red, moderate, inserted near center of bud

Leaf: erect, medium length, broad width, module 15:1–19:1,

mildly variegated with white; sheath green or yellow-green, always variegated with white, off-white, or pink, heavily coated in wax, light to moderate group of hairs down center; dewlap yellow-green or green, occasionally with some pink or purple hues, broad double crescent or ascending squarish deltoid; outer auricle transitional with a light to moderate tuft of medium-length hairs; inner auricle poorly formed rounded nub that occurs an inch or more below the dewlap

Flesh: dark brown, very dark brown ring near the rind transitioning to a lighter brown core, soft, very sweet, very juicy; rind moderately hard, tends to bend instead of snap

Tassel: not observed, cane said never to tassel

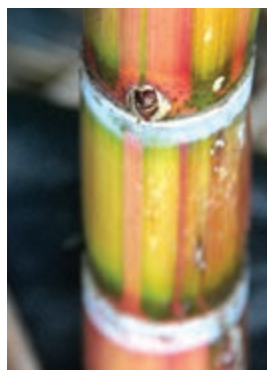
Growth: very erect, compact, short, moderately thick stalks, grows well in all environments, particularly in uplands



With sun exposure, 'Pua'ole' stalks darken to a deep pink and green.



'Pua'ole' dewlaps are poorly developed, at best being a small nub occurring well below the dewlap.



The 'Pua'ole' node is relatively inconspicuous, with the root band and growth ring often being about the same color as or slightly darker than the stalk.



'Pua'ole' leaf variegation is consistently very sparse.

SOLID • DARK COLORED

HONUUA'ULA

(NIHO PUHI, PUHI PAKA O PELE)

Status: held in collections

Background Information: *Honua'ula* literally means “red [*ula*] earth [*honua*],” referring to red soil. This cane is associated with the district on Maui of the same name. The arid region has a deep-reddish soil and swirling winds that

caused red dust clouds to swirl about, reportedly reminiscent of how the leaves of a large patch of ‘Honua’ula’ blowing in the wind caused a reddish glare. Other recorded names for this cane refer to the teeth of the moray eel and allude to the emerging buds, which are distinctly sharp and pointy compared to other varieties. *Niho puhi* literally means “eel teeth,” while *puhi paka o Pele* means “the eel of Pele” and refers to the yellow-edged moray (*Gymnothorax flavimarginatus*) a large, common reef eel.

Identifying Characteristics: Stalks are dark purple. The leaves, often pink or purple, easily identify this cane. The sheaths are wholly dark purple, heavily waxy, and smooth. The buds are long, narrow, and deltoid. ‘Honua’ula’ is a distinct cane not easily confused with any other Hawaiian varieties.

Stalk Color: reddish brown to dark purple, sometimes nearing black; wax bloom very sparse



‘Honua’ula’ produces many long, but skinny, semirecumbent stalks.



‘Honua’ula’ stalks range from light purple to almost black.



'Honua'ula' sheaths are purple and heavily waxy.



The narrow deltoid buds of 'Honua'ula' are very pointed.



'Honua'ula' leaves may express a range of colors, from green with a purplish tint to a deep purple color.

Gymnothorax flavimarginatus. Photo by Bernard DuPont, Wikimedia, CC-BY-SA-3.0.



Internode: long, often skinny, very slightly conoidal or cylindrical; bud furrow always present, shallow and long; wax band moderate sized and prominent; growth ring dark purple like the stalk; root band dark purple like the stalk, conoidal, 2–3 rows of eyes

Bud: narrow deltoid with triangular base; virtually hairless; bud wings create a rounded tip behind the bud

Leaf: very smooth, moderate/long length, moderate width, module 20:1–24:1, purple or purplish or pink, droops from near middle, serration is very small and of little notice; upper midrib tends to be pinkish, bottom midrib retains greenish coloration; sheath is deep purple or has heavy purple cast, very waxy, virtually hairless; dewlap is invariably dark purple, much darker than leaf or sheath, long and thin with rounded tip; outer auricle transitional with a dense clump

of medium-length hairs at insertion point; inner auricle tiny pointed nub that occurs below the insertion point

Flesh: brown or dark brown, very dark brown ring near rind, hard and tough, not so juicy, very sweet, distinct caramel taste and slightly burnt smell; rind tough

Tassel: dense, rosy silver with distinct darker purple points, very long and moderately broad, held well aloft

Growth: erect to semi-erect, skinny and tall growth

MĀIKOIKO

(‘ELE‘ELE, KAUILA, NIKA, HŌNAUNAU #1, HONOMALINO #1)

Status: held in collections

Background Information: *Māikoiko* refers to the black surgeonfish (*Acanthurus nigroris*) that is common in Hawaiian reefs. ‘*Ele‘ele* literally means “black, dark, the black color of Hawaiian eyes.” The name also refers to an edible seaweed (*Enteromorpha prolifera*) that is long, green, and filamentous, and also used for a variety of *kalo* (alternatively known as ‘Hinupua‘a’ or ‘Naioea’), a variety of *mai‘a* prized for its shiny black trunk, and a variety of ‘uala. ‘*Kauila*’ refers to two endemic tree species (*Alphitonia ponderosa* and *Columbrina oppositifolia*), which are noted for their extremely

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dense hardwood that is dark reddish. The name appears to be specific to Kaua'i, where some of the canes that are typically dark purple take on a more reddish-brown hue akin to the *kauila* wood. 'Kauila' also refers to highly *kapu* ceremonies in which this cane is used. *Nika* literally means "black; blackened; blackness," and also refers to a variety of 'uala. Several sources say that this was the most common cane among Hawaiian household gardens and was relished for chewing as it snaps and peels easily and the dark pith is sweet and flavorful.

Identifying Characteristics: Stalks are dark purple, often almost black. Leaf scar is greatly lipped and maintains

a fringe of hairs. Root band has only 2 rows of eyes. This variety may be confused with other dark canes 'Badila', 'Not Halāli'i', and 'Wailua' but is distinguishable from all by the pubescent leaf scar and sparse, large root eyes.

Stalk Color: purple, dark purple, or black, unexposed stalks muddy red; wax bloom very sparse

Internode: short-jointed; concave or cylindrical, leaf scars distinctly lipped and often fringed with long hairs; bud furrow very shallow; wax band moderate thickness, very prominent, olive green if wax is removed; growth ring dark purple, only prominent when unexposed; root band same color as growth ring, 1–2 rows of eyes.

Bud: short, deltoid, purple or red, extending beyond the growth ring, very pubescent, particularly with longer hairs; bud wings purplish, inserted near the center of the bud

Leaf: very erect, medium/long length, moderate width, module 23:1–27:1, plentiful, closely bunched, light green, sparsely hairy on edges and behind



(above) 'Māikoiko' stalks are often almost black.

(left) 'Māikoiko' produces many semi-erect to stalks with long, skinny leaves.



'Māikoiko' sheaths are often flush with purple, and the dewlaps are olive green.



The 'Māikoiko' bud has a very prominent extended hair group, and the leaf scar is often fringed with hairs.



Ulva spp. Photo by Filip Nuyttens, WoRMS, CC-SA-BY-NC-4.0.



Acanthurus nigroris. Photo by Arthur Chapman, CC-BY-NC-3.0.

dewlap, serration small, closely packed, and very sharp; lower midrib sparsely hairy; upper midrib milky white or pale yellow, very slight tinge of red; sheath light green, turns purple with sun, light wax coating, moderately covered with brown hairs; dewlap dark purple, squarish deltoid or flaring ligulate; outer auricle transitional with a light tuft of moderate-length hairs; inner auricle long, pointed, vertical, occurs just below the dewlap, often poorly formed or missing

Flesh: brown, very dark brown ring near the rind

Tassel: open, sparse, very large, lightly colored, purplish, held shortly aloft, seldom tassels

Growth: semi-erect, many stalks, densely packed

MOANO

Status: held in collections

Background Information: This name literally refers to a pale red color and figuratively means “to bloom” but is most often used to denote the red goatfish (*Parupeneus multifasciatus*) whose red color, so a fable told, was caused by the fish eating the *lehua* flowers of the *ōhi'a* tree. Misnomers for this cane include 'Moana' and 'Manoa'. This name is also applied to a variety of *kalo* (“Ula’ula

Moano’) that has a similar red coloration on its stalk. ‘Moano’ is perhaps the most common backyard variety today, and is often the variety found when people say they have the “red” Hawaiian cane.

Identifying Characteristics: Stalks are light purple with a much lighter-colored root band and growth ring. Bud furrow is very strongly marked, deep, and long. Buds are large and deltoid. Dewlap is strongly squarish deltoid. Auricle often well developed, small pointed and occurring at dewlap. ‘Moano’ may be confused with ‘Wailua’, but is distinguished by deep bud furrow, ‘Uhu’, but distinguished by well-formed auricle, and ‘Nānahu’, but distinguished by sheath coloration and variegation.

Stalk Color: light red-purple to deep red, becoming very dark purple with exposure; wax bloom very sparse to light
Internode: cylindrical with slight variations; bud furrow strongly marked, very deep, extending the length of the internode; wax band medium width, prominent, typically constricted; growth ring dark purple, red, or rarely orange; root band purple or orange-green, 2–3 rows of eyes

Bud: pink or purple, narrow ovate or narrow deltoid, very tall, truncated tip; sparsely pubescent with short and long hairs near the tip; bud wings purple, inserted below the middle of the bud

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'Moano' grows semi-erect and produces a moderate amount of stalks.

Leaf: droops near the middle, medium length, very broad width, module 14:1–18:1, green, occasional spotting of yellow or white, moderate long hairs along the edge, almost hairless behind dewlap, serration is moderate sized and closely packed; upper midrib is creamy white or pale yellow; lower midrib often with a thin yellow stripe down the center; sheath greenish yellow, flushed with pink or purple, moderately waxy, very hairy down the center, thick margin of dead tissue; dewlap squarish deltoid or ascending squarish; outer auricle often slight round-pointed growth with a tuft of short hairs; inner auricle medium-pointed deltoid growth

Flesh: dark brown

Tassel: not observed

Growth: very erect to semi-erect, few, moderately thick stalks



Parupeneus multifasciatus. Photo by David Burdick.



The color of 'Moano' ranges from a reddish purple to a deep purple.



The 'Moano' auricle is well formed and calcarate occurring at the dewlap.



The 'Moano' bud is narrow deltoid with a rounded bottom.

NĀNAHU

(AKILOLO 'ULA'ULA)

Status: held in collections

Background Information: *Nānahu* literally means “coal; charcoal” or can mean “to bite.” Some records state that the name should instead be spelled ‘Nanahū’, which literally means “bent out of shape; crooked, as a stick.” ‘Nānahu’ is the red mutant of “‘Akilolo’ and is synonymous with the postcontact name “‘Akilolo ‘Ula‘ula’. This is the primary cane used in making traditional tattoo ink, where *wai kō* is mixed with the charcoal or soot from burnt *kukui*.

Identifying Characteristics: Stalks are purple, but often express very faint sparse banding. Sheaths typically show weak variegation with purple and are smooth. Leaf midrib often pinkish. Greater auricle calcarate with rounded tip occurring at or very near the dewlap. This cultivar may be confused with ‘Moano’, ‘Uhu’, and ‘Wailua’, but sheath is more purple and variegated.

Stalk Color: appears solid dark red or purple, very dark purple with exposure; actually slight banding of olive green underlaid on the red, striping often not easily noticeable; wax bloom very sparse



(above) ‘Nānahu’ stalks occasionally appear to have faint banding with a darker purple.

(left) The growth of ‘Nānahu’ is very erect and relatively compact.

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'Nānahu' sheaths are flush with purple and are weakly variegated with pink or purple stripes.



The 'Nānahu' bud is triangular with a very rounded bottom, and long hairs visible at the tip.



The root band of 'Nānahu' is narrow, and the growth ring tumescent and occasionally green.

Internode: cylindrical or very slightly conoidal; bud furrow deep and long; wax band prominent, medium width; growth ring purple or olive green, tumescent; root band same color as the stalk, rarely olive green, 3 rows of eyes

Bud: deltoid, long, greenish purple, very sparsely pubescent; bud wing red, broad, inserted low on the bud

Leaf: very erect, medium/short length, medium/broad width, module 16:1–20:1, short, noticeably crinkled tips, purplish cast, heavy collection of long hairs along edge, serration is large and moderately spaced; upper midrib is creamy white, yellow or pink; sheath lightly variegated with pink or purple, purple flush with sun exposure, moderately to heavily waxy, virtually void of hairs; dewlap yellow or yellow-green, often ringed with light pink, squarish sub-crescent or ascending ligulate; outer auricle transitional with a moderate tuft of medium-length hairs; inner auricle calcarate with a rounded tip

Flesh: dark brown, very dark brown ring near the rind, moderately juicy, moderately sweet

Tassel: large, open, silver, slightly pink, held shortly aloft

Growth: very erect, moderately short, compact

NOT HALĀLI'I

Status: held in collections

Background Information: There is virtually nothing known about this sugarcane. The general characteristics of the cane are consistent with Hawaiian varieties. Recent genetic analysis also supports this concept. Accession notes associated with this cane include “not quite 'Ie'ie,” “definitely Hawaiian,” and “close to Halāli'i.” This cane appears to have entered the collections through Waimea Valley Arboretum in the late twentieth century from a private donation and spread to other germplasms from there.

Identifying Characteristics: Stalks are typically dark purple. Internodes can be extremely bobbin shaped, being much fatter at the bottom than the top. This cultivar may be confused with other dark canes 'Moano', 'Māikoiko', and 'Wai-lua', but is distinguishable by the strong internode shape.

Stalk Color: muddy red to purple; wax bloom very sparse to light

Internode: strongly bobbin or conical shaped, notable leaf scar with thick lip; bud furrow deep or shallow, extends the length of the internode; wax band medium broad,



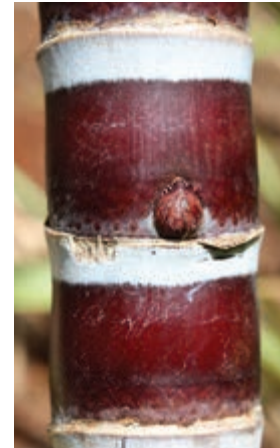
'Not Halāli'i' produces semi-erect stalks with dense, erect leaves.



'Not Halāli'i' internodes are strongly conoidal shaped.



The transitional auricle of 'Not Halāli'i' exhibits considerable hair growth.



The 'Not Halāli'i' bud is ovate, with purple wings that occur only on the upper half.

prominent; growth ring darker than stalk, tumescent; root band same as stalk or slightly darker, 3–4 rows of eyes

Bud: purple, ovate, sparsely pubescent; bud wings purple, inserted at or above the center of the bud

Leaf: erect, average size; sheath green, occasionally flushing with purple, moderately to heavily waxy, sparsely to moderately pubescent; dewlap yellow-green or green, ascending squarish deltoid or ascending double crescent;

sheath green, moderately pubescent down center only; dewlap narrow and ascending; greater auricle is a small nub occurring well below the dewlap with a large tuft of short to medium-length hairs; lesser auricle is transitional with large tuft of short to medium-length hairs

Flesh: white or very light brown

Tassel: not observed

Growth: erect to semi-erect, moderate width and height

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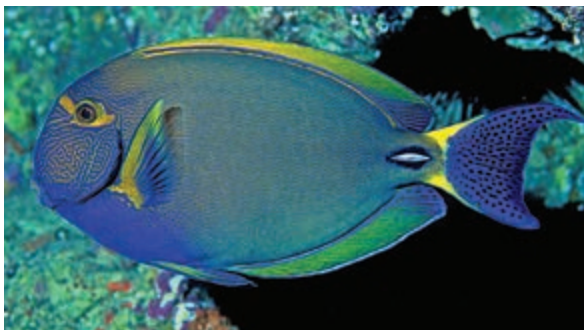
PALANI

(PALANI HOU, PALANI 'ULA)

Status: no known specimens

Background Information: *Palani* literally means “to stink; to smell sour; a detested person” and refers to a deeply colored surgeonfish (*Acanthurus dussumieri*) that is famous for its strong odor. *Palani 'ula* simply means “red 'Palani.” The word *hou* is used in a variety of contexts, and can mean “new, fresh, again, do again, repeat,” “to stab, shove, poke, pierce,” or “perspiration or sweat.” All three names are said to be synonyms by various sources. *Palani* also indicates a variety of *'uala*.

Historical Description: The stalk is described as “purple with a deep olive cast when young, changing to reddish-yellow on exposure to the sun” by Moir and simply “purple” by Spencer. The sheaths are green and tended to split above the bud, and the leaves green. The flesh is very dark and very soft and juicy. The growth tends to be short in stature and erect. It is said to be the “parent” of, meaning it mutates into, the 'Moloka'i 'Akoki'.



The *palani* fish is famous for its strong odor and ornate patterns. Photo by Ian V. Shaw, Reef Life Survey, CC-BY-3.0.

PĀPA'A

(PALE 'ŌPUA, PAPA)

Status: no known specimens

Background Information: *Pāpa'a* typically means “burnt,” but can also mean “cooked crisp,” “a scab,” or “firmly walled; hold fast; tight; turning over and over while falling.” The name is said to refer to the burnt-sugar smell peculiar to the raw juice of this cane. The name also refers to a flatfish species (*Bothus mancus*) often called *pāki'i*, and the black-tip reef shark (*Carcharhinus melanopterus*) Fornander states that the name 'Pāpa'a' was given because of a certain land being called Kōpapaa, the name of which was derived



Pāpa'a may refer to flatfish species that lie in the sand. Photo by Roban Kramer, Wikimedia, CC-BY-SA-3.0.



The black-tip reef shark is sometimes called *pāpa'a* due to its “burnt” fin. Photo by Jan Derk, Wikimedia, public domain.

from *ho'ōpa'apa'a*, meaning “quarreling.” The name 'Papa' is found in old plantation records, but is believed to be a misnomer as no traditional references to the name were found.

Historical Description: In general this cane is said to have been virtually identical to 'Honua'ula', distinguishable only by “the presence of a very small groove under the eye.” However, Kaaiakamanu dissents, saying that this *kō* “has been mistakenly identified by some as the *kō* Honua'ula,” and that *Pāpa'a* “has a dark red color and its leaf is not even like the Honua'ula's.”

Stalk Color: The stalks of this cane were said by all sources to be deep red or purple, and Fornander states that it is of a dark color when young and changes to red when it is ripe.

Leaf: Moir says the leaf sheaths are purple striped and that there is a faint purple cast to the leaves, but most sources say this cane is virtually identical to 'Honua'ula', which has purple sheaths and decidedly purple leaves. While Kaaiakamanu indicates the leaves are not like 'Honua'ula', he does not describe them.

Flesh: The flesh is said to have been light brown, very dark brown, or reddish, to have had a white center core, and to have been very good for chewing. The rind was hard. There is disagreement as to the texture of this cane, as some state that it was prized for chewing because it was soft and juicy, while others say that it was hard and not so sweet, but these may represent the cane grown in different climates.

Growth: In general the growth was said to be slow, ratooning to be scant, and the growth pattern to be like that of ‘Honua‘ula’.

PŌHINA

Status: held in collections

Background Information: *Pōhina* literally means “gray, misty, foggy, dimly visible, hazy . . . to fall prone, topple” and refers to the smoky appearance of the cane. This is a closely related cane to ‘Uahiapele’ according to Moir’s classifications and to genetic analysis. Like ‘Uahiapele’, this cane grows well in the uplands. The name ‘Pohina’ is also applied to a variety of *kalo* and *‘uala*. While this cane is mentioned in Hawaiian sources, it does not appear to be esteemed.

Identifying Characteristics: Stalks are reddish purple and moderately covered in wax. Internodes are slightly barreled with very strongly marked bud furrow and distinctly constricted wax band. ‘Pohina’ may be confused with ‘Uahiapele’, but is always lighter in color, less waxy, less barreled, and smaller in stature.

Stalk Color: dirty brown or dirty red with a tinge of olive green, eventually becoming purple or rarely bronze; wax bloom variable, light to heavy, typically heavy, diminishing from bottom of each internode

Internode: slightly barreled; bud furrow deep and extending length of internode; wax band wide, merging into the



The stalks of ‘Pōhina’ are short and tend to stool, with the buds eagerly sprouting new shoots.

wax bloom, distinctly constricted, olive green when the wax is removed; growth ring purple or dark purple; root band olive green or purple, typically heavily coated in wax, 3–4 rows of eyes

Bud: narrowly ovate or narrowly deltoid, green turning to purple, moderately to heavily pubescent, distinct group of long hairs from behind tip and short hairs at the base; bud wing purplish, medium broad, inserted near or below the center of the bud

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The coloration of the 'Pöhina' stalk is often a lighter purple or even a greenish or orangish purple.



The dewlaps of 'Pöhina' are deltoid shaped, somewhat uncommon among the Hawaiian canes.



The small buds of 'Pöhina' have purple wings starting near the center of the bud.



'Pöhina' sheaths are among the hairiest of the Hawaiian varieties.

Leaf: drooping toward tips, medium length, medium/narrow width, module 24:1–28:1, very sparsely pubescent along the edges, serration medium size and moderate spacing; upper midrib is white, occasionally with a pale yellow hue; sheath light green flushing to purple with exposure, lightly waxy, moderately hairy along the center and upper sides; dewlap dark yellow-green, green, or olive green, crescent deltoid or broad deltoid; outer auricle transitional with a dense group of medium-length hairs; inner auricle is small rounded, occurring at or slightly below the dewlap

Flesh: whitish yellow or very light brown with a dark brown ring near the rind, hard and very sharp, not very juicy, very sweet with a good flavor

Tassel: not observed

Growth: semi-erect and short, heavy stooling, heavy-flowering cane, tends to die back after tasseling

UAHIAPELE

(NA'AUKAKE)

Status: held in collections

Background Information: *Uahiapele* literally means “the smoke of Pele,” referring to the volcano goddess in Hawaiian mythology. This name is often used to refer to dark, smoky-colored plants and animals in Hawai‘i. It refers to a tree endemic to Kaua‘i (*Pelea barbigera*) and also to a

purplish variety of *kalo*. It is said to grow exceptionally well in colder climates, similar to the *kalo*. *Na'aukake* means “sausage; intestine” and refers to the distinctly barrel-shaped internodes of this cane.

Identifying Characteristics: Stalks purple and moderately to heavily waxy. Internodes barrel-shaped. Leaf scar lipped with lingering pubescence. Sheath heavily coated in hairs down center and sides, and pubescence can be found protruding from edges. This cane may be confused with 'Pöhina', but is always darker in color, waxier, more barreled, and larger in stature.

Stalk Color: brownish red, reddish purple, or purple, occasionally olive green, can be auburn with excessive exposure; wax bloom moderate to heavy

Internode: barrel-shaped or prominently shouldered, leaf scars typically inclined and lipped, fringe of long light-brown hairs extending from the leaf scar; bud furrow typically strongly marked; wax band medium width, decisively constricted, often blending into wax bloom; growth ring olive green or purple; root band olive green or greenish purple, sometimes red, 3–4 rows of eyes

Bud: green, ovate, very sparsely pubescent; bud wing purple or brownish, medium broad, inserted below the center of the bud

Leaf: drooping more toward the tips than from the middle; very long length, medium width, module 21:1–25:1, upper



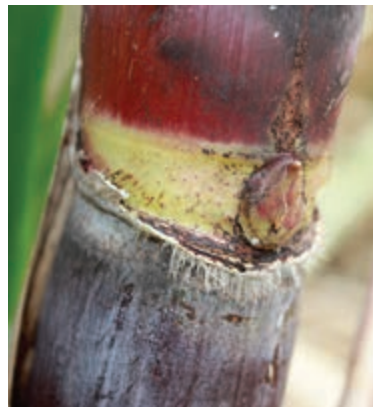
'Uahiapele' grows very densely, producing many semi-erect stalks.



'Uahiapele' stalks are distinctly barrel-shaped and very waxy.



The large squarish dewlap of 'Uahiapele' is a unique feature among the Hawaiian canes.



The 'Uahiapele' leaf scar often retains a fringe of lightly colored hairs.



'Uahiapele' sheaths are very hairy down the center and along the sides, with long, white hairs.

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midrib is white, occasionally with a pale yellow or pale pink hue; sheath green flushed with purple, turns deep purple, moderate wax coating, heavily coated in hairs down the center and the upper sides, sparse hairs can be found extending from the upper edge; dewlap green or olive-green, often with purpling, broad double crescent or squarish deltoid; outer auricle transitional with a dense clump of medium-length hairs; inner auricle small, poorly formed rounded projection occurring an inch or more below the dewlap

Flesh: very white with a greenish ring near the rind, juicy and sweet, bitter flavors

Tassel: open, large, sparse, held well aloft

Growth: semi-erect, densely packed, moderate stalks, short, ratoons very well, heavy stooling, heavy tasseling cane

UHU

Status: held in collections

Background Information: *Uhu* literally means “to bolt; break away.” This cane shares its name with the parrotfishes (*Scarus* spp.), which are large, coral-eating reef fish. The color of this variety is reminiscent of the females of several common parrotfish varieties in Hawaiian reefs, which can be various hues of red, in contrast to the blues and greens exhibited by the males.

Identifying Characteristics: Stalks typically dark red. Internode slightly barreled with shallow but long bud furrow. Upper midrib typically has distinctly yellow base. Sheath is heavily flushed with purple, sparsely hairy, and splits to allow the emergence of bud. Dewlap often ringed with pink and broad squarish deltoid. ‘Uhu’ may be confused with ‘Nānahu’, but is distinguished by the lack of sheath variegation, or with ‘‘Ula’’, but distinguished by a less formed or absent auricle, and less red coloration to the leaves.

Stalk Color: typically a dark dirty red, but can be greenish, bronze, red, purple, or a splotchy combination of colors; wax bloom very sparse to light

Internode: straight or slightly barreled; bud furrow shallow, extending the length of the internode; wax band narrow to medium, mildly prominent, often faint or missing; growth ring purple, occasionally olive green or even yellow; root band greenish, usually being olive green or orange-green, 3–4 rows of eyes

Bud: long, ovate or deltoid, moderately pubescent; bud wing red, medium broad, inserted below the middle of the bud

Leaf: very erect, short length, medium/broad width, module 14:1–18:1, virtually devoid of hairs, serration large and



‘Uhu’ produces very thick, erect stalks.



Scarus spp. Photo by Ken-ichi Ueda, Wikimedia, CC-BY-SA-3.0.



'Uhu' stalks are the lightest shade of red compared to the other Hawaiian canes.



The yellow or light-green dewlaps of 'Uhu' are often ringed in pink.



'Uhu' buds are long and deltoid with a rounded base.

well spaced; upper midrib white with a distinctly yellow base; sheath green with purple flush, moderately waxy, only sparsely hairy and tends to split down the middle to allow the bud growth; dewlap yellow or light green, often ringed with pink, squarish deltoid or broad double crescent; outer auricle transitional with a dense group of medium-length hairs; inner auricle small rounded nub, occurs slightly below the dewlap

Flesh: brown

Tassel: not observed

Growth: erect, broad stalks

'ULA'ULA

(ALA'IHI)

Status: held in collections

Background Information: *'Ula'ula* literally means "red," the most sacred color in Hawaiian culture. The name may apply to blood, red or pale pink *kapa* cloth, and denotes a variety of *kalo* with red veins. While *'ula'ula* is the name for the red snapper (*Etelis marshi*), the cane is instead associated with *'ala'ihi*—different types of squirrelfish (*Holocentrus* spp.), which are spiny red reef fish that congregate in

dark caves in the coral reefs during the day and come out to feed at night. This cane is closely related to 'Pua'ole' and is reported as the red mutant of that variety.

Identifying Characteristics: Stalks are deep red with deep, long bud furrow. Sheaths purple, heavily waxy, and smooth. Leaves with distinctive reddish tinge. Dewlap squarish and ringed heavily with pink. "'Ula'ula' may be confused with 'Uhu', but is distinguishable by well-formed auricle and distinctive reddish tint to leaves.

Stalk Color: red, dark red, or purple; wax bloom very sparse to light

Internode: cylindrical or very slightly conoidal; bud furrow deep, usually extending the length of the internode; wax band narrow to moderate, very prominent; growth ring red or purple; root band olive green or purple, 3–4 rows of eyes

Bud: ovate, green, moderately pubescent; bud wing purple, inserted near the center of the bud

Leaf: very erect, short length, medium/broad width, module 15:1–19:1, decidedly purple cast, virtually devoid of hairs, serration is small and closely packed; upper midrib has a pinkish hue or can be outright pink; lower midrib often has a thin yellow stripe down the center; sheath

VARIETAL DESCRIPTIONS



The reddish tint to the short, erect leaves of ‘Ula’ is best observed from a distance.

green with a purple flush, moderate to heavy wax, virtually devoid of hairs, tends to crack down the middle; dewlap yellow or yellow-green, densely ringed with pink, ascending squarish or flaring squarish; outer auricle transitional with a short light hair group; inner auricle calcarate growth that occurs a bit below the dewlap

Flesh: dark brown or dark orange-brown with a very dark ring near the rind, very juicy, moderately sweet, excellent chewing cane as the flesh is soft

Tassel: open, large, silverish, held well aloft

Growth: very erect, many fat but short stalks



The internodes of ‘Ula’ are a dark red and may be very slightly conoidal.



‘Ula’ sheaths usually flush to purple, and the yellow dewlaps are almost always ringed with pink or purple.



The bud furrow of the ‘Ula’ is very deep and typically extends the length of the internode.



Holocentrus spp. Photo by JT Williams, Wikimedia, CC-BY-2.5.

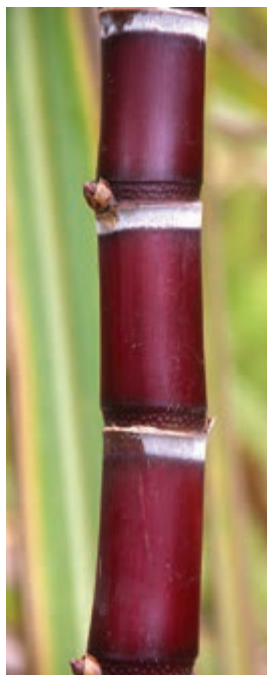
WAILUA HOMESTEAD

Status: held in collections

Background Information: This variety is held at Maui Nui Botanical Gardens and was collected from the Wailua Homesteads on Kaua'i. No additional data accompanied this cultivar. This cane exhibits an unusual characteristic of rarely having a very thin stripe of bright yellow, a characteristic that in Hawai'i has otherwise only been associated with the cane 'Manulele'. This cultivar is a vigorous producer and is common in backyards on Kaua'i.



'Wailua Homestead', commonly found in Wailua, Kaua'i, produces tall, fat stalks of good quality.



'Wailua Homestead' stalks are slightly conoidal and often off-set or kinked.



On 'Wailua Homestead', the fat, ovate buds typically do not extend beyond the growth ring.



'Wailua Homestead' dewlaps are uniquely ascending squarish with a curved lower edge.



A unique feature of 'Wailua Homestead' is the occasional occurrence of a very thin stripe of canary yellow.

Identifying Characteristics: Stalks are light to dark purple, typically bulge just above the node, have a very distinct wax band, and rarely express a very thin stripe of bright yellow. Bud furrow weak and root band slightly greener than stalk. **Stalk Color:** light muddy red to dark purple, burns to orange or auburn with sun exposure, very rarely there is a thin stripe of canary yellow; wax bloom very sparse to light

VARIETAL DESCRIPTIONS

Internode: bobbin shaped or cylindrical; bud furrow weakly expressed; wax band medium to thick, prominent; growth ring same color as stalk but darker, slightly tumescent; root band slightly greener than stalk, 3–4 rows of eyes

Bud: ovate, greenish purple, very sparsely pubescent; bud wing purple, medium broad, inserted near the center of the bud

Leaf: erect; sheath light green, flushing to purple in the sun, moderately waxy, sparsely pubescent; dewlap yellow-green or green, ascending squarish or ascending double crescent; outer auricle transitional; inner auricle small rounded nub slightly below the dewlap

Flesh: light brown

Tassel: not observed

Growth: semi-erect, moderately thick, tall

SOLID ▪ LIGHT COLORED

‘AINAKEA MELEMELE

(‘AINAKEA KE‘OKE‘O)

Status: no known specimens

Background Information: This name literally means “yellow ‘Ainakea,” and this cane is the solid yellow mutant of ‘Ainakea’. This cane is also known as ‘Ainakea Ke‘oke‘o,



The dull yellow-brown stalks of ‘Ainakea Melemele’ reportedly look identical to the stalks of ‘Uala’, shown here.

literally meaning “white ‘Ainakea.” These are postcontact names, and it is likely that an unknown Hawaiian name exists for this variety. Moir reported that the cane is “rather difficult to separate from ‘Uala,” with “no clear-cut differences apparent.” “‘Uala’ is the solid yellow mutant of ‘Akoki’, and it appears that ‘Akoki’ and ‘Ainakea’, two canes very similar in appearance, give rise to two very similar yellow mutants: ‘Uala’ and ‘Ainakea Melemele’. ‘Pilimai’, the yellow mutant of ‘Pakaweli’, also looks nearly identical.

Historical Description: ‘Ainakea Melemele’ is reported by Moir to have had dull, yellow-brown stalks, dark brown pith, and erect stalks of medium height.

HC62

Status: held in collections

Background Information: ‘HC62’ is a highly variable-looking cane that can range from yellow to green to deep red to purple. Due to its high variability, there are difficulties in distinguishing it from other closely related varieties or vice versa. Based on genetics, ‘HC62’ is a Noble Cane variety, and observations indicate it may be a Hawaiian cane variety.

Identifying Characteristics: The stalks are variable in color, often with multiple colors expressed on each stem. This cane does not have any notably distinctive features; it is very average for a Hawaiian cultivar. The bud furrow is deep and long, growth ring green and tumescent, dewlap green and broad double crescent, and greater auricle small calcarate, occurring well below the dewlap.

Stalk Color: highly variable coloration, most often yellow-green with dark rose flush, when unexposed may be



The small, erect leaves of 'HC62' shed easily, making it a clean-looking cane.

yellow, yellow-green, or green–yellow-orange, with sun exposure may be bronze, reddish bronze, or light purple, occasionally stalks may be so flushed as to appear reddish purple, often stalk has multiple colorations; wax bloom very sparse

Internode: cylindrical or slightly conoidal; bud furrow deep, extends the length of the internode; wax band medium width, prominent; growth ring green, yellow-green or orange; root band greenish or orangish; 3–4 rows of eyes

Bud: ovate, purple, pubescence moderate to heavy, noticeably long hair group extending from tip; bud wing narrow, purple, inserted near the center of the bud

Leaf: erect, moderate/short length, moderate/broad width, module 16:1–19:1, smooth, numerous, sparsely hairy along the edges; sheath green, often with a slight yellowing, long, moderately waxy, slightly to moderately hairy down the center; dewlap yellow-green to dark green, occasionally flushing with purple, broad double crescent or subcrescent; outer auricle transitional with a very sparse hair group; inner auricle small calcarate, occurs well below the dewlap

Flesh: lightly colored, large whitish core, occasional darker specks being visible, medium to soft toughness, moderately juicy, mildly sweet, and somewhat bitter in taste

Tassel: not observed

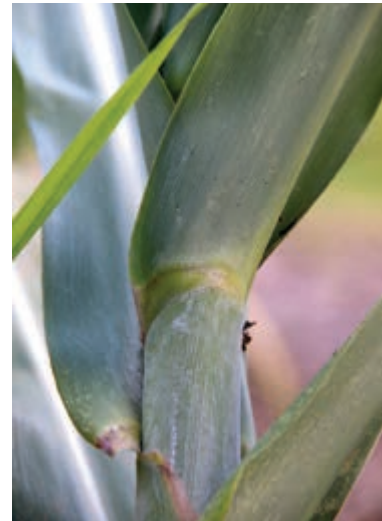
Growth: semi-erect, moderate thickness, stools closely packed



The often multicolored stalks of 'HC62' typically have a bright green growth ring.



On 'HC62', the calcarate auricle occurs slightly below the dewlap.



The 'HC62' dewlap is strongly curved, being double crescent or subcrescent.

VARIETAL DESCRIPTIONS

HINAHINA

Status: no known specimens

Background Information: The name *hinahina* is popular among botanical features in Hawai'i. It is applied to the silversword (*Argyroxiphium sandwicense*), Florida moss (*Tillandsia usneoides*), a native heliotrope (*Heliotropium anomalum*), native geraniums (*Geranium cuneatum* and others), native artemisia (*Artemisia austalis* and others), the Hawaiian fiddle-leaf (*Nama sandwicense*), and the beach vitex (*Vitex rotunda*). The name itself means "gray; gray or white haired," and all these plants share a common feature of appearing gray or silver. Many of them have small white hairs that reflect light, giving the plant a grayish gleam in the sun. There is a cane held in collections today as 'Hinahina' (see 'Not Hinahina'), but this cane does not match the historical descriptions.

Historical Description: This cane is well documented historically as having been a gray-green cane with a white waxy bloom, giving it a look worthy of the 'Hinahina' name.

Stalk Color: The stalks were "grayish-green . . . with a rosy flush" according to Moir, "bronze green overcast with gray" according to Artschwager and Brandes, and "green with a pink flush" according to Caum. All sources agree on a moderate to heavy coating of wax, and it is said to have looked somewhat like 'Lahi'.

Internodes: According to Artschwager and Brandes the growth rings were olive, narrow, and swollen; the bud furrow lacking; the root band ivory and 7–8 mm high, with 3–4 rows of small, crowded eyes.

Bud: The buds were green with olive wings, 16x11 mm, growing at the leaf scar and extending above the growth ring; the buds were broadly ovate with broad wings that were fringed and hairy.



The name *hinahina* is used to denote many plants with gray or silver tones, such as (a) *Heliotropium anomalum* and (b) *Argyroxiphium sandwicense*. Photo by Forest & Kim Starr, Wikimedia, CC-BY-3.0.

Leaf: The leaves are said to have been long and broad. The sheaths had prominent hair groups down the center and on both upper sides of the sheath; the dewlaps were squarish crescent; the greater auricle was small calcarate and basally fringed, and the lesser auricle was transitional.

Flesh: The flesh was dark brown or orange.

Growth: The general growth type was semi-erect, with stalks of average diameter.

HŌNAUNAU #2

Status: held in collections

Background Information: This name refers to an unknown cane that was collected in the Hōnaunau area on Hawai'i Island. It is believed to be an indigenous sugarcane variety, a supposition supported by genetic tests. According to Schenck et al. (2004) this cane is morphologically distinct from, but genetically identical to, 'Honomalino #2'.

Identifying Characteristics: Stalks typically yellow with a bright green root band. Bud furrow absent or very inconspicuous. Sheath moderately hairy in a narrow strip down the center. This cane may be confused with 'Pakē', but is less barreled and less waxy; 'Uluhui', but lacks bud furrow, and sheaths are more pubescent and do not crack; 'Lahi', but sheath pubescence restricted to center of sheath and dewlaps squarish deltoid; and 'Pokapua', but sheaths less pubescent and less waxy.

Stalk Color: typically yellow-green, may be pale yellow to green, takes on a slight rose flush in the sun, flush typically originates just above growth ring; wax bloom very sparse

Internode: concave-convex or slightly conoidal; bud furrow very inconspicuous or missing; wax band medium broad and prominent; growth ring yellow or yellow-green,

typically lighter colored than the stalk; root band green, typically darker than the stalk, 3–4 rows of eyes

Bud: light green, short, fat, ovate; lightly pubescent, no long hairs; bud wings reddish green, medium broad, inserted above the middle of the bud

Leaf: drooped from the middle, medium/long length, medium/broad width, module 20:1–24:1, noticeably crinkled near the tip, sparsely hairy along the edges,

NATIVE HAWAIIAN ▪ SOLID ▪ LIGHT COLORED



The 'Hōnaunau #2' cultivar is very top-heavy, with lots of long, broad leaves.

The 'Hōnaunau #2' root bands are often conspicuous, being bright green against the typically yellow stalk.



moderately hairy behind the dewlap, serration small and well spaced; sheath light green, often yellow or reddish splotches, lightly to moderately waxy, moderate to heavy hairs down sheath center only; dewlap light green, mildly ascending squarish or squarish deltoid; outer auricle transitional with a very sparse hair group at point of insertion; inner auricle rounded calcarate, occurs at or just below dewlap

Flesh: white, very hard and sharp, has little juice, acrid and bitter

Tassel: full, thick, dark silver, held very well aloft, long and narrow

Growth: semi-erect, closely compact, many short stalks, very top heavy with leaves, tendency toward aerial roots



The ascending squarish deltoid dewlap of 'Hōnaunau #2' is lighter than the leaves or stalk.



The short, fat, round buds of 'Hōnaunau #2' have wings that only occur on the upper half.



'Hōnaunau #2' has large leaves that are typically very tightly packed.

VARIETAL DESCRIPTIONS

‘ILI‘ŌPUA

Status: no known specimens

Background Information: No meaning or origin of the ‘Ili‘ōpua could be found. The word may literally mean “cloudy [‘ōpua] rind or skin [‘ili].”

Historical Description: This cane is said to have been virtually identical to ‘Kea’ except that ‘Kea’ is always larger, the sheath splotched with red, and with a long hair group extending from the tip of the bud. Some sources have said that this name is synonymous with ‘Opukea’, which has similar historical comparisons to kō ‘Kea’.

Stalk Color: The stalks are described as “yellow” by Kamakea, “greenish-yellow” by Moir, and “yellowish-green overcast with gray” by Artschwager and Brandes.

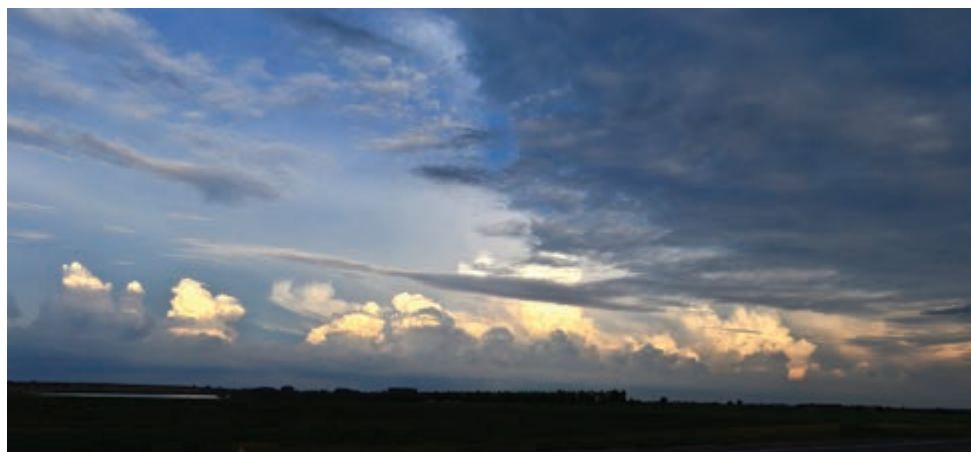
Internodes: USDA reports a sparse wax bloom, prominent wax bands, shallow but long bud furrows, and olive-green growth rings on the shouldered internodes; the root band, also green, contained 3–4 rows of eyes.

Bud: The buds were ovate with a round-pointed tip and extended above the growth ring; the buds were rather hairy, particularly on the posterior side, and had medium-broad wings that were fringed and reddish.

Leaf: The sheaths are said to have been smooth; the dewlap typically ligulate with the bottom edge rising and then leveling off and the top edge undulating; the lesser auricle transitional; and the greater auricle is small calcarate.

Growth: The growth of this cane is said to have been very erect with compact stooling and clinging trash. It is said to have been a heavy stooler with dense green tops and is claimed to be one of the best known and most used canes in old Hawai‘i.

‘Ōpua may refer to billowy clouds on the horizon that are often interpreted as omens. Photo by Kevin Udy, CC-BY-SA.



KEA

Status: no known specimens

Background Information: *Kea* means “white”; the name is said to refer to the white flesh of the cane and also indicates *uhiuhi* (*Caesalpinia kavaiensis*) a native dry-forest tree. ‘Kea’ is the most commonly referenced and sacred cane in the Hawaiian collection and is presumed to be the original cane variety brought to the islands. During the early 1800s, this was the most common variety planted near Hawaiian homes. After Kamehameha conquered Hāna, Maui, the *konohiki* were ordered to plant ‘Kea’ so visiting chiefs from the Big Island could enjoy it. ‘Kea’ is known for its profuse stooling and dense growth, which, along with its very sweet juice, is why the earliest sugar plantations in Hawai‘i preferred this cane over all other Hawaiian varieties. There is a variety held in collections today as ‘Kea’ (see ‘Not Kea’), but it does not match the historical descriptions, and genetic analysis clearly shows that it is a hybrid variety.

Historical Description: *Kea* is said to have been quite distinct from other varieties of kō, with the stalks being greenish white or greenish yellow as opposed to the yellows, reds, and striped canes that dominate the Hawaiian collection.

Stalk Color: The stalks were “straw green tinged carmine when sun exposed,” according to Jenman and Harrison, “medium to small sized stalks of greenish yellow,” according to Moir, “greenish-white” according to Spencer, “pale-white” according to Kimura, “whitish” according to Kaaiakamanu, and “greenish-yellow with sparse bloom” according to Artschwager and Brandes.



The earliest plantations in Hawai'i preferred the 'Kea' variety for production. Photo by unknown photographer, from Hawai'i State Archives Digital Collection.

Internodes: The internodes were of decent length, though the cane itself was not exceedingly tall, and of only average or subaverage girth. According to Artschwager and Brandes, the wax bands were heavy, the bud furrow inconspicuous, and the growth ring olive green; the root bands were green and 7–9 mm high with 4 rows of densely packed eyes.

Bud: The buds were green, 15×10 mm, ovate with a round pointed tip extending above the growth ring; the wings inserted at or below the center of the bud, medium broad and fringed; the sheaths very waxy and nearly hairless.

Leaf: The dewlap was ascending ligulate with medium-length hairs on the outer surface; the lesser auricle transitional, and the greater auricle large calcarate and unfringed. The leaves were dark green, growing densely on the cane. The midrib was pale white. The flesh was very white or yellowish (*lenalena*).

Flesh: It was much esteemed for eating; the pith was brittle, sweet, and juicy when young, but as it aged the outer shell and flesh are said to have become even softer and more palatable.

Growth: Although the growth was thick it is often referred to as a "clean-looking cane," owing largely to its very erect growth pattern leading to a straight, full plant. The growth

is stated to have been quite distinct in appearance, resembling the growth of 'Creole' cane. 'Kea' is said to have been well adapted to withstand both drought and high elevations. This cane is reported to have flowered very abundantly, producing many large, pale flowers.

LAHI

Status: held in collections

Background Information: *Lahi* literally means "thin, frail, or delicate" and refers to the thin rind of the cane. References to this name only occurred on Maui and 'Oahu, where it is also applied to a variety of *mai'a*. In modern collections, this cane seems morphologically identical to "Ualehua", except "Ualalehu" tends to be a slightly larger cane, having longer internodes and sheaths and reaching a greater height. Genetically 'Lahi' and "Ualalehu" are

very closely related but apparently distinct. 'Lahi' is said to be the yellow mutant of 'Laukona', and the two are similar in growth and general clump appearance.

Identifying Characteristics: Stalks are yellow and flush with pink in the sun. Sheaths are very hairy along the center and upper sides. Dewlap narrow ligulate or flaring ligulate. Virtually identical to 'Ualalehu', but always smaller with shorter internodes, sheaths, and overall height. 'Lahi' may be confused with 'Pakē', but is less barreled and less waxy; 'Uluhui', but stalks are skinnier and brighter in coloration; and 'Pokapua', but stalks are less waxy and dewlap much narrower.

Stalk Color: light green or yellow-green, fades to yellow, slight rose flush with sun, burns to auburn or carmine with excessive exposure; wax bloom very sparse to light

Internode: typically slightly conoidal or concave-convex, can be cylindrical; bud furrow very prominent, deep and long; wax band prominent, medium to wide; growth ring dark yellow or orange, rarely green; root band green or greenish, conoidal; 3–4 rows of eyes

Bud: green, ovate; moderately hairy with both short and long hairs; bud wing green or olive green, medium broad, inserted near the middle of the bud



'Lahi' generally grows in a recumbent way, and even upright stalks will express curvature at the base.



The internodes of 'Lahi' are typically concave-convex.



The narrow dewlap of 'Lahi' is usually bright yellow.



The 'Lahi' root band is often green, while the growth ring is brightly colored yellow or orange.

Leaf: drooping from near the middle, medium/long length, medium width, module 24:1–28:1, smooth, numerous, sparsely hairy along edges, moderately hairy behind the dewlap, serration very small and well-spaced but sharp; sheath green, often heavy yellowing or splotches of yellow or red, lightly waxy, moderately to heavily coated with hairs down the center and upper sides; dewlap yellow-green or green, occasionally reddish tinged, narrow ligulate or flaring ligulate; outer auricle transitional with a hair group of moderate density and length; inner auricle rounded deltoid occurring at insertion point

Flesh: light brown, mildly soft, moderately juicy, mildly sweet, somewhat acrid

Tassel: long, open, silverish, held well aloft

Growth: recumbent, well-spaced, stalks numerous and long

MĪKOKOI

(MIKIOI, MĪKOIKOI)

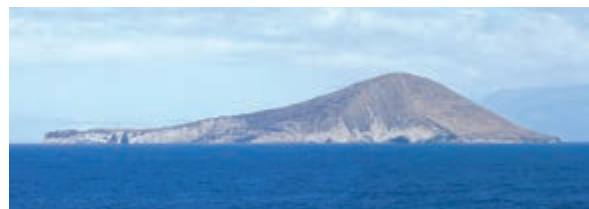
Status: no known specimens

Background Information: *Mīkokoī* and *mīkoikoī* are both a reduplication of *mīkoī*, literally meaning “to nibble, or eat in small portions as salt with poi.” Mikioi means “deft, excellently made” and also refers to a strong gusty wind of Ni‘ihau. The use of this name seems to have been prevalent in the past, and it is unclear whether this is a misnomer or a synonym for ‘Mīkokoī’.

Historical Description: This cane is said to have been a lighter brown mutant of ‘Manulele’.

Stalk Color: Artschwager and Brandes state that the stalk was “olive becoming brownish-red.” The stalks were large and of medium height with conical internodes.

Internodes: The wax bloom was very sparse, wax band narrow but prominent, internodes cylindrical or slightly concave, bud furrow strongly marked, and growth rings red and tumescent. The root band had 3–4 rows of eyes.



One of the recorded names for ‘Mīkokoī’ refers to *ka makani Mīkioī a Lehua*, “the gusty Mīkioī wind of Lehua Island.” Lehua, shown here, is a small island off the coast of Ni‘ihau. Photo by Tkasmai, Wikimedia, CC-BY-SA-3.0.

Bud: The buds were reddish, ovate with a round-pointed tip, and had moderately prominent pubescence. The wings were narrow and inserted below the middle of the bud.

Leaf: The sheath is said to have been sparsely hairy and without a purplish cast, like the leaves. The dewlaps were ligulate, the greater auricle transitional or small calcarate, and the lesser auricle transitional with a very short hair group. The leaves had no purplish cast.

Flesh: The flesh is said to have been dark brown or orange and soft.

OMOMO

Status: no known specimens

Background Information: The word *omomo*, or *omoomo*, has the same meaning as *omo*, which can mean “to suck, to absorb, or to gasp,” and can also refer to a gourd used for a container, cliff diving, or the remora fish (*Remora* spp.). This name is sparsely found in historical records, though with no associated descriptions or information. It was in the HSPA’s very first sugarcane collection at Makiki, making it likely a native name applied to a native cane.



Omomo often refers to the remora fish, which will often cling to larger sea animals such as sharks and whales. Photo by Albert Kok, Wikimedia, CC-BY-SA-3.0.

OPUKEA

Status: no known specimens

Background Information: Fornander related how this cane was named: “This cane was discovered by a famous man of olden times. He hunted for it until he located it at Laupahoehoe, and when he found it he noted it was Opukea cane; later he went and asked Liliha the name of this cane, and he was told the same name which he had already given it.” This cane is often confused with ‘Kea’, and, in some statements, the two canes are said to be synonymous; however, most testimony indicates two different, though similar, varieties.

VARIETAL DESCRIPTIONS

Historical Description: This cane is said to have looked much like ‘Kea’ and ‘Lahi’, though all three are distinct. ‘Opukea’ is said to have been resistant to the eyespot disease, whereas ‘Lahi’ was badly affected and ‘Kea’ partially affected. Other sources say that ‘Opukea’ was “identical to ‘Kea’ but always dwarfed by it.” ‘Opukea’ is a suitable substitute for the same ceremonial applications as ‘Kea’ when that cane is not available.

Stalk Color: The stalks are described as “solid yellow” by Kamakea and Moir and “greenish-yellow” by Artschwager and Brandes. It takes a rosy red flush when exposed to the sun. The internodes are concave and shouldered, being somewhat constricted above each node and enlarging as the next node is approached.

Internode: The wax bloom is sparse, the wax bands broad and distinct, the bud furrow strongly marked, and the growth rings green and flush against the stalk. The root band is green, cylindrical constricted and 7–8 mm with 3–4 rows of eyes.

Bud: The buds are green with olive wings, general pubescence prominent, and ovate with prominent basal appendage and truncated tip. The wings are broad and inserted below the middle of the bud.

Leaf: The sheaths are purplish with a light or moderate hair group down the center. The dewlaps are ascending flaring ligulate. The lesser auricle is transitional with a short hair group, and the greater auricle is small calcarate.

Flesh: The flesh is soft ivory or distinctly white. It is a heavy-stooling cane and not a free tasseler. When it is eaten, the trash is brittle.

Growth: The general growth is like that of ‘Lāhainā’, meaning semirecumbent and top heavy.

PILIMAI

(AKILOLO KE’OKE’O)

Status: no known specimens

Background Information: *Pilimai* literally means “come this way, come hither, or cuddling.” An alternative name is “Akilolo Ke’oke’o”, meaning “white ‘Akilolo.’” Another synonym found in the HSPA original collection is “‘Uala-Kauai’, meaning that when collected on Kaua’i this cane was referred to as “‘Uala’.

Historical Description: The cane was said to be the yellow-green mutant of ‘Akilolo’ and to be very similar to “‘Uala’ in appearance except that the eyes are not opposite but at the “four o’clock position.” Moir reports that this mutation

is one of the most common among Hawaiian canes.

Stalk Color: The stalks were bronze-yellow, yellow-green, or olive-yellow with red sunscald patches.

Internodes: The internodes were cylindrical, the wax bloom sparse, the wax bands prominent, the bud furrow strongly marked, and the growth rings green and tumescent. The root bands, 6–7 mm high, were green with 3–4 rows of crowded eyes.

Bud: The buds, 15×11 mm, were green and ovate with a round-pointed tip. The wings were reddish, medium broad, fringed, and inserted below the middle of the bud.

Leaf: The leaves were long, smooth, and broad. The dewlaps are ascending ligulate, and both auricles were transitional.

Flesh: The flesh was dark brown.

Growth: The stalks were large. Kaaiaimanu states that “the characteristic of this kō is its thickness [in growth] (‘āpupupu).”

POKAPUA

(POKOPUA, PAKAPUA)

Status: held in collections

Background Information: This name literally means “dwarf.” Some sources equate this name to “‘Ili’ōpua’, which is often said to be very similar to ‘Kea’, but always dwarfed by it. However, both ‘Pokapua’ and “‘Ili’ōpua’ were held in the HSPA collection for many years, collected under different names, and noted to be different canes. Furthermore, historical descriptions of “‘Ili’ōpua’ report that it is a relatively smooth cane without many hairs, while ‘Pokapua’ is by far the hairiest of all the canes held in collections today.



The stalks of this yellow-green variety of ‘Pakaweli’ may be identical to, or at least indistinguishable from, ‘Pilimai’.

Identifying Characteristics: Stalks are greenish yellow with a moderately waxy bloom. Buds are small and ovate. Leaves drooped with long, sparse pubescence along upper surface, lower midrib, edges, and base. Sheath extremely pubescent along center and sides. Maybe be confused with 'Pakē', 'Lahi', "Ualalehu", or 'Waimea', but is distinguishable by the extreme pubescence of the sheath and leaves.

Stalk Color: yellow, yellow-green, or green, occasionally overcast with gray; wax bloom light to moderate

Internode: slightly barreled or shouldered; bud furrow moderate to strongly marked, shallow but long; wax band very wide, prominent, slightly depressed; growth ring yellow or light green, lighter than stalk; root band lightly coated with wax, light green or green, 3–5 rows of eyes

Bud: ovate, green to purple, extend to the growth ring; moderately to heavily pubescent, prominent long hair group behind the tip; bud wings green to purple, narrowly broad, inserted at or just below the center of the bud

Leaf: drooped from near middle, medium/long length, broad width, module 19:1–23:1, crinkled, large veins, very pubescent having long hairs along the upper surface, lower midrib, edges, and base; upper midrib yellow near the base; lower midrib is green and occasionally has a thin stripe of white or yellow down the center; sheath light green, often spotted with yellow near the top, heavily coated in wax, extremely hairy down center and sides; dewlap yellow-green or green, variably shaped, always broad and ascending, typically double crescent or flaring ligulate; outer



The long, broad leaves of 'Pokapua' droop heavily.



The 'Pokapua' internodes are slightly barreled.



The dewlap of 'Pokapua' is variably shaped but always broad and distinctly ascending.



The 'Pokapua' growth ring curves to accommodate the bud, which occurs entirely within the root band.



This 'Pokapua' cultivar is the hairiest of all the Hawaiian varieties, with dense growth all along the sheath and hair found along the midrib and surface of the leaves.

VARIETAL DESCRIPTIONS

auricle transitional with a long, dense hair group; inner auricle is calcarate, with growth occurring at the dewlap

Flesh: white, yellowish, or greenish white, very brittle, hard, rather juicy, sweet, sulfuric and acrid flavors; rind hard, tends to snap easily and cleanly

Tassel: dense, short, broad, silver or slightly rosy, held moderately aloft

Growth: semi-erect to recumbent, thick stalks, closely packed

'UALA

('UALA MAOLI)

Status: held in collections

Background Information: *'Uala* refers to the sweet potato (*Ipomea batatas*) and the cane is so named because of the resemblance of its flesh to the flesh of the sweet potato. Spencer reports that another name for this cane is 'Ule'ohu'i, but more often 'Ule'ohu'i is said to be synonymous with a different cane, 'Uluhui'. Moir reports that "'Uala' is sometimes called 'Pilimai' but also states that the two canes are similar but different. "'Uala' is reported to be the yellow mutant of 'Akoki'. "'Uala Maoli, a name found only in plantation records, means "true or native 'Uala," and so it is likely that this name did not exist until there was an introduced "'Uala' to confuse it with. "'Uala' is said to thrive in wetter climates, and with the exception of 'Pua'ole' produces better in Kā'ū than any other cane.



"'Uala' will often have well-spaced leaves.



"'Uala' stalks typically flush with red, occasionally in a splotchy manner.



The moderately waxy sheath of "'Uala' is mostly devoid of hairs.



The "'Uala' bud furrow is very prominent and the growth ring often bright green.

Identifying Characteristics: Stalks are green or greenish yellow, often with a splotchy red flush. Bud furrow is typically shallow but extends the length of the internode. Dewlap is narrow and double crescent. Sheath moderately waxy and virtually smooth. ‘Uala’ may be confused with ‘Hōnaunau #2’ and ‘Lāhainā’, but is distinguished by its lack of sheath pubescence, and with ‘Uluhui’, but distinguishable by having a much narrower dewlap and fewer root eyes.

Stalk Color: yellow to olive green, flushing pink or dark rose in the sun; wax bloom very sparse to light

Internode: cylindrical or slightly conoidal/bobbin; bud furrow shallow, long; wax band narrow, mildly prominent; growth ring typically darker than the stalk, often greenish or olive, tumescent; root band olive green, orangish green, or purplish, 2–3 rows of eyes

Bud: narrow ovate and olive green turning to reddish purple; moderately pubescent, distinct long hairs extending from behind tip; bud wings olive, medium broad, fringed, inserted below the middle of the bud

Leaf: erect, medium length, medium/broad width, module 16:1–20:1, virtually devoid of hairs, most strikingly at the base behind the dewlap where most other Hawaiian canes are moderately hairy, serration is of medium size but well spaced; lower midrib is green but often with yellowing and occasionally a thin yellow stripe down the center; sheath light green with purple splotches, has light to moderate wax and is virtually devoid of hairs; dewlap yellow or light green, occasionally with some purpling, narrow double crescent or ascending ligulate; outer auricle transitional with a light tuft of short hairs; inner auricle poorly developed rounded nub that occurs at least one inch below the dewlap

Flesh: brown with a white core and dark brown ring near the rind, fibers are somewhat brittle, moderately juicy, mildly sweet, mildly watery, mildly acrid, rind is soft and thin

Tassel: open, large, silverish, very slightly rose

Growth: semi-erect, dense, variably sized stalks, of ‘Lāhainā’ type



Splattered ‘ulu, a familiar sight, reveals the yellowish inner flesh for which this kō variety is named.



The fruit and male flower of an ‘ulu tree.

‘ULU

Status: no known specimens

Background Information: ‘Ulu refers to the breadfruit (*Artocarpus altilis*), which was an important food source in regions of Hawai‘i. A variety of *kalo*, ‘Mana Ulu’, exhibits a combination of green and pink on the stalk and yields *poi* that is yellow like baked breadfruit. Only one reference to this cane name was found, which states that it is a pale yellow to pale green cane and that the flesh is yellow like the flesh of the ‘ulu.

ULUHUI

(‘ĀWELA MELEMELE, ULE‘OHĪ‘U)

Status: held in collections

Background Information: This cane is fairly well referenced under the names ‘Uluhui’ and ‘Ule‘ohi‘u’, and equated to ‘Āwela Melemele’ by Moir. No description or definition of the name could be located. This cane was reported by Fornander to be used as a medicinal salve.

Identifying Characteristics: Exposed sections of stalk are yellow-orange or bronze. Leaves are short and broad with low leaf module ratio, sparsely hairy along edges and hairless at leaf base behind dewlap. Dewlap yellow and broad ascending double crescent. This cane appears identical to ‘Ualalehu’ but is always dwarfed by it. ‘Uluhui’ may be confused with ‘Lahi’, but is distinguished by dewlaps being broad and ascending, and auricle being poorly formed and occurring well below the dewlap.

VARIETAL DESCRIPTIONS



'Uluhui' is a very average cane in size and number of stalks.

Stalk Color: unexposed sections can appear green or yellow-green, but rapidly change to yellow-orange; bronze flushing with rose or red with sun exposure; wax bloom very sparse

Internode: cylindrical or slightly conoidal; bud furrow variably expressed, can be deep and long; wax band medium thickness, prominent; growth ring yellow, orange, or green, tumescent; root band green or orange, 2–3 rows of eyes

Bud: ovate or deltoid, reddish yellow or green, moderately pubescent with short hairs, long hair group from behind tip; bud wings green, very broad, inserted below the middle of the bud

Leaf: very erect, medium-short length, broad width, module 13:1–17:1, sparsely hairy along edges and noticeably hairless at base behind the dewlap, serration moderate size and tightly packed; sheath green with distinct yellowing or yellow splotches that turn rose or purple, moderately waxy, very sparsely hairy, tend to crack open to allow bud growth; dewlap yellow or greenish yellow, broad ascending double crescent or ascending squarish deltoid; outer auricle transitional with a moderate hair group; inner auricle poorly formed rounded nub occurring an inch or more below the dewlap

Flesh: dark brown, very dark brown ring near rind, lighter core marked with very dark brown dots, very juicy, mildly sweet

Tassel: not observed

Growth: erect, average, medium-sized stalks, medium height



The coloration of the 'Uluhui' stalk changes very rapidly with exposure to the sun.



The ascending dewlap of 'Uluhui' is usually bright yellow.



'Uluhui' buds are very broad and short, and moderately pubescent.

Heirloom Varieties in Hawai'i

INTRODUCED VARIETIES • BANDED

'AINAKEA HAOLE

Status: no known specimens

Background Information: The term *haole* refers to foreigners, and more specifically to Europeans; it therefore presumably refers to an introduced sugarcane variety. This name is recorded from Hīlea plantation records in the mid-1800s. The only physical description of this cane is from Hīlea plantation, which reports that the stalk is “light and green striped,” and that the flesh is “white.” Later, Moir reports on both the “Ainakea Maoli” and “Ainakea Haole,” distinguishing a native and a foreign “Ainakea”. Given the very early reference by Hīlea plantation, there are only a handful of canes, all of them Noble Canes, that would have been introduced at that time.

HĀPAI

(IRI DAE'ERAH, NEMU DAE'ERAH,
BUDDHA BELLY, EGG CANE)

Status: held in collections

Background Information: Although given a Hawaiian name, this sugarcane is a relatively recent introduction from Papua New Guinea. The Papuan names found use *dae'erah* as the generic name for cane, and *nemu*, which means “belly,” or *iri*, which means “egg.” The Hawaiian name, which means “pregnant,” refers to the incredibly rounded internodes, which are the cane’s most unique feature. This cane has many common names around the world, such as ‘Buddha Belly Cane’ and ‘Egg Cane’, also referring to its swollen internodes. The name ‘Hāpai’ also



'Hāpai' is a semi-erect cane with drooped leaves.

VARIETAL DESCRIPTIONS



The heavily barreled internodes for which the cane is named are a unique feature of 'Hāpai'.



The broad dewlaps of 'Hāpai' are typically purple.



The purple buds of 'Hāpai' are long and pointed.

refers to a variety of banana whose fruit ripens within the stalk.

Identifying Characteristics: Banded stalks are typically green striped with light purple. Internodes are highly barreled and are the cane's most striking and identifiable feature. Buds are long lanceolate. The dewlap is dark purple and flaring ligulate. 'Hāpai' is a distinct cane not easily confused with other varieties.

Stalk Color: yellow to green heavily striped with light pink to dark purple, flushing rose in sun; wax bloom very sparse

Internode: extremely barrel-shaped; bud furrow variable, deep or shallow, never extending the length of the internode; wax band narrow, prominent; growth ring inconspicuous, slightly more yellow than stalk; root band greener than stalk, stripes tending to truncate in band, 4–5 rows of eyes

Bud: purple, long lanceolate, rounded bottom, pointed tip; pubescence moderate; short hairs along upper sides, distinct long tuft of hairs from behind bud; bud wings purple, generally smooth, attach below the center of the bud

Leaf: droop near middle, medium/short length, medium/narrow width, module 20:1–23:1, long white hairs along the edge, moderately pubescent behind dewlap, large serration; lower midrib often with thin white or yellow stripe down the center; sheath whitish green, fading to purple with sun, occasionally slightly variegated with white, pink,

or purple, very waxy, smooth and hairless; dewlap dark purple, broad, flaring ligulate; outer auricle transitional with short hairs; inner auricle small rounded

Flesh: white

Tassel: open, moderately tall and broad, silverish and purplish, held moderately aloft

Growth: short and sparse, semi-erect

'IE'IE

(CAVENGERIE, KAVA RANGRI, LOUZIER)

Status: held in collections

Background Information: 'Ie'ie typically refers to an endemic woody vine (*Freycinetia arborea*) that is a common plant in Hawaiian wet forests with long, narrow leaves akin to those of sugarcane. The vine is most well known for its aerial roots, which were an important material for making 'ie (woven baskets and fishtraps) and mahiole (helmets). "Ie'ie" is a Noble Cane variety that was originally exported from New Caledonia, and likely collected in one of the nearby island groups. The earliest reports of this cane refer to it as 'Kava Rangri'. It was a popular variety used in New World sugarcane plantations, including Hawai'i, Jamaica, and Mauritius. No specific information regarding the introduction to (or possible collection in) Hawai'i of "Ie'ie" was identified.

Identifying Characteristics: Stalks are purple striped with dark purple. Sheaths are long and variegated. The transitional auricle is fringed with an extended area of long, dense hairs. Nearly identical to 'Mahai'ula', but is less robust, with thinner stalks and poorer ratooning, and is always lighter in color.

Stalk Color: reddish purple sparsely striped with very dark purple or deep olive green; can fade to deep orange or auburn striped with olive green; wax bloom very sparse

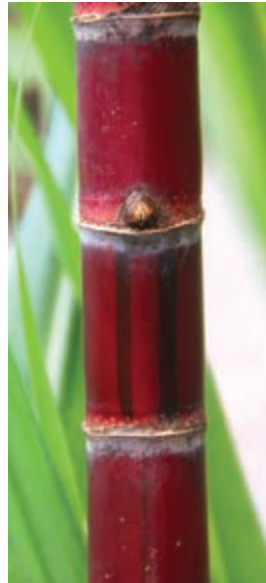
Internode: cylindrical or slightly shouldered; bud furrow deep but short; wax band very wide, prominent; growth ring dark purple like the stalk, tumescent; root band light purple or peach, lighter than stalk, 2–3 rows of eyes

Bud: green, short, deltoid, flat, flaring bottom, rounded tip, lightly pubescent; bud wings red, medium broad, inserted low on the bud

Leaf: drooping from near middle, occasionally slightly variegated, medium/long length, medium width, module 20:1–24:1, upper midrib milky white or pale yellow, serration large and closely packed; sheath heavily variegated



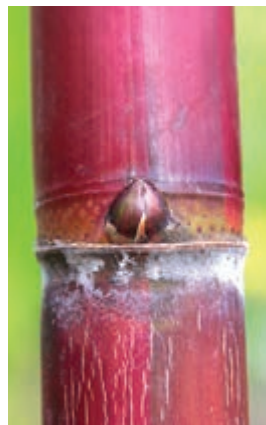
'le'ie' produces many semi-erect to semirecumbent stalks.



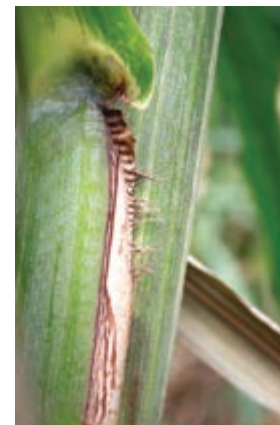
The 'le'ie' stalk may be striped with purple, but often it will be a translucent olive green.



'le'ie' sheaths are waxy and variegated, with a fringe of hairs along the edge below the dewlap.



The 'le'ie' root band is always lighter colored than the stalk.



The leaf sheath of 'le'ie' is fringed with long hairs in place of the absent auricle.

VARIETAL DESCRIPTIONS

with white and pink, thick coating of brownish hair down center, moderately waxy, tends to split along the bud; dew-lap light green, heavily coated with wax so as to appear grayish, deltoid or ascending double crescent shaped, occasionally hairy; outer auricle transitional with many long hairs; inner auricle small pointed growth

Flesh: brown

Tassel: open, very rosy, long drooping projections, held shortly aloft

Growth: semirecumbent, moderate height, moderate stooling, compact clump



The growth of 'Not Uhu' is semi-erect to recumbent.

NOT UHU

Status: held in collections

Background Information: This cane occurs in collections with the name 'Uhu' but does not match the historical descriptions. No accession data about where this cane came from, or how the name 'Uhu' was attached to it. This cane is very similar to the 'Hawaiian Original' variety, and a closer study of the two is needed. Its features indicate that it is a Noble Cane, but its well-developed pointed auricle suggests that it is not a Hawaiian variety.

Identifying Characteristics: This cane is quickly narrowed down by being one of only two varieties with banded stalks that are noticeably waxy. This cane may be mistaken for 'Hawaiian Officinarum' but is always darker in color with denser stalk wax.

Stalk Color: pale yellow-green striped with dull red darkening to dark yellow striped with dirty red or purple; wax bloom moderate to heavy

Internode: slightly barreled; bud furrow shallow or deep, extends the length of the internode; wax band medium broad, often inconspicuous,



'Not Uhu' stalks are the waxiest of any banded cane in Hawai'i.

slightly raised; growth ring striped like the stalk, yellow or greener; root band green or yellow, striped like the stalk with red stripes often truncating within the root band, often more wax coated than stalk, 3–4 rows of eyes



The internodes of 'Not Uhu' are decidedly barreled, with distinct root bands and growth rings.



The 'Not Uhu' auricle is upright and pointed, occurring at the dewlap.

Bud: yellow-green, deltoid, large; pubescence moderate, long hairs extending from behind the tip; bud wing greenish, thick, inserted near the middle of the bud

Leaf: drooped, long, and broad; sheath light green, no variegation or purpling, moderately to heavily waxy, moderately to heavily hairy; dewlap light green to dark green, ascending squarish crescent; outer auricle transitional with a small tuft of medium-length hair; inner auricle medium pointed, occurs at the dewlap

Flesh: very light brown with a distinct dark brown ring near the rind

Tassel: not observed

Growth: semi-erect to recumbent, dense growth pattern, produces large and long stalks

STRIPED BAMBOO

(BIG RIBBON, STRIPED CHERIBON)

Status: held in collections

Background Information: John Balaz donated this Noble Cane to the ethnobotanical collections under the idea that it was a Hawaiian cane. However, this cultivar appears to be identical to an early introduction known as 'Big Ribbon' or 'Striped Cheribon' cane, which was common worldwide as an heirloom variety that produced well in plantation agriculture. After 'Lāhainā' had succumbed to red-rot fungus and declined in production, this was the world's most prevalent Noble Cane grown.

Identifying Characteristics: This is a uniquely colored cane, with deep rose stalks striped with a deeper reddish brown. Root band is much lighter, often green and yellow, with roots eyes colored slightly purple.

Stalk Color: very deep rose striped with muddy purple or buff brown; occasionally yellow striped with semitranslucent olive green; wax bloom very sparse to light

Internode: cylindrical or slightly conoidal; bud furrow strongly marked, deep, may be short or long; wax band medium broad, prominent; growth ring striped like stalk, yellow, tumescent; root band striped like stalk, much lighter, so often yellow and green striped, 3–4 rows of well-spaced eyes, eyes colored muddy purple

Bud: green and purple, large, deltoid, moderate to heavy pubescence, distinct long tuft of hair extending from behind the tip, consistent hair group along the bottom edge; bud wing purple, medium broad, inserted near the center of the bud

VARIETAL DESCRIPTIONS



'Striped Bamboo' produces large, tall stalks with long, drooped leaves.

Leaf: drooped, long length, medium width, module 22:1–26:1, occasionally mildly variegated; sheath green, mildly variegated with white, moderately to heavily waxy, moderately to heavily hairy; dewlap yellow or green, often ringed with pink or purple, deltoid or double-crescent deltoid; outer auricle transitional with a dense tuft of short to moderate-length hairs; inner auricle small rounded, occurring at the dewlap

Flesh: brown

Tassel: not observed

Growth: semi-erect

TOLO MAUGA

(NOT MANULELE)

Status: held in collections

Background Information: This cane is held in most collections as 'Manulele', however it does not match most historical descriptions, which describe it as buff-brown striped with purple. This cane appears morphologically identical to an introduced Sāmoa sugarcane variety 'Tolo Mauga', which literally means "mountain sugarcane."

Identifying Characteristics: Stalk muddy red or purple sparsely striped with greenish yellow. Internodes slightly barreled and smooth with no bud furrow and many corky cracks. Sheaths smooth, heavily waxy. Dewlaps dark colored and ligulate. Distinct cane.



The stalk colors of 'Striped Bamboo' are unique and variable, ranging from yellow striped with green to red striped with purple/black.



'Striped Bamboo' dewlaps are narrow and often ringed with a thin line of purple.



The growth ring of 'Striped Bamboo' is often strongly colored and much lighter than the stalk, with large buds extending well beyond the growth ring.

Stalk Color: muddy red, purple, or dark brown-purple lightly striped with yellow-green, yellow, or bright yellow, yellow stripes rarely taking a rose flush in the sun; wax bloom very light

Internode: slightly barreled; bud furrow inconspicuous, very shallow; wax band wide, prominent; growth ring bright green or yellow; root band dirty green or dirty yellow, 3–4 rows of eyes

Bud: olive green with purple, short, ovate, almost round, pointed tip that barely reaches the growth ring, pubescence light; bud wings olive with purple, moderately broad, inserted near the base of the bud

Leaf: grow toward each other wrapping around the stalk, erect when young, drooping from middle when aged, medium/long length, broad width, module 19:1–23:1, thick veins, very slight purple cast, very small serration, sparse hairs along the edge and base; upper midrib often yellowish; sheath light green, often whitish, heavy wax coating, virtually no hairs; dewlap dark, dark green or purple-green, ligulate; outer auricle transitional with a moderate tuft of short hairs; inner auricle transitional with a moderate tuft of short hairs, rarely small rounded, occurs well below the dewlap

Flesh: brown

Tassel: not observed

Growth: semi-erect, average amount of thick, short stalks



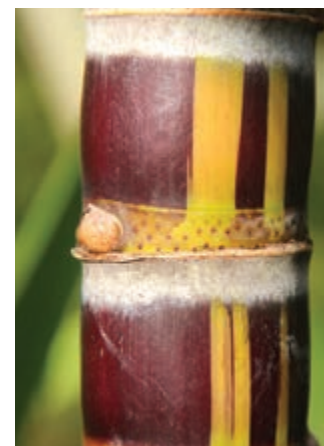
'Tolo Mauga' produces short, fat stalks that are semi-erect.



'Tolo Mauga' stalks are commonly covered in small corky cracks.



The 'Tolo Mauga' ligulate dewlap is dark colored.



The root band and growth ring of 'Tolo Mauga' are both colored much lighter than the stalk.

INTRODUCED VARIETIES • SOLID COLORED

BADILA

Status: held in collections

Background Information: ‘Badila’ is a famous cultivar that was transported around the New World in the early plantation days, grown in sugar plantations in the Caribbean, the Philippines, Mauritius, Brazil, and elsewhere. It appears to have been introduced to Hawai‘i in the early 1920s, very late in terms of the industry and past its peak globally. By this point in time commercial hybrids had become the planting standard. Therefore, although there is recorded production of ‘Badila’ from several plantations, it was never grown significantly in Hawai‘i. As one of the original, highly prized Noble Canes, the ‘Badila’ variety is mentioned here as an ancestor to many modern commercial hybrids, and one of the standards for growth stature.

Identifying Characteristics: Stalks very dark purple. Internodes barrel shaped with prominent leaf scar, inconspicuous bud furrow, and only 2–3 rows of eyes. Growth is short, erect, and compact with long and broad leaves. Sheath heavily coated in wax and sparsely hairy. ‘Badila’ may be confused with ‘Māikoiko’, but can be distinguished by lack of hairs on leaf scar and small pointed auricle.

Stalk Color: dark purple, nearly black; wax bloom very sparse to light

Internode: slightly conoidal or barrel shaped, prominent lip of leaf scar; bud furrow inconspicuous; wax band moderate to wide, very prominent; growth ring same as stalk, inconspicuous; root band purple, typically coated or half coated in wax, 2–3 rows of large eyes



The growth of ‘Badila’ is short and erect with heavily drooped leaves.



'Badila' stalks are very dark purple, almost black.



'Badila' dewlaps are broad squarish deltoid and range from yellow to purple.



The root band of 'Badila' contains only two rows of large root eyes.

Bud: ovate-lanceolate, purple, lightly pubescent; bud wing purple, not broad, inserted at or above middle of bud

Leaf: drooped from middle, long and broad; sheath light green, heavily wax coated, sparsely hairy; dewlap light green to yellow, occasionally purple, wax coated as to appear gray, squarish deltoid; outer auricle transitional with a dense group of moderate-length hairs; inner auricle small pointed occurring at the dewlap

Flesh: white

Tassel: not observed

Growth: compact, semi-erect to erect, short and thick stalks

LĀHAINĀ

(BOURBON, CANA BLANCA, KENIKENI, KINIKINI, OTAHEITE, LOUZIER)

Status: held in collections

Background Information: 'Lāhainā' was the first cane introduced to Hawai'i, brought to Lāhainā harbor by Captain Pardon Edwards on the whaleship *George Washington* from the Marquesas Islands in 1854. A popular local name for this cane became 'Kenikeni', which means "ten cents." Rumor says that was the price the original stalk sold for; however, dimes did not exist in Lāhainā at the time of introduction. Alternative histories indicate the name was 'Kinikini', meaning "numerous, very many," which was applied to the 'Cuban' cane introduced by Edwards at the same time. However, 'Cuban' did not fare well and the local name 'Kinikini' became more widely applied to 'Lāhainā' and then, over time, was bastardized to 'Kenikeni'. With the introduction of 'Lāhainā', the Hawaiian varieties began to be displaced from the plantations. 'Lāhainā' was grown to the almost total exclusion of all other varieties until commercial hybrids emerged. This cultivar was one of the first Pacific Noble Canes to spread around the world, starting when Captain Bligh took it to Jamaica from the Tahitian Islands in 1791, and it became the most prevalent cane in Brazil, Australia, the New World colonies, and even Europe. The fame of this cane is unmatched; it is known by many names around the world, including 'Bourbon', 'Cana Blanca', and 'Louzier'. The first commercial hybrid released in Hawai'i, 'H109', was mothered by 'Lāhainā'. 'Lāhainā' requires considerable moisture to reach its growth potential but can withstand drought as well as most other canes. It thrives at altitudes less than 1,500 ft and grows increasingly rapidly at lower elevations.

Identifying Characteristics: Stalks are green or greenish yellow. Buds are very prominent, large and fat, and densely pubescent with short hairs. Sheaths are heavily waxy and heavily pubescent. The inner auricle is short but very vertical and occurs just below the dewlap. May be confused with other green-yellow canes but can primarily be distinguished by distinctive vertical auricle.

Stalk Color: green, fade to yellow-green or yellow with sun, burn to auburn, greener near nodes; wax bloom very sparse

Internode: typically concave-convex or cylindrical, can be slightly shouldered; bud furrow strongly marked, deep, extends the length of the internode; wax band moderately broad, prominent; growth ring yellower than stalk; root band greener than stalk, 2–4 rows of eyes

VARIETAL DESCRIPTIONS

Bud: large, prominent, round, fat, pubescence heavy; bud wings purplish, inserted near the middle of the bud

Leaf: very erect, medium length, medium width, module 21:1–25:1, virtually hairless, upper midrib occasionally pale yellow; sheath light green, heavily coated with wax, thickly covered with prickly hair; dewlap light green or darker,

squarish deltoid; outer auricle transitional with a moderate tuft of long hairs; inner auricle short, round, vertical, occurs just below the dewlap

Flesh: soft and juicy, white, rind moderately hard

Tassel: not observed

Growth: semirecumbent, very large, heavy tops



'Lāhainā' produces many semirecumbent stalks with long, dense leaves.



'Lāhainā' stalks are clean, shiny and dull yellow with bright green root bands.

The narrow and upright auricle of 'Lāhainā' indicates that this is not a Hawaiian cultivar.



'Lāhainā' sheaths are heavily coated in wax and hairs.

LEHU

(HAIRY BAMBOO)

Status: held in collections

Background Information: The only historical references to the name ‘Lehu’ are in regard to an indigenous Noble Cane introduced from Papua New Guinea. This cane gets its more common name, ‘Hairy Bamboo’, from a unique and distinct characteristic—the entire stalk is covered with short, soft, silver hairs. The Hawaiian name applied to this cane, ‘Lehu’, literally means “ashes; ash-colored” and comes from the appearance of this cane, which, from a distance, can appear grayish and dead due to the reflection of light

caused by the hairs. A record of this variety’s introduction to Hawai‘i was not identified. It is noted as not being exceptionally sweet or good for eating, but it is a vigorous grower and most likely appreciated for its unique appearance.

Identifying Characteristics: This cane is easily identifiable by the unique characteristic of having short, soft hairs covering the internodes of the stalks. It is a distinct cane, not easily mistaken.

Stalk Color: yellow-green, olive green, or gray-brown, often darker blotches of gray, rose tinge in sun; covered in short hairs that give the cane an overall gray appearance; wax bloom light to moderate



(above) ‘Lehu’ vigorously produces many semi-recumbent to recumbent stalks.

(left) The entire ‘Lehu’ stalk is covered in short, soft hairs.

VARIETAL DESCRIPTIONS



'Lehu' leaves are closely spaced, with a pointed upright auricle and purple dewlap.



The stalk hairs are exceptionally prevalent on the 'Lehu' leaf scars.

Internode: slightly barrel shaped or shouldered; long fringe of hairs at leaf scar; bud furrow inconspicuous; wax band wide, prominent; growth ring bright green or rarely yellow, prominent but narrow; root band greener than stalk, often olive, 2–3 rows of eyes

Bud: olive, ovate or broad deltoid, pointed tip, pubescence very sparse; bud wings red, thin, inserted below the middle of the bud

Leaf: droop from toward the middle, medium/long length, medium/narrow width, module 27:1–31:1, smooth, serration very small; sheath densely covered in hairs; sheath green to yellow-green, moderate to heavy wax; dense hairs down center and upper sides; dewlap dark olive green or purple-green, often partially or entirely covered in wax, squarish deltoid; outer auricle transitional with a heavy vesture of long hairs; inner auricle small rounded, occurs just below the dewlap

Flesh: green-white

Tassel: not observed

Growth: recumbent, many well-spaced stalks

'OLIANA

('OLEANA)

Status: no known specimens

Background Information: "Oliana", or "Oleana", refers to "Oriental," as well as to an introduced ornamental shrub (*Nerium oleander*). The flowers vary from white to bright

pink. The small, hairy seeds look like cane seeds and are the color of the dark brown hairs found along the stalk.

Historical Description: The stalks were said to be a pale yellow to pale greenish and similar to the 'Lāhainā' cane in both growth and color. The sheath was entirely covered with long red-brown hairs. The flesh is said to be very dark brown and very hard. In general, this cane was not esteemed by any account.



'Oliana also refers to an introduced shrub with (a) delicate white or pink flowers and (b) brown, hairy seeds. Photos respectively by Shlomi Fish and Giovani Bufalo.

PAKĒ

Status: held in collections

Background Information: This name means "brittle or weak" and can also refer to plain, undyed *kapa* cloth. The name may refer to the fact that the stalks of this cane have a thin rind that snaps easily and cleanly. One source stated that the name should be 'Pākē', referring to China or Chinese, because the cane came from Southeast Asia. No historical references to this cane name were located, but its characteristics are consistent with a Noble Cane variety. Personal communication indicates the late introduction of this cane. The cane commonly gives rise to a yellow-and-green-striped mutant.

Identifying Characteristics: The stalks are often bright yellow, mildly barreled, with a light but noticeable wax bloom. The root band only supports 2–3 rows of eyes. The dewlap is narrow and squarish. 'Pākē' may be confused with 'Lahi' or 'Pokapua' but can be distinguished by the sparse eyes in the root band and squarish dewlap.



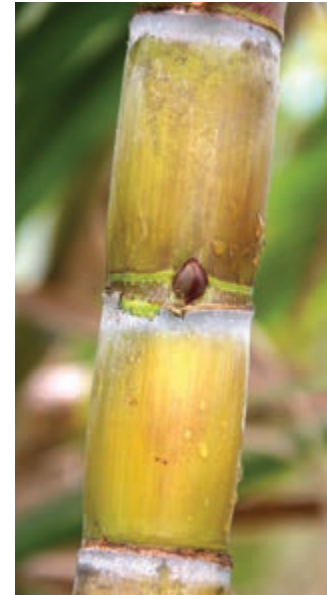
'Pakē' grows dense, producing short but fat semirecumbent stalks.



'Pakē' stalks often express a light, but noticeable wax bloom.



On 'Pakē', the narrow dewlap is typically green with a thick wax coating.



The growth ring and root eyes of 'Pakē' may be brightly colored.

VARIETAL DESCRIPTIONS



Fig. 11.18. 'Pakē' has very white flesh and makes a clean juice.

Stalk Color: yellow or yellow-green, rarely green; wax bloom very sparse to moderate

Internode: barreled; bud furrow shallow, extends the length of the internode; wax band moderate, depressed; growth ring green or orange; root band greenish, 2–3 rows of eyes

Bud: green, ovate, pubescent, moderately covered with short hairs; bud wing olive green, very narrow, inserted near the center of bud

Leaf: erect or drooped near the tips, virtually devoid of hairs, serration small and moderately spaced; sheath light green, moderately covered with wax, sparsely hairy down the center; dewlap yellow-green or green, narrow ligulate; outer auricle transitional with a moderate group of long hairs; inner auricle rounded nub, occurs just below dewlap

Flesh: white

Tassel: not observed

Growth: semi-erect to recumbent, closely compact

YELLOW CALEDONIA

(WHITE TANNA)

Status: held in collections

Background Information: 'Yellow Caledonia' was a popular cane in the early plantation days around the world, when



The heavily drooped leaves and semirecumbent growth of 'Yellow Caledonia' forms large clumps.



'Yellow Caledonia' stalks may be yellow, but more often have notes of green and brown.



'Yellow Caledonia' sheath is moderately to heavily waxy with a purple dewlap.



The root eyes of 'Yellow Caledonia' are strongly colored and are a unique feature to identify this variety.



'Yellow Caledonia' flesh is white with clear green tones.

it was predominantly known as 'White Tanna'. Assumed to have been collected in New Caledonia, this cane was prized for its good production in various climates. In the late 1800s and early 1900s 'Yellow Caledonia' represented more than half of all the sugar planted in Hawai'i, before being displaced by hybrid varieties.

Identifying Characteristics: The stalks are greenish yellow and often slightly barreled. The most prominent feature of this cane is often the root eyes, which are dark in coloration compared to the lightly colored root band. The dewlaps are purple and squarish deltoid. This cultivar may be confused with other yellow canes, but the root eyes make it easy to distinguish.

Stalk Color: yellow-green fading to a reddish brown, unexposed stalks are usually yellow, but darken rapidly when exposed; wax bloom very sparse to light

Internode: cylindrical or slightly barreled; bud furrow typically weakly expressed but can be deep and long; wax band

broad, very prominent, slightly depressed; growth ring usually bright green but can be yellowish or orange, very prominent, slightly tumescent; root band green changing to the color of the stalk, eyes are distinctly darkly colored and very conspicuous, 3–4 rows of eyes

Bud: reddish, ovate, round, short, and fat, pubescence sparse; bud wings reddish, inserted below the center of the bud, thin

Leaf: drooped, medium/long length, medium/broad width; sheath green with no purpling, moderately waxy, very sparsely pubescent; dewlap purple, ascending squarish deltoid or ascending double crescent; outer auricle transitional with large tuft of short to moderate hairs; inner auricle small rounded nub occurring about an inch below the dewlap

Flesh: white or very light brown

Tassel: not observed

Growth: semi-erect, thick stalks of moderate height

HYBRID VARIETIES

BRASH

(HC 27)

Status: held in collections

Background Information: This cane was introduced into the modern ethnobotanical collections by Adrienne Brash from Tantalus, O’ahu. Brash claimed this to be a native Hawaiian variety. Observations show that this cane is morphologically identical to ‘HC 27’. HC, standing for “Hawaiian Cane,” is a name typically given to unknown native varieties. However, both genetic tests and morphological features (such as the long, pointed auricle and heavy wax bloom) indicate that this is not a Hawaiian variety and likely an early hybrid.

Identifying Characteristics: Stalks are dark purple and heavily coated in wax. Several distinctive features, including

only 2–3 rows of eyes in root band, a dark purple dewlap, and long, pointed auricle occurring at the dewlap.

Stalk Color: purple or dark purple, occasionally bronze or light olive green; wax bloom medium to heavy

Internode: variable, often concave, can be slightly barreled; bud furrow absent or weakly expressed; wax band difficult to discern beneath the heavy wax bloom, very wide, olive green when wax removed; growth ring dark purple or rarely green; root band dark purple or rarely green, 2–3 rows of eyes

Bud: purple or rarely olive green, broadly ovate, fat and round, lightly pubescent; bud wing broad, truncated tip, attached low on bud

Leaf: erect with drooping tips, moderate length, moderate/narrow width, module 24:1–28:1, well-spaced, sparse,



‘Brash’ growth is dense and semi-erect to recumbent.



'Brash' stalks are heavily waxy, and the internode shape highly variable.



The very long, pointed auricle of 'Brash' is suggestive of hybrid varieties.



On 'Brash', when the wax is removed, the root band and growth ring are rarely colored green.



'Brash' leaves rarely express very sparse green variegation.

noticeably crinkled surfaces, often have white or yellow spotting near base, tend to drop off cane exposing stalk; sheath light green, flushed with rose or purple from the base, moderately waxy, moderately hairy; dewlap purple, often wax coated to appear grey, strongly squarish deltoid; outer auricle transitional, occasionally with sparse long hair group; inner auricle distinctive, long lanceolate, narrow and pointed

Flesh: light brown or brown

Tassel: not observed

Growth: semi-erect, tall, thin to medium thickness, ratoons well, produces many well-spaced stalks

H109

Status: held in collections

Background Information: 'H109' was the first major commercial hybrid created in Hawai'i by HSPA, which was formed in 1895 and began breeding sugarcane in 1905. The first breeding effort created 5,000 seedlings from a mixed patch of sugarcanes, and so it is unknown which variety fathered 'H109', but the mother was 'Lāhainā'. Fitness and production were examined for each of the new varieties, with 'H109', the 109th seedling in the series, deemed the choicest variety. The yield increase associated with this cultivar, which resulted from a combination of its many long stalks and increased resistance to insects and diseases, was one of the crucial factors in the early growth of the sugar plantations in Hawai'i. Between 1927 and 1932 over half of all the sugarcane grown in the state was of the 'H109' variety.

Identifying Characteristics: Stalks are often a mottled olive green and purple with a moderate to heavy wax bloom. Unique characteristics include considerable pubescence along the leaf edges and leaf base, pointed auricle of medium size occurring just below the dewlap, and long reddish buds that tend to pull away from the stalk.

Stalk Color: olive green to faded purple, turning bronze or yellow with sun exposure; wax moderate to heavy

Internode: slightly barreled, short jointed; bud furrow absent; wax band broad, inconspicuous, blends into wax bloom; growth ring yellow or orange, waxless, distinct; root band purple or olive green, heavy wax coating, rows of eyes

Bud: red or reddish, long, lanceolate, tends to pull away from stalk, very sparsely pubescent; bud wings red, thin, inserted near the center of the bud

VARIETAL DESCRIPTIONS

Leaf: erect, medium/short length, medium/narrow width, module 19:1–23:1, considerably pubescent along edges and at base; sheath light green, fading dominantly to purple, heavy wax coating, heavy coating of white hairs; dewlap light green, occasionally ringed in pink, deltoid shaped; outer auricle transitional with a moderate tuft of medium

to long hairs; inner auricle pointed, medium sized, occurring just below the dewlap

Flesh: white, slightly greenish

Tassel: not observed

Growth: semi-erect, produces many stalks close together, generally thin



The leaves of 'H109' are thin and very erect.



'H109' sheaths are waxy, pubescent, and flush with a light purple.



The growth ring on 'H109' is slightly tumescent and bright yellow or orange.



'H109' stalks are only moderately thick, heavily coated in wax, and variable in color.

H50-7209

Status: held in collections

Background Information: This hybrid was selected by the HSPA in 1950, having been produced in 1948 and grown out in 1949. The breeding efforts at the time were focused

on battling a series of droughts, and this cane was selected for its exceptional production in drier conditions. This cane saved the sugar industry in Hawai'i during this time, and by the late 1960s composed approximately 40 percent of the cane grown in the state. As indicated by the large tracking number associated with this sugarcane (this was

the 7,209th seedling tested in the year 1950), the HSPA was deeply engaged in sugarcane hybridization and was testing thousands of new varieties every year.

Identifying Characteristics: The stalks are olive green to light purple with a heavy wax bloom. The internodes are distinct, being narrow and long jointed, lacking a bud furrow, having a large and conspicuous growth ring, and with wax bands that are very wide and noticeably depressed. The greater auricle is long and pointed, sometimes over 2 inches long, and occurs at the dewlap.

Stalk Color: olive green to light purple, occasionally light green splotchy with yellow, muddy purple or orange-yellow with exposure to sun; wax bloom moderate to heavy

Internode: long jointed, cylindrical, often kinked; bud furrow absent; wax band wide, noticeably depressed, often indistinguishable from wax bloom; growth ring yellow or green, rarely purple, large and very conspicuous; root band similar to stalk color, often greener, rarely peach, 3–4 rows of eyes

Bud: greenish to purple, often red, round, relatively flat, very sparsely pubescent; bud wings reddish, inserted near or above the center of the bud, flaring tip



The hybrid variety 'H50-7209' produces many thin stalks in dense growth.

VARIETAL DESCRIPTIONS



'H50-7209' stalks are heavily coated in wax, usually obscuring the olive green or light purple coloration.



The extreme auricle seen on 'H50-7209' is not easily missed.



'H50-7209' stalks may strongly kink, as seen here.

Leaf: drooped, medium/long length, narrow width, module 28:1–32:1, nearly hairless, small serration; sheath yellowish green, purple with exposure, moderate wax coating, void of hairs; dewlap variably colored, yellow/green/purple, squarish deltoid; outer auricle transitional with sparse hairs; inner auricle pointed, very large, can be over 2 inches long, occurs at insertion point

Flesh: white, hard

Tassel: not observed

Growth: semi-erect, stools are closely compact, stalks long and thin

H52

(HC52)

Status: held in collections

Background Information: HC stands for Hawaiian Cane, and although this abbreviation is supposed to refer to unknown indigenous canes, the heavy wax bloom, pointed auricle, and general appearance of this cane are all suggestive of an early hybrid. It is unclear if the name 'HC52' arose recently as a misnomer.

Identifying Characteristics: Stalks are purple with a moderate or heavy wax bloom. The most defining characteristic

of this cane is the very large purple dewlap that is broad squarish deltoid with a truncated square tip. The greater auricle is medium sized and pointed, occurring at the dewlap.

Stalk Color: purple; wax bloom moderate to heavy

Internode: barreled; bud furrow modest, shallow, typically short; wax band broad, prominent, constricted, usually blending into wax bloom; growth ring reddish purple, typically wax free; root band reddish or reddish purple, typically wax free, 3–4 rows of eyes

Bud: very large, olive green to purple, lanceolate, sparsely pubescent; bud wings purple, narrow, inserted near the middle of the bud

Leaf: erect, moderate length, moderate/broad width, module 17:1–21:1, long hairs along the edges; sheath green, flush to light purple with exposure, moderately waxy, heavily coated with hairs down the center; dewlap purple, very large, broad squarish deltoid with a truncated squared tip; outer auricle transitional with long hair group; inner auricle medium sized, pointed, occurs at the dewlap

Flesh: white or light brown

Tassel: open, large, long, narrow, very full, purplish, held well aloft, tassels very freely

Growth: semi-erect, large stalks, well spaced



'HC52' produces few, but huge stalks.



The internodes of 'HC52' are barreled and moderately frosted with wax.



On 'HC52', the small auricle may be pointed or calcarate, and the large, square dewlaps are evident.



The growth ring and root band on 'HC52' are typically the same color as the stalk.

VARIETAL DESCRIPTIONS

NOT KEA

Status: held in collections

Background Information: This cane is currently held in collections as 'Kea', but genetic tests have shown that this cane is so different from Hawaiian canes that it is almost a separate species. Several records equate 'Kea' to the introduced

cane 'Sacuri'. However, other sources indicate that it was not 'Sacuri' itself, but actually, a seedling offspring that made it to Hawai'i from the Indonesian area, which would account for the vastly different genetics of this cane.

Identifying Characteristics: The stalks are typically yellow or green-yellow with a moderate to heavy wax bloom. The internodes get slightly narrower moving up the stalk.



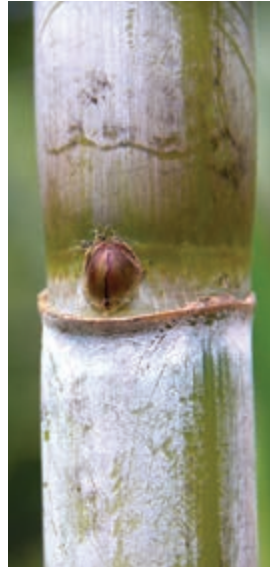
'Not Kea' has dense growth and produces tall, skinny stalks.



'Not Kea' stalks are often greenish yellow with a moderately waxy bloom.



Unlike other hybrids in Hawai'i the auricle on 'Not Kea' is often small and deltoid.



On 'Not Kea', the buds are round and flat, and occur entirely within the root band.

The dewlap is distinctive, typically being bright yellow and subcrescent and occasionally expressing long hairs. Unlike in most of the hybrid varieties, the auricle is poorly developed and occurs well below the dewlap.

Stalk Color: ranges from pale white to straw green, green, or greenish, fades to yellow with sun; wax bloom moderate to heavy

Internode: straight or slightly barreled, distinctly narrows up the stalk; bud furrow inconspicuous or absent; wax band very wide, prominent; growth ring yellow-green or orange, occasionally olive green; root band green or light green; three to four rows of eyes

Bud: green, ovate, pubescence sparse; bud wing broad, greenish, inserted near the middle of the bud

Leaf: erect or slightly drooping toward the tips, smooth, lightly hairy on the edges and the base behind the dewlap, serration large and closely spaced; sheath green, moderately waxy, lightly to moderately hairy down the center; dewlap bright yellow or reddish, subcrescent, ascending ligulate or deltoid, occasionally with long hairs; outer auricle transitional with a dense group of long hairs; inner auricle calcarate or rounded deltoid, occurs just below the dewlap

Flesh: white

Tassel: open, large, broad, silverish, held shortly aloft

'UALALEHU

(WINI, YELLOW BAMBOO)

Status: held in collections

Background Information: This name literally means "ashen or gray 'uala." H. M. Whitney takes credit for the development of this cane through the controversial claim of a grafted hybrid. Whitney asserts to have grafted the buds of the introduced 'Lāhainā' onto planting stock of



The long, skinny stalks of "Ualalehu' ratoon poorly.

VARIETAL DESCRIPTIONS



The internodes are often concave-convex shaped on "Ualalehu".



The yellow dewlap on "Ualalehu" is narrow ligulate.



On "Ualalehu", the deep bud furrow extends from the large, ovate bud.

the indigenous "Uala" in 1877 at Keāiwa, Kā'ū. This cane is also called kō 'Wini', the Hawaiian pronunciation of "Whitney," or 'Yellow Bamboo'. Several historical sources equate "Ualalehu" and 'Lahi', and although they appear very similar today genetic analysis suggests that they are different varieties.

Identifying Characteristics: Stalks are yellow and flush heavily with pink in the sun. Sheaths are very hairy along center and upper sides. Dewlap narrow ligulate or flaring ligulate. This cane is very similar to 'Lahi', except that it is always larger in stature, more robust, and longer jointed.

Stalk Color: green or yellow-green, fades to yellow, slight rose flush with sun, burns to orange-yellow or auburn with exposure; wax bloom very sparse

Internode: conoidal or concave-convex; bud furrow strongly marked, deep, extending the length of the internode; wax band medium to wide, prominent; growth ring dark yellow or orange, rarely green; root band green or greenish, three to four rows of eyes

Bud: green, ovate; moderately pubescent with short and long hairs; bud wings olive green or purple, medium broad, inserted near the middle of the bud

Leaf: drooped near the middle, medium/long length, medium/broad width, module 20:1–24:1, smooth, numerous, sparsely hairy along the edges, moderately hairy behind the dewlap, serration is very small and well-spaced but tends to be rather sharp; sheath green, often heavy yellowing or splotches of yellow or red, lightly waxy, moderately to heavily coated with hairs down the center and upper sides; dewlap yellow-green or green, occasionally reddish tinge, narrow deltoid or ligulate; outer auricle transitional with a hair group of moderate density and length; inner auricle rounded deltoid, occurs at the dewlap

Flesh: light brown, brown ring near the rind, mildly soft, moderately juicy, mildly sweet, very acrid

Tassel: not observed

Growth: semi-erect to recumbent, well spaced, stalks numerous and long

'WAIMEA'

('WAIMEA #4')

Status: held in collections

Background Information: This is not a cane name, but refers to the location in which the cane was originally collected. Waimea and Waimea #4 are held in collections as

different canes, but close examination does not reveal any consistent differences between the two. The canes will be described collectively here.

Identifying Characteristics: Stalks are yellow-green or yellow with a typically moderate wax bloom. Distinctive characteristics include a very thick root band with five rows of



'Waimea' produces many, moderately spaced stalks.



The yellow-green 'Waimea' stalks may be lightly coated in wax.

VARIETAL DESCRIPTIONS



The large, pointed auricle suggests that 'Waimea' is not a Hawaiian cultivar.



On 'Waimea', the growth ring is bright yellow or orange, while the root band is greenish.

crowded eyes and ovate buds with broad reddish wings that are inserted well above the middle of the bud.

Stalk Color: green, turning yellow-green then yellow with exposure to the sun, very slight rose flush with exposure; wax bloom moderate to heavy

Internode: cylindrical or obconical; bud furrow variable, can be deep and long; wax band very broad, prominent, blending to wax bloom; growth ring yellowish or orange, wax bloom tapers before or at growth ring; root band yellow-green, typically wax free, four to five rows of eyes

Bud: green, ovate, moderately pubescent with short and long hairs; bud wings reddish, broad, inserted well above the middle of the bud

Leaf: drooped from near the middle, medium/long length, medium/broad width, module 19:1–23:1, tend to yellow profusely from the edges, moderately hairy at the base behind the dewlap, occasionally sparsely hairy on the upper surface; sheath light green, often splotched with red, moderately waxy, very hairy down the center and the upper sides; dewlap yellow-green or green, narrow ligulate or narrow squarish deltoid; outer auricle transitional with a light to moderate group of medium-length hairs; inner auricle small calcarate when well-formed but is rarely so, usually appears as a medium rounded nub protruding at the dewlap

Flesh: white or very light brown

Tassel: open, broad, rose or deep rose, held moderately aloft

Growth: erect, long stalks, thin to moderately wide and well-spaced stalks

Appendix I

Moir Classification

Source: Moir (1932b)

- I. Group I—Badila type; erect.
- a. Akilolo family—Dark brown pith, position of buds on the stalk not opposite but at the points of the hands of a clock at four o'clock. Named after a fish whose colors are found in the stripes of two colors. Medium height canes under normal conditions.
- i. 'Akilolo'—striped green and deep purplish red when young; yellow and deep red on older exposed stalks; leaf sheath striped with purple.
 - ii. 'Nanahu'—or 'Red Akilolo'—the red mutant of 'Akilolo'. Solid purple leaf sheath and fairly heavy purple cast to the leaves.
 - iii. 'Pilimai'—or 'Yellow Akilolo'—the yellow-green mutant of 'Akilolo'. Very similar to 'Uala' in appearance but eyes not opposite.
 - iv. 'Pakaweli'—or 'Hou'—or 'Pailolo'—names given to the same cane on various islands. Deep purple-red and green striped cane identical with 'Akilolo' except that the leaves are somewhat variegated. The purple stripes on the leaf sheath are underlaid with white, giving a pinkish red appearance in contrast to the deep purple of 'Akilolo'. An occasional top will be very much variegated with even a pink flush throughout the white on the leaves. This cane will also produce mutants of solid yellow and red very similar to 'Pilimai' and 'Nanahu'. A close study has not been made to distinguish any differences.
- b. Akoki family—Very dark brown pith; position of buds opposite on stalk; top very heavy and leaves somewhat longer than Akilolo; stalks usually larger and plant more vigorous in appearance, especially so in wetter districts where Akilolo does not thrive.
- i. 'Akoki'—deep red and green when young, changing to purple and brown-yellow on exposure; leaf sheath striped with purple.
 - ii. 'Uala'—yellow mutant of 'Akoki'—very large stalks—often called 'Pilimai' because of close similarity, but a stronger cane than 'Pilimai'.
 - iii. 'Papaa'—deep red or purple mutant of 'Akoki', large-sized stalks, leaf sheath purple striped in contrast to 'Nanahu's solid color; faint purplish cast to leaves.
 - iv. 'Makaa'—a faint, green striped mutant of 'Uala'.

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- c. Manulele family—Dark brown pith color; position of buds opposite on stalk; conical internodes; large stalks of medium height.
- i. ‘Manulele’—yellow-brown with red-brown stripe underlaid with green in newly exposed portions, changing to buff brown and maroon in old exposed stalks, with a very fine stripe of canary yellow.
The leaves are somewhat variegated, while the leaf sheaths are green with a purplish cast, and striped with white; the leaves have a decided purplish cast.
 - ii. ‘Honuaula’—brown-red mutant of ‘Manulele’. Leaf sheath and leaves decidedly purple in color. Newly striped stalks are of a dirty brown color.
 - iii. ‘Mikokoi’—lighter brown-red mutant of ‘Manulele’ without purple cast to leaves and sheath.
- d. Ainakea family—Position of buds opposite; pith dark except where stated below; erect and of medium height. This family may be related to the Akoki family.
- i. ‘Ainakea’—striped maroon red and apple green when young, changing to purplish red and yellow when mature. One of the prettiest canes in the collection. Could be mistaken for ‘Ohia’ when young but on taking a cross section of the stalk the pith will be found segmented—white where the stalk is red outside, and brown where it is yellow. Leaves are somewhat variegated and leaf sheaths are distinctly striped with white.
 - ii. ‘Yellow Ainakea’—the yellow mutant of ‘Ainakea’—Pith dark brown. It is very difficult to separate from ‘Uala’—no clear-cut differences seem apparent.
- e. Awela family—Very strongly of the Badila type of growth and appearance. Very dark pith color, very susceptible to borer damage, because of being easily knocked over by other canes and covered with trash; position of buds opposite. The leaf sheath has the tendency to split open above the bud with the sprouting eyes coming through the split.
- i. ‘Awela’—or ‘Puaole’—green and yellow striped cane that becomes flushed with rose when exposed to the sun, barrel-shaped internodes, leaf sheath striped with white and leaves somewhat variegated.
 - ii. ‘Uluhui’—or ‘Uleohiu’—or ‘Yellow Awela’—bronze yellow mutant of ‘Awela’ or vice versa. On exposure to the sun the stalks take on a deep reddish bronze cast over the yellow, looking like old gold.
 - iii. ‘Alaihi’—probably a red mutant or very closely related to ‘Awela’. Deep red cane, decidedly barrel-shaped internodes, leaf sheath purple and leaves with purple cast.
- f. Palani or Molokai Akoki family—Markedly of Badila type of growth and appearance, very dark pith color, short in stature, position of buds similar to Akilolo, that is, not opposite, leaf sheath having strong tendency to split above the bud.
- i. ‘Molokai Akoki’—brownish purple and deep olive, green striped cane, purple stripes on leaf sheath and leaves with flush of purple.
 - ii. ‘Palani’—purple cane with deep olive green cast when young, changing to reddish yellow on exposure to the sun, green leaves and sheath. Very likely the parent of the cane ‘Molokai Akoki’ and not its mutant.
- g. Miscellaneous—Not definitely placed in the above groups but of the same general appearance and closely related.
- i. ‘Ohia’—deep red and green striped cane when young, becoming bronze red and yellow-brown on exposure. (The colors are the same as the leaves and flower of the *Ohia-ai* tree from which it got its name.) Leaf sheath striped with white, which is nearly always flushed with pink; leaves somewhat variegated; position of buds as in the Akilolo family, to which it is probably related; pith very dark brown, especially near the rind.
 - ii. ‘Waiohia’—deep olive-brown striped with dull red; no stripes on leaf sheath or purple cast to leaves; dark colored pith; position of eyes like in Akilolo family. A fairly vigorous grower but with small stalks.
 - iii. ‘Lauloa’—yellow-green, striped with light yellow-brown, when young; with exposure a deep olive, striped with dark brown-red (not distinct as in ‘Akilolo’, ‘Akoki’, etc.); broad, long, green leaves; large sized stalks; pith-deep brown; position of buds opposite. A more robust looking cane than the others of this type.

MOIR CLASSIFICATION

- iv. 'Uhu'—a dirty red cane very similar to 'Lauloa' in general appearance and probably related to it, deep brown pith; position of buds opposite; leaves green.
 - v. 'Ulaula'—a deep claret red cane of medium size when young, changing to black purple on exposure; position of buds opposite; leaf sheath, purple; leaves with strong purple cast; old midribs of leaves deep purple; pith, deep orange-brown.
 - vi. 'Pilikoa'—yellow-green, with pale brown red stripes when young, changing to deep bronze yellow with darker brown-red stripes; position of buds as in Akilolo family; pith colored in segments as in 'Ainakea'; leaf sheath and leaves green.
- II. Group II—Canes of the Lahaina type of growth in contrast to the Badila, usually free tasseling, heavy stooling, and rather semi-erect to recumbent growth in contrast to the erectness of the other type; large, long, heavy tops.
- h. Laukona family—Vigorous growing, heavy stooling canes of medium size with long conical internodes; pith of dark brown; position of buds, opposite; very susceptible to mosaic, eye-spot, and brown stripe diseases; large, long tops; tassels long, open and light.
 - i. 'Laukona'—or 'Manini' (*laukona* because of its use in the *kahuna* profession; *manini* because of its great resemblance to the striped fish of this name)—orange-yellow with light green stripes, when young, changing to pea green stripes on orange-yellow, with a rose flush over all; leaves and sheath very much variegated. Frequently mutates to a solid yellow cane ('Lahi').
 - ii. 'Lahi'—or 'Ualalehu'—(the latter name later applied to the 'Yellow Bamboo'). The yellow mutation of 'Laukona', otherwise same as 'Laukona' without variegations and stripes and very much more robust in growth.
 - iii. 'Pink Striped Lahi'—a pink or light red striped mutation of 'Lahi'—otherwise same as 'Lahi'.
 - i. Maikoiko family—A very common cane, relished for chewing purposes. Medium-sized stalks; vigorous stooler and grower; position of buds opposite; pith very dark brown; leaves of light yellowish green with very slight tinge of red; sheaths deep red; very striking wax band, root band, and growth ring when newly stripped of its old leaves; root eyes very prominent. This cane seldom tassels and when it does shows a purple, open tassel well above the cane.
 - i. 'Maikoiko'—or 'Ko Elelee' (black cane)—or 'Kawila'—or 'Niger Cane'—the blackest cane in the series when exposed to the sun. Distinct fringe of long hairs on leaf scar of node.
 - ii. 'Striped Maikoiko'—a buff brown and maroon striped cane when young, becoming olive brown and very deep purple on exposure. Readily mutates to 'Maikoiko'.
 - j. Uahi-a-Pele family—Heavy stooling cane very similar in appearance to H109; internodes, barrel-shaped; pith very dark brown; position of buds opposite; very susceptible to eye-spot disease; heavy tasseler.
 - i. 'Uahi-a-Pele' ('Volcano Smoke')—or 'Naaukaki'—a light red-purple cane with a very heavy wax bloom. The term *naaukaki* meaning "sausagelike" is very descriptive of the shape of the internodes. A fringe of long brown hairs (half-inch or over) remains at the leaf scar after the leaf is removed, the hairs being longest just below the buds.
 - ii. 'Pohina'—almost identical to 'Uahi-a-Pele' except that it is less vigorous, dies back after tasseling, which it does freely, and has practically no wax bloom. This gives it a dirty red to brown color.
 - k. Opukea-Halalii family—A very vigorous, large-sized stalk cane of the Lahaina type; heavy stooler; somewhat constricted above nodes and enlarging as the next node is approached; distinct wax band; not a free tasseler; pith distinctly white; resistant to eye-spot. These canes are quite different to other Hawaiian canes, and probably the most superior of them all.
 - i. 'Halalii'—or 'Wehehala'—or 'Ukuhala'—or 'Pakaiea'—the first three names are in relation to its top, being somewhat like a small hala tree (*Pandanus odoratissimus*). It was supposedly first noticed by the Hawaiians of Niihau growing in the sand dunes with the stalks buried by the drifting sand leaving only the green top above the

APPENDIX I

surface; therefore the name. The last name is a seaweed. This is a light orange-yellow and green striped cane with a decided pink flush on exposure, giving a red, yellow, and green striped appearance to the whole stalk; flesh next to the rind colored like stripes outside; leaves somewhat variegated (slightly more than those of Badila type but less than 'Laukona'), sheaths striped with white; position of buds opposite. Often called by Hawaiians of today 'Puaole', whose colors it resembles. It is very similar to the 'Nanemo' or 'Bogela' cane of Australia, introduced from New Guinea.

- ii. 'Opukea'—the solid yellow cane that gives rise to 'Hawaii' or is the mutant of 'Halalii'. It takes on a rosy red flush on exposure. Where it is a mixed planting with 'Kea' and 'Lahi', it is rather difficult to separate, except where eye-spot disease is prevalent; then 'Lahi' is badly infected. *Kea*, medium, and *opukea*, clean.
- l. Kea family—The only other family group besides Halalii that has white pith. Erect type of growth; medium to small sized stalks of greenish yellow, heavy stoolers; compact, deep green tops; buds somewhat of the Creole cane type of growth.
 - i. 'Kea'—the best known and most used cane of the collection. The erect compact stooling of this cane with its clinging trash, leaves the stool in such a shape that one cannot see through it. It never attains any very great height. Medium susceptibility to eye-spot and borer damage.
 - ii. 'Iliopua'—identical with 'Kea' but never attaining the stature of 'Kea', that is, always dwarfed. Like 'Kea', readily damaged by borer due to the very compact nature of the leaves and stalks preventing parasitism of the borer by the Tachnid fly.
- m. Miscellaneous group—These are a few canes—probably seedlings, mutations or direct importations—that do not fit into the above groupings.
 - i. 'Hinahina'—this cane may be a member of the Laukona group, but no close study has been made to determine points of similarity. Grayish-green cane with a rosy flush, and the whole covered with a very heavy wax bloom; very susceptible to mosaic and eye-spot; pith, dark brown; position of buds opposite. General appearance like 'Lahi'.
 - ii. 'Oliana'—a cane very similar in appearance to 'Lahaina', that is, in type of growth and color, but the pith is very dark brown and the leaf sheath is very fully covered with long red-brown hairs; position of buds opposite; cane very hard.
 - iii. 'Moano'—a red cane that becomes very dark purple on exposure; leaf sheath very hairy and somewhat purple in color; leaves of medium dark green, never with purple cast nor stiff and erect like the Badila-type canes listed above; pith, dark brown; position of buds opposite.
 - iv. 'Lehu'—or 'Hairy Bamboo'—or 'Fotiogoo'—this is more than likely a recently, introduced cane extensively planted by the Hawaiians and given the name *lehu*, meaning ashes. The stunted mature canes look like dead stalks except that they have green leaves attached. A gray to green-brown cane with a heavy vesture of hairs over the whole stalk, giving it a frosted appearance; pith, a green-white; position of buds opposite; scattered, long hairs on both upper and lower surfaces of leaf; leaf sheath covered with hairs; buds large and glabrous.

Appendix II

Kō Names and Associated Marine Species

Kō Name	Associated Marine Species
‘Akilolo	<i>Gomphosus varius</i> or <i>Julis pulcherrima</i>
‘Ala’ihi	<i>Holocentrus</i> spp.
‘Āwela	<i>Thalassoma trilobatum</i>
‘Āweoweo	<i>Priacanthus</i> spp.
‘Ele’ele	<i>Ulva prolifera</i>
Hau	<i>Pinctada margaritifera</i> and others
Hou	<i>Thalassoma</i> spp.
Kāni’o/‘Ōni’oni’o	<i>Sicyopterus stimpsoni</i>
Laenihi pūkea	<i>Hemipteronotus</i> or <i>Iniistius</i> spp.
Lele	Unknown fish
Manini	<i>Acanthurus triostegus</i>
Mahai’ula	<i>Pseudocaranx</i> or <i>Gnathanodon</i> spp.
Māikoiko	<i>Acanthurus nigroris</i>
Maka’ā	<i>Malacanthus brevirostris</i>
Moano	<i>Parupeneus multifasciatus</i>
Omomo	<i>Remora</i> spp.
Pakaiea	<i>Ulva fasciata</i> and <i>Monostroma oxysperma</i>
Pākalakala	<i>Galaxaura lapidescens</i>
Pakaweli	Unknown fish
Palani	<i>Acanthurus dussumieri</i>
Pāpa’a	<i>Bothus mancus</i> and <i>Carcharhinus melanopterus</i>
Piliko’a	<i>Paracirrhites forsteri</i> , <i>Cirrhitops fasciatus</i> , and <i>Amblycirrhites bimacula</i>
Puhi Paka o Pele	<i>Gymnothorax flavimarginatus</i>
Uhu	<i>Scarus</i> spp.
‘Ula’ula	<i>Etelis marshi</i>
Weke	<i>Mullidae</i> spp.

Appendix III

Cross Reference to Corresponding Crop Names

Variety Name	Kalo	'Uala	Mai'a	'Awa
'Akilolo	X			
'Ele'ele	X	X	X	X
Hāpai			X	
Kākonakona		X		
Lahi			X	
Lauloa	X	X		
Manini	X	X	X	
Moano	X			
Nika		X		
Pakaiea	X			
Palani		X		
Pōhina	X	X		
Uahiapele	X			
'Ula'ula	X			
'Ulu	X			

Glossary of Hawaiian Terms

'ai	food or food plant, to eat
'aina	sugarcane refuse
'āina	land
akua	gods, goddess, spirit
ali'i	chief, chiefess, rules
'ape	large taro-like plant (<i>Alocasia macrorrhiza</i>)
'apu	coconut shell cup, to drink, general name for medicinal potions
'auwai	ditch, canal
'awa	<i>kava</i> plant (<i>Piper methysticum</i>); bitter, bitterness
'ea	general term for infections; coated tongue, sometimes accompanied by sore throat; the thrush disease of children.
'ēlau	upper section of sugarcane stalk adjoining leaves
hāhā	grope, feel with the hands, diagnose
haku	braid, plait
hale	house
hana aloha	love magic, to practice love magic
hānai	adopted child, adopted, adopt
hau ka'eka'e	<i>Hibiscus tiliaceus</i> , a lowland tree found in many warm countries that grows low and tangled, forming dense, impenetrable thickets; the bark easily strips off and was the main source of cordage in many Polynesian cultures; the sap extracted by soaking the bark in water was used in many medicines
haupia	coconut cream dessert
heiau	pre-Christian place of worship
hilo	gonorrhea; a running sore
hōlua	sled, mountain sledding, the sledding course
honua	land, world, earth
hou	new, again, fresh
'ie	woven basket, fish trap, flat braid

GLOSSARY

imu	underground oven
ipu	gourd plant (<i>Lagenaria siceraria</i>)
‘iwi	bones
kahuna	priest, expert
kalo	taro (<i>Colocasia esculenta</i>)
Kanaloa	one of the four great Hawaiian gods, associated with saltwater
kane	male; or tinea, a fungal skin disease
Kāne	leading of the four great Hawaiian gods, associated with fresh water
kaona	hidden meaning, as in Hawaiian poetry; concealed reference
kapa	bark cloth, most common fabric of Hawaiians
kapu	taboo, prohibition
kea	white
Ke‘a	bow, dart
keiki	child, offspring, shoot, sucker
ke‘oke‘o	white
kī	<i>ti</i> leaf (<i>Cordyline fruticosa</i>)
kino	body, form
kino lau	body form, earthly form taken by a supernatural being
kō	sugarcane (<i>Saccharum officinarum</i>)
ko‘a	fishing grounds, coral head, shrine
kōheoheo	poisonous
kohepopo	lit. rotten vagina
konohiki	headman of an <i>ahupua‘a</i> land division under the chief
kowali pehu	morning glory (<i>Ipomea</i> spp.) vines
Kū	one of the four great Hawaiian gods, associated with war and prosperity
kūlolo	sweet, taro-based pudding
lā‘au	tree, plant, medicine, medical
lani	sky, heaven
lapa‘au	medical practice, to treat, cure
lau	leaf, many
lei	lei, garland, wreath, necklace
lenalena	pale yellow
lo‘i	wetland agriculture, flooded terrace
lolo	brains
Lono	one of the four major gods, associated with peace and dryland agriculture

GLOSSARY

luakini	temple, church
mahiole	feather helmet
mai'a	banana or plantain (<i>Musa</i> spp.)
mala 'ai	dryland agriculture, planting field
mālo'o	dry lands, lands used for rainfed agriculture
mana	supernatural or divine power, to empower; branch, limb, crotch
maoli	native, true, genuine
melemele	yellow
momona	fat, fertile, rich, sweet
niu	coconut (<i>Cocos nucifera</i>)
'ohe	bamboo
'ole	none, without
'ōlelo	language, speech, word
'ōlelo Hawai'i	Hawaiian language
'ōlelo nō'eau	wise saying
pa'akai	sea salt
pā'ao'ao	latent childhood disease, with physical weakening
pani	close, shut, block; final bit of food used in ceremonies as closing
pili	native grass (<i>Heteropogon contortus</i>)
pona	joint, stalk
pua	flower
pu'a	tied up together
pulapula	seedlings, sprouts, cuttings, as of sugarcane
pule	prayer, to pray
pūpū	snack, appetizer, shell
pu'u	mound, hill
'uala	sweet potato (<i>Ipomea batatas</i>)
ukuhala	penalty for wrongdoing; to pay for wrong done
'ula, 'ula'ula	red
wahine	female
wai kō	sugarcane juice
waikī	gonorrhoea, of males; painful urination, perhaps due to cystitis
wauke	paper mulberry (<i>Broussonetia papyrifera</i>) from which kapa is made
wehehala	remove a personal transgression by prayer, remission of sin

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About the Author



Noa Kekuewa Lincoln is of Native Hawaiian descent. The Hawaiian cultural epistemology, which places the environment at the core of human well-being, has been the *kuamo'o* of his personal and professional accomplishments. Noa received his PhD in Environment and Resources from Stanford University, where his work focused on traditional agricultural development pathways and management strategies. He has worked in marine and terrestrial ecosystem restoration and conservation around the Pacific and coupled those efforts with cultural and environmental education and community engagement. For many years, he worked on traditional Hawaiian ethnobotany and agriculture, most notably at the Bishop Museum's Amy B. H. Greenwell Ethnobotanical Garden. He is currently assistant professor at the University of Hawai'i at Mānoa with a focus on Indigenous Crops and Cropping Systems and president and co-founder of Māla Kalu'ulu, a cooperative organization focused on restoring and researching traditional Hawaiian agroforestry systems.

