The tale of Hawai‘i’s two scented laua‘e, *Microsorum spectrum* and *Microsorum grossum:* Solving the mystery of their history and restoring indigenous knowledge, using the synergism of Linnaean and Polynesian taxonomy

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Research

“Auhea wale oe e ka ipo lauae?” Where are you, my **laua‘e** sweetheart?
Song by W. A. Kiha, written before 1886; translated by P. Anderson-Fung

Abstract

Background: This study quelled a fervent disagreement by restoring indigenous knowledge. The issue was—had the **laua‘e** fern, *Microsorum grossum,* been part of Hawaiian culture “since earliest times,” as asserted by certain cultural specialists, or was it introduced to Hawai‘i after 1900, as inferred from historical records? Assuming both expert opinions were correct, I surmised that there had been another plant species named **laua‘e** prior to 1900, the identity of which had become obscure.

Methods: This hypothesis was tested by reconstructing the history of Hawaiian **laua‘e** using a dual-disciplinary approach—drawing on knowledge referenced by Linnaean and indigenous plant names—to answer three questions. Was there evidence that *M. grossum* grew in Hawai‘i before 1900? If not, was there evidence of another species named **laua‘e** before 1900? If so, what was it?

Results: Records of botanical surveys provided no evidence that *M. grossum* was present in Hawai‘i before 1919, and the distribution of Polynesian names for the species was consistent with this finding. English and Hawaiian literature of the 19th century evidenced an unidentified plant, named ”**lauae**,” that was herbaceous and very fragrant. Observations from field biologists led to the inference that this was *Microsorum spectrum,* and its Hawaiian name, **laua‘e**, was confirmed by handwritten notes on an herbarium specimen.

Conclusion: Awareness of the **laua‘e maoli** ‘native **laua‘e**’, *M. spectrum,* faded as its populations shrank, and the introduced **laua‘e hānai** ‘adopted **laua‘e**’, *M. grossum,* eventually supplanted the cultural role of its predecessor.

Keywords: Ethnobotany, plant name, fern, historical reconstruction, cultural memory, comparative linguistics.

Background

Sometimes, the most important *use* of a plant is to serve as a tangible reminder of the deep affection our indigenous ancestors felt for the plants in their environment and the places where they grew. Now, imagine that this emotional link to our indigenous past was threatened by the assertion that one of these cherished plant species had not been present in the environment of our ancestors. Such was the case with Hawai'i's beloved **laua'e**, the connotation of which inspired the following study. This work exemplifies both the adaptability of cultural memory to changes in the biocultural environment, and our ability to restore indigenous knowledge obscured by such changes—in this case, revitalizing awareness of a long forgotten, native **laua'e**, a species once plentiful in the cultural landscape of our Hawaiian ancestors.

TEK, cultural memory, and biocultural diversity

Drawing on centuries of experience, indigenous cultures often develop a "body of knowledge, practice, and belief" about their environment—commonly referred to today as traditional ecological knowledge (TEK) (Berkes 1999, Hunn 1993a). This cumulative wisdom embodies both profound scientific understanding and intimate emotional attachment to what the Greeks called the *oikos* 'dwelling place' at the heart of indigenous ecology 'study of the *oikos'* (Anderson 1996, Milton 2002). In pre-literate Hawaiian society, TEK was transmitted verbally, and perpetuated by repeated interaction with biological species, as well as memorization of their names, and the chants, stories, rituals, protocols, practices, and beliefs that conveyed their cultural salience (Anderson-Fung & Maly 2002, Charlot 2005, Handy *et al.* 1972).

Clearly, then, forces that prevent a people from interacting with culturally important species and their ecosystems, or that suppress language and other forms of cultural expression, can result in loss of TEK from cultural memory (Assmann 2008, Assmann & Czaplicka 1995). Like other indigenous homelands, Hawai'i has experienced many TEK-diminishing forces, including expansion of developed lands, reduction of native ecosystems, introduction of invasive species, loss and endangerment of native species (Cuddihy & Stone 1990, Gon *et al.* 2018, HSWAP 2020, Loope *et al.* 2013, Van Driesche 2000), and suppression of Hawaiian language and cultural expression (McMullin 2005, Meyer 1998, Pukui *et al.* 1972, Schütz 1994). While Hawaiian cultural practices and language have experienced significant restoration since the 1970s, other cultures continue to lose TEK—and the biocultural diversity on which it depends—at an alarming rate (Maffi 2005, Pretty *et al.* 2009). This has prompted ethnobiologists to press urgently for documentation and memory banking of TEK (Nazarea 1998), and "demystification and mainstreaming" of conservation, taxonomy and bioinformatics (Thaman 2013).

The synergism of global Linnaean and regional indigenous plant names

Science, plant names, and taxonomy are at the heart of this study, and in order to explain their relationship to TEK, a few relevant premises are provided. Following the perspectives of Medawar (1979), science is defined here as an activity that occurs whenever we humans *explore* 'look closely at' *nature* 'things not made by humans' for the purpose of *understanding* it better. Consequently, both Linnaean and indigenous plant names are considered *scientific,* and the oft used contrast between "Western scientific" and "indigenous" names is avoided as a false dichotomy which infers, inadvertently, that indigenous names are not scientific and do not occur in Western Eurasia—a home to contemporary and ancient indigene (Amiel 2019, Hublin 2015) and, in Europe alone, "160 culturally distinct groups" (East *et al.* 2022).

Plant name studies are, in fact, made possible by the well-studied, universal, *scientific* human ability to recognize—and therefore give names to—the same *taxa* 'groups of like organisms' in nature (Atran 1998, Atran *et al.* 1997, Berlin 1992, Hunn & Brown 2011, McClatchey 2011). Linnaeaus (1751) was convinced of the existence of this cognitive common ground, and that it was shared by plant-knowers worldwide. He therefore crafted his taxonomic system with this premise and the ultimate goal of providing every species on Earth a unique Latin binomial name—to which its corresponding indigenous/cultural names could be appended (Quammen 2007).

In keeping with this *philosophia botanica,* this work differentiates plant names as either *global Linnaean names*—which provide a unique, global identifier for each taxon on Earth—or *regional indigenous/cultural names*—which provide a multiplicity of culturally significant identifiers for each Linnaean taxon.

Taxonomy and conservation of TEK

In order to be accessible to cultures worldwide, Linnaean taxonomy uses only "distinct, visible, and preferably measurable attributes" (Uddenberg 2008:46), to determine the global Linnaean name of a species (Benton 2000). Once an indigenous plant name is synonymized with a Linnaean binomial, it becomes part of a global information archive, and the TEK it references is added to the global treasury of human insight regarding Earth's species (Beckman 2008, Quammen 2007).

Pairing global and regional plant names helps to conserve TEK in several ways. First, it safeguards the identity of the indigenous/cultural plant name—and the TEK it references—for posterity. This, of course, is assured only if the pairing is documented in either the published literature or on herbarium specimens that are housed in permanent collections—and preferably both (Nesbitt 2014). Second, pairing allows us to store, retrieve, and compare cultural/indigenous names, knowledge and lore about a particular taxon within and between cultures, both contemporarily and historically. As an example, contemporaneous comparison of indigenous names with their corresponding Linnaean taxa has revealed TEK useful for the conservation of plant and animal species important to the home culture (Nabhan 2003, Striplen & DeWeerdt 2006, Turner 2014, Wilder *et al.* 2016).

Among related cultures, whose members speak languages derived from a common ancestral proto-language, comparative linguistic studies determine the sound changes that occur between extant languages. With this, ethnobotanists can map different linguistic forms of a single ancestral plant name—known as its linguistic cognates—and the Linnaean taxa they reference, across a regional homeland over time. These studies demonstrate that a people tend to use cognates of pre-existing plant names consistently for the same taxa in new homelands—unless and until they encounter significant changes in the species composition of their new environment or undergo intrinsic cultural change. In these cases, pre-existing names are usually given to different or additional taxa that are morphologically similar to the previously-named taxon, or that share the same cultural significance as the species previously named (Berlin 1992, Turner 2014, Whistler 1995). These principles are fundamental to comparative plant name studies, which have long provided important evidence for the historical movements of indigenous people—including those of Polynesia (Geraghty 2009, Guppy 1895, Safford 1921, Zepernick 1970).

This study demonstrates an additional benefit of studying indigenous and Linnaean plant names in related cultures over time—*viz.* the restoration of TEK deeply obscured and apparently lost from the cultural memory of an indigenous people, due to changes in their cultural and natural environment over 200 years.

Hawaiian laua‘e: A frond of contention

Motivation for this study was provided by a contentious and passionately held difference of opinion regarding Hawai‘i’s beloved **laua‘e** fern, *Microsorum grossum* (Langsd. & Fisch.) S. B. Andrews (Polypodiaceae). The issue was—had the **laua‘e**, *M. grossum,* been introduced to the islands after 1900, as stated by fern taxonomists, or had it been a part of Hawaiian culture “since earliest times,” as asserted by certain cultural specialists? In order to appreciate the exigency of this study, it is necessary to first be familiar with the conception of **laua‘e** that was widely held in Hawai‘i near the end of the 20th century, when the controversy emerged.

*The unidentified **laua‘e** of oral and ritual tradition.* The **laua‘e** /lau.ˈʷaʔe/ and its fragrance are described with great affection in many old Hawaiian songs and chants, as are the places with which they are associated. Particularly well known are the *‘ōlelo no‘eau* ‘poetic references’ extolling the fame of the fragrant **laua‘e** of Kalalau and Makana, on Kaua‘i (Pukui 1983). Literary references to **laua‘e** often suggest that the plant, or its fragrance, is a metaphor for a loved one, and the word **laua‘e** by itself can mean ‘beloved, sweet, of a lover’ (Pukui & Elbert 1986: 194). **Laua‘e** also had ritual significance in the *hula and* was placed at the *kuahu* ‘altar’ of *hālau hula* ‘hula schools’ on Kaua‘i at “the turn of the century and well into the 1920s” (Pukui 1942).

***Laua‘e** of the contemporary landscape.* The plant commonly known as **laua‘e** today is *M. grossum*, known also as “the **maile**-scented fern” (Neal 1948). Its subtle fragrance is similar to that of the **maile**, *Alyxia stellata* (J. R. Forst. & G. Forst.) Roem. & Schult. (Apocynaceae) and is most noticeable after a rain and when the fronds are crushed or dried. Its deeply pinnatifid fronds are distinct from others with this general shape because their large *sori* ‘spore dots’ are deeply-sunken into the leaf, producing conspicuous raised bumps on the upper surface (Palmer 2003). The fern grows readily in cultivation and will spread quickly under the right conditions. It is now common in the lower elevation forests of the six largest Hawaiian Islands and is planted extensively in both residential and urban landscapes (Wilson 2005). It is probably one of the most well-known plants in the islands today, where it is commonly used as a motif for a diverse array of products iconic of Hawai‘i’s cosmopolitan culture—as evident from an internet image search for **laua‘e** or **lauae**.

***Laua‘e** of the mid-twentieth century.* In the 1940s, this **laua‘e**, *M. grossum,* was described as “popular among Polynesians for leis, bits being strung with flowers and especially with sections of *hala* fruits” (Neal 1948:26). Subsequently, *M. grossum* fronds were used to decorate tables at Hawaiian gatherings, and the plant became a common inhabitant of residential yards—especially those of native Hawaiians—who often grow **laua‘e** and **ti** plants, *Cordyline fruticosa* (L.) A. Chev. (Asparagaceae), around their homes. When I asked a Hawaiian elder, born in 1918, why she had planted **ti** and **laua‘e** all

around her house, she replied simply, "It's Hawaiian style, right?" (Catherine Fung, personal communication, 2002), thus perfectly summarizing the status that **laua'e** (*M. grossum)* had achieved during her lifetime.

***Laua'e** in revitalized Hawaiian culture (c. 1970-present).* After 1970, when the Hawaiian cultural renaissance began (Barrère *et al.* 1980:2), *M. grossum* came to play a greater role in Hawaiian culture than it had in the preceding half century. This was the result of both innovation and restoration of earlier cultural practices. Lei **laua'e** 'lei made of **laua'e**' were created during this period and are currently very popular in Hawai'i, especially as adornments for hula dancers. These attractive, fragrant, dark green lei are made by integrating pieces of *M. grossum* leaves into cord-like strands of twisted, intertwined **ti** leaves. Old chants, songs, hulas, and protocols featuring **laua'e** are again being performed. In 1999, I attended a Hawaiian music concert at the Waikiki Shell, and watched as a potted *M. grossum* plant, identified by the commentator as **laua'e**, was respectfully placed on a *kuahu hula* 'hula altar' that had been erected on the stage (Enomoto 1997), suggesting that it was considered to be the **laua'e** described by Puku'i (1942) for hula at "the turn of the [20th] century."

Figure 1. The introduced laua'e, *M. grossum,* shown here as a growing frond and in a *lei kōkō* 'lei that ties' around the hair of hula student Ku'uleilaua'e Fung. Photos by Kai Markell.

*The **laua'e** controversy and the importance of its resolution.* Controversy arose in the 1990s, when Hawaiian cultural practitioners and their students learned that botanists had designated *M. grossum* an alien species that had not become naturalized in Hawai'i until about 1919 (Wagner 1950, Wilson 1996). Hawaiian cultural memory—of the 1990s—held that the **laua'e** had been a part of Hawaiian culture long before 1900. For example, a well-respected authority on Hawaiian *lei* 'garlands' described the **laua'e** fern "*Microsorium* [sic] *scolopendria*" as a plant that had been used to make *lei* "for hundreds of years" before the arrival of Capt. Cook in 1778 (McDonald 1989:17,86). Similarly, a hula practitioner on Kaua'i listed the same **laua'e** species—using the synonym *Polypodium phymatodes*—as one of their "native plants or Hawaiian introduced plants" (Bailey 1987:6).

Certain community members believed these scientists were wrong and criticized them for disregarding Hawaiian traditional knowledge. Charles Lamoureux (personal communication, 1996), a fern specialist at the University of Hawai'i, responded

that he did not doubt the Hawaiian conviction that **laua'e** had been a part of their culture before 1900, but stated emphatically that "that fern, however," pointing to the *M. grossum* plant he had placed on his desk, "was not in Hawai'i at that time."

The challenge and approach to resolution.
As a native Hawaiian scientist with a deep affection for native plants, I was compelled to try and heal the uncomfortable, divisive feelings generated by this disagreement. I hypothesized that since both indigenous Hawaiian science and contemporary, global botany are based on expert knowledge of Hawaiian plants—both perceptions of **laua'e** must be correct. The only way this can be true is if there are two **laua'e**: *M. grossum,* widely known as **laua'e** in 20th century Hawai'i, and another species—known as **laua'e** to Hawaiians of the 19th century—the memory and identity of which had become obscure. The challenge was, could this hypothesis be demonstrated?

The approach used was to reconstruct the history of Hawaiian (HAW) **laua'e** by answering three questions. (1) Is there any evidence that *M. grossum* grew in the Hawaiian Islands before 1900? (2) If not, is there evidence of a plant named **laua'e** in Hawai'i before 1900? (3) if so, what was the identity of this precursory **laua'e**?

The method of data collection is described as a dual-disciplinary approach, because it draws on knowledge referenced by both Linnaean and indigenous plant names. The term "dual-disciplinary" was chosen in lieu of "bi-cultural" because Linnaean plant names are determined without the use of culturally-specific knowledge. Information from English and Hawaiian language literature was combined with expert knowledge of field biologists and cultural practitioners, to arrive at the final answers.

Materials and Methods

Means to determine whether *M. grossum* was present in Hawai'i before 1900.
Step 1: Use evidence from Linnaean taxonomy. Reports of botanical surveys, conducted by European and American botanists in Hawai'i between 1778-1925, were searched for records of *M. grossum* growing in the islands as a naturalized species. As a test of the thoroughness of these surveys, the presence or absence of four additional Polypodiaceae species—currently growing as uncultivated species in the islands—was also recorded, in Table 1. The species' names, their bio-geographical status, scent, and frond lengths, are as follows (Palmer 2003, Wagner *et al.* 2005):

- **pākahakaha**, *Lepisorus thunbergianus* (Kaulf.) Ching; indig.; unscented, 6-35 cm
- **pe'ahi**, *Microsorum spectrum* (Kaulf.) Copel.; endemic; scented, 10-50 cm long
- **'ae**, *Polypodium pellucidum* Kaulf.; endemic; lightly scented fronds to 55 cm long
- **laua'e haole**, *Phlebodium aureum* (L.) J. Sm.; alien; unscented fronds 30-100 cm
- **laua'e***, Microsorum grossum;* reportedly alien; mildly scented fronds to 75 cm long.

The species comprise a good test group because (1) each currently occurs on all six of the largest Hawaiian Islands (Imada 2012), (2) they range in size, and (3) the alien ferns are larger and, therefore, presumably harder to overlook, than the native ferns.

Historical searches for *M. grossum* in Hawai'i are complicated for two reasons: (1) *M. grossum* was, for many decades, misidentified as a different species, *viz. Microsorum scolopendria* Copel.; and (2) the latter species, *M. scolopendria,* was recorded in early botanical literature as *Polypodium phymatodes* L.—a name that is designated as both a legitimate synonym for *M. scolopendria* (The Plant List 2013) and a misapplied name for the species (Florence *et al.* 2007). Fortunately, fern taxonomists are now in agreement that *M. scolopendria* has never been collected "in the wild in Hawai'i" (Palmer 2003) and that all reports of its occurrence in Hawai'i are really *M. grossum* (Hoshizaki & Moran 2001). For this study, then, all records of *P. phymatodes* and *M. scolopendria* from Polynesia were interpreted as *M. grossum*.

Wilson (1996) was the first to correctly identify *Phymatosorus grossus* (Langsd. & Fisch.) Brownlie—a synonym of *M. grossum*—as the species that grows in Hawai'i. He credited this insight to Brownlie (1977), who "pointed out that *Phymatosorus scolopendria*, [syn. *M. scolopendria*] … has fronds with only one to four pairs of lobes and grows as an epiphyte, whereas *P. grossus* has larger fronds with up to 10 pairs of lobes and is mostly terrestrial" (Wilson 1996:134).

Molecular studies explain the reason for the confusion—the species are very closely related. "The current data suggest a separation between *M. grossum* and *M. scolopendrium* [sic] but it is not clear if this separation reflects a speciation event or

intraspecific phylogeographic variation in a single species, *M. scolopendrium*" (Krier *et al.* 2008:1165). A study by Schneider et al. (2004) demonstrated that *Phymatosorus* is a polyphyletic group that is not distinct from *Microsorum*, suggesting that all *Phymatosorus* species should be placed in *Microsorum,* as recommended previously by Nooteboom (1997). Despite this, the species is still referred to as *P. grossus* by several botanical authorities (Palmer 2003, The Plant List 2013, Wagner *et al.* 2005).

Step 2: Use evidence from Polynesian taxonomy. The natural distribution of *M. grossum* includes most of tropical Polynesia—with the exception of the Hawaiian Islands, where it is considered a naturalized (alien) species (Palmer 2003, Wagner *et al.* 2005). Palmyra Atoll, located about 1,000 miles south of Honolulu, is said to be "the [northern] edge of its original natural range in the Pacific" (Wagner 1950:111). *M. grossum* is very common at Palmyra Atoll, as well as Sāmoa, Tonga, and Niue, in Western Polynesia (Rock 1916, Sykes 1970, Whistler 1991:64, Whistler 2000:174), and the Cook, Society, Austral, Rapa, Tuamotu, Mangareva, and Marquesas archipelagoes of East Polynesia (Florence *et al.* 2007, Florence 2021, McCormack 2007, Wagner & Lorence 2002). It is absent from Rapanui (Meyer 2013) and Aotearoa (Breitwieser *et al.* 2016), both of which lie outside of the tropical latitudes.

We may infer, then, that *M. grossum* could, theoretically, be native to Hawai'i, and if so, then Polynesians who migrated to Hawai'i from other island groups, might have given it one (or more) of their pre-existing names for the species. If this name was the linguistic predecessor of HAW **laua'e**, then Polynesian "forms" of HAW **laua'e** —known as its linguistic cognates—ought to exist elsewhere in Polynesia, especially in the Marquesas and Society Islands, which are widely accepted as the sources of Hawai'i's founding indigenous populations (Allen 2014, Kirch 2017:245).

Linguistic cognates are words "similar in sound and meaning, evolved from one earlier form" (Schütz 1994:331). They occur only in languages—such as those of Polynesia—that are related by descent from a common ancestral language. Cognates exist because "sound changes occur in all languages over time and ... are, typically, regular ... [meaning] that within a language community pronunciations change systematically, such that sound *x* becomes sound *y* under statable phonological conditions—not just in a few words, but in all words that meet those conditions" (Pawley & Ross 1995:44). The correspondences between the phonemes 'perceived units of sound' of Polynesian languages have been extremely well studied (Biggs 1971, 1978, Elbert 1953, 1982, Hale 1846, Marck 2000). Changes in vowel sounds are rather complex, but the changes that occur between consonants are quite straight forward and have been charted in tables of consonant correspondences.

This study used consonant correspondences summarized in Appendix Table A1, from Marck (2000), to construct the following hypothetical cognates of HAW <**laua'e**> for ten Polynesian languages and two Marquesan dialects.
***lauake**, ***auake** - Tongan and Niuean; ***laua'e** - Samoan;
***'auake** - N. Marquesan; ***'aua'e** - S. Marquesan; ***raua'e** -Tahitian;
***rauake** - Cook Is., Tuamotu, and New Zealand Māori, Mangarevan, and Rapanui.

Henceforward, angle brackets '<...>' are used to denote a particular spelling of a word, and a leading asterisk '*' signifies that the word is hypothetical and may not actually occur in the language listed. Table A2 summarizes the inferred genealogical relationships between the Polynesian languages featured in this study.

In order to determine whether *M. grossum*—or other *Microsorum* species—were named by cognates of HAW **laua'e**, Polynesian and Linnaean names for *Microsorum* species were compiled in Tables A3-A5, and are summarized in Fig. 2, which displays the names by their relative geographical location.

I cast a wide net for Polynesian names to compare with HAW **laua'e** because: (1) the region is home to many *Microsorum* species that are morphologically similar to *M. grossum;* and (2) some of these were confused previously with *M. grossum.* As was the case in Hawai'i, *M. grossum* was previously misidentified as *M. scolopendria* (syn. *P. phymatodes)* in many parts of Polynesia, but most contemporary floras treat them as separate species (following Brownlie 1977:381-386) and have reclassified previous records of *M. scolopendria* and *P. phymatodes* as *M. grossum*. This is the case in Hawai'i (Wagner *et al.* 2005), French Polynesia (Florence *et al.* 2007), the Cook Islands (McCormack 2007), and Sāmoa (Whistler 2000:174).

Means to determine whether there was a plant named laua‘e in Hawai‘i before 1900.

*Step 3. Investigate the history of the word **laua‘e** and the fern M. grossum in Hawai‘i.* Comprehensive searches were undertaken to find documentation that referenced: (1) a plant named **laua‘e** in Hawai‘i; (2) *M. grossum* in Hawai‘i; and (3) *M. grossum* as **laua‘e**. Linnaean and/or Hawaiian names were recorded as rendered by their source. Names recorded as <**lauae**> were conservatively regarded as *probable* evidence of the word <**laua‘e**>, since the glottal stop was rarely used to spell Hawaiian words in the 18th, 19th and early 20th centuries (Schütz 1994:141-149).

Definitions for <**lauae**> and <**laua‘e**> were recorded from Hawaiian dictionaries, plant name lists, botanical studies, and mainstream literary works published between 1865—when the first Hawaiian-English dictionary was issued (Andrews 1865)—and 1948, when "**Laua‘e**" was featured as the "**Maile**-scented fern, *Polypodium phymatodes*" in *In Gardens of Hawaii"* (Neal 1948:26). These findings were combined with documentation evidencing the absence or presence of *M. grossum* in Hawai‘i from botanical reports and herbarium specimens dating back as far as 1779. Results were listed chronologically in Table 2, which juxtaposes the histories of these names.

Step 4. Investigate the historical salience of ***laua‘e** in Hawaiian culture.* Literary references attributable to a 19th century <**lauae**> were gleaned from Hawaiian and English language literature of the 19th and 20th centuries. Hawaiian dictionaries, newspapers, plant name lists, original manuscripts, songs, chants, and (English language) ethnobotanical studies were perused. Relevant passages were excerpted, translated if necessary, and recorded in Appendix Tables A6-A7. Phrases "likely to refer to a plant" were distinguished from "unambiguous references to a plant." This is necessary for Hawaiian literature because of its propensity for metaphorical allusion and its rich use of *kaona*, 'the hidden meanings' of words (Elbert 1962, Pukui 1949).

Informal interviews were also conducted with persons familiar with **laua‘e** and its role in Hawaiian culture. Persons interviewed are listed in the acknowledgements. All participants were treated with respect and in keeping with the code of ethics that governs ethnobiological research (International Society of Ethnobiology 2006). Prior informed consent was provided by all.

Means to determine the identity of the 19th century laua‘e

*Step 5. Search for cognates of HAW **laua‘e** in other Polynesian languages.* If cognates of HAW **laua‘e** existed in other languages—but did not name *Microsorum* species—they would not be detected in Step 2. Therefore, the hypothetical cognates of HAW **laua‘e** constructed previously were searched for in dictionaries for ten Polynesian languages listed in Table A8. If found, the identity of the plant(s) named by these cognates would likely provide clues to the identity of Hawai‘i's precursive **laua‘e**.

*Step 6. Determine if the word **laua‘e** might have been constructed literally.* Because HAW *lau* and its Polynesian cognates mean 'leaf', linguistic cognates of HAW **a‘e**—which occurs elsewhere in Polynesia as **ake** and **a‘e**—were also searched for in other Polynesian languages, in case the Hawaiian name had been constructed literally, to refer to **laua‘e** as (1) the 'leaf of the **a‘e** plant', or (2) 'a leafy sort of **a‘e** plant', or (3) 'a leaf that is *a‘e'* , where *a‘e* refers to a particular quality. Special effort was made to ascertain whether any of the cognates had the denotation 'fragrant' or 'scented', since HAW <**laua‘e**> was given the gloss 'fragrant leaf' by Neal in 1948 and 1965 (Table 2). Cognates were searched for in dictionaries and published botanical works, and their plant-related meanings were recorded in Table A9.

*Step 7. Infer the identity of the 19th century **laua‘e** and seek verification.* The identity of the precursory **laua‘e** was inferred from the information acquired in steps 4-6; field biologists and cultural practitioners with expert knowledge of Hawaiian plants were asked for feedback on the inference; and verification of the identity was sought by examining label information on voucher specimens of the "suspect" species at Herbarium Pacificum (BISH) at the B. P. Bishop Museum in Honolulu.

Using distinctive type to showcase special words

This journal uses the Gisha font for text and distinguishes indigenous plant names using **simple**, **bold type**. In addition, I use the Arial font for Polynesian words since it more clearly and correctly represents the Polynesian glottal stop and macron than does Gisha. Italic type is used throughout to *emphasize* and *contrast* words that merit *special* attention, *regardless* of their language of origin (Fowler 1926, Trask 1997). This includes words from languages other than that *of the narrative,* which must be recognized as such in order to be interpreted correctly (Trask 1997). This in no way implies that italicized words are *foreign. Hawaiian Dictionary* (Pukui & Elbert 1957-1986) uses italics in *exactly* this manner—italicizing *Hawaiian* words in the Hawaiian-English section, and *English* words in the English-Hawaiian section. Note also that the surname of Mary Kawena Pukui is spelled without a glottal stop—in keeping with her stated preference (Schütz 2020:133).

Results

Each stage of this study depends on the findings of the previous. Therefore, each research question is answered below, before continuing to the next, in a manner atypical of most scientific publications, wherein the results are interpreted in the Discussion.

Evidence for a 20th century arrival of M. grossum in Hawai'i

Result 1: Evidence from Linnaean taxonomy. Table 1 summarizes the results of botanical surveys conducted in the Hawaiian Islands between 1779 and 1922. Neither *P. aureum* nor *M. grossum* was collected or recorded by any of the European and American botanists who surveyed the Hawaiian flora prior to 1900. Significantly, two of these botanists—Gaudichaud (1826) and Brackenridge (1854)—came to Hawai'i as part of pan-Pacific voyages of discovery, and while both men collected *M. grossum* and *P. aureum* elsewhere in the Pacific (shown by "+" in Table 1), neither recorded these species for the Hawaiian Islands. In contrast, ten of the eleven surveys recorded each of the three native species in Polypodiaceae—despite their smaller size and less conspicuous habit.

Table 1. Polypodiaceae species recorded for the Hawaiian Islands during botanical surveys conducted 1779 - 1922

Year of survey and name of collector*	*Poly. pellu.*	*Micro. spec.*	*Lepi. thun.*	*Phle. aure.*	*Micro. gross.*	**Publication in which collections reported**
1779 Nelson	X	X	X			St. John 1978
1790-95 Menzies	X	X	ø			St. John 1977
1816-17 Chamisso	X	X	X			Kaulfuss 1824
1819 Gaudichaud	X	X	X	+	+	Gaudichaud 1826
1826-7 Lay & Collie	X	X	X			Hooker & Arn. 1841
1840 Brackenridge	X	X	X	+	+	Brackenridge 1854
1864-5 Mann	X	X	X			Mann 1867
1870+ Lydgate	X	X	X			Lydgate 1873
1880+ Bailey	X	X	X[1]			Bailey 1882
1867-87 Hillebrand	X	X	X			Hillebrand 1888
1895-96 Heller	X	X	X			Heller 1897
1897-1913 Various	X	X	X	X[2]		Robinson 1913
1922 Skottsberg	X	X	X	X	X[3]	Christensen 1925

Legend. **Abbreviations:** *Poly. pellu.-Polypodium pellucidum; Micro. spec.-Microsorum spectrum; Lepi. thun.-Lepisorus thunbergianus; Phle. aure.-Phlebodium aureum; Micro. gross.-Microsorum grossum.* **Key to symbols:** * All fern collections made prior to 1914 were reviewed by Robinson (1912-1913); 'ø' - the species was not collected during the survey; '+' - the expedition's botanist collected and identified the species elsewhere in Oceania, but not in Hawai'i. **Notes: X[1]** - Bailey (1882) misidentified X[1] as *Polypodium lanceolatum* L., a synonym of *Pleopeltis macrocarpa* (Bory ex. Willd.) Kaulf. (The Plant List 2013), which does not occur in Hawai'i (Wagner *et al.* 2005). This study infers that X[1] is *Lepisorus thunbergiana;* **X[2]** -*P. aureum* was first collected as a naturalized species in Hawai'i in 1910 (*Forbes 308* BM) (Robinson 1913: 202); **X[3]** -*M. grossum* was first collected as a naturalized species in Hawai'i in December 1919 (*Forbes 1778.M,* BISH) (Wilson 1996:134).

Result 2: Evidence from Polynesian taxonomy. Polynesian names for *Microsorum* species were compiled and sorted according to their current Linnaean name and the island group from which they were recorded (Tables A3-A5). Each table provided the Linnaean and Polynesian names given by each source, and notes regarding the form of the leaf and whether it was fragrant.

Indigenous names were found for the nine *Microsorum* species listed below, which are distinguished as DPF 'deeply pinnatifid' and NDP 'not deeply pinnatifid'. Species' distributions are provided after their Linnaean names.

- DPF fragrant *M. commutatum* (CL Blume) EB Copeland; SW/SE tropical PN;
- DPF fragrant *M. grossum* (Langsd. & Fisch.) S.B. Andrews; SW/SE tropical PN;
- DPF unscented *M. membranifolium* (R. Br.) Ching; Society & Tonga Isles;
- DPF scented *M. parksii* (Copel.) Copel.; Society, Austral, & Rapanui Isles;
- DPF unscented *M. powellii* (Baker) Copel.; Society, Cook, & Samoa Isles;
- NDP unscented *M. punctatum* Copel.; Society Isles only.
- DPF scented *M. pustulatum* (G. Forst.) Copel.; Aotearoa only.
- DPF musky scented *M. scandens* (G. Forst.) Tindale; Aotearoa only.
- NDP fragrant *M. spectrum* (Kaulf.) Copel.; Hawaiian Isles only.

Figure 2 maps the relative geographical location of Polynesian names for these *Microsorum* species. Indigenous names for *M. punctatum* of the Society Isles and *M. pustulaum* of Aotearoa were excluded for lack of space and because they were linguistically distinct from all other *Microsorum* names.

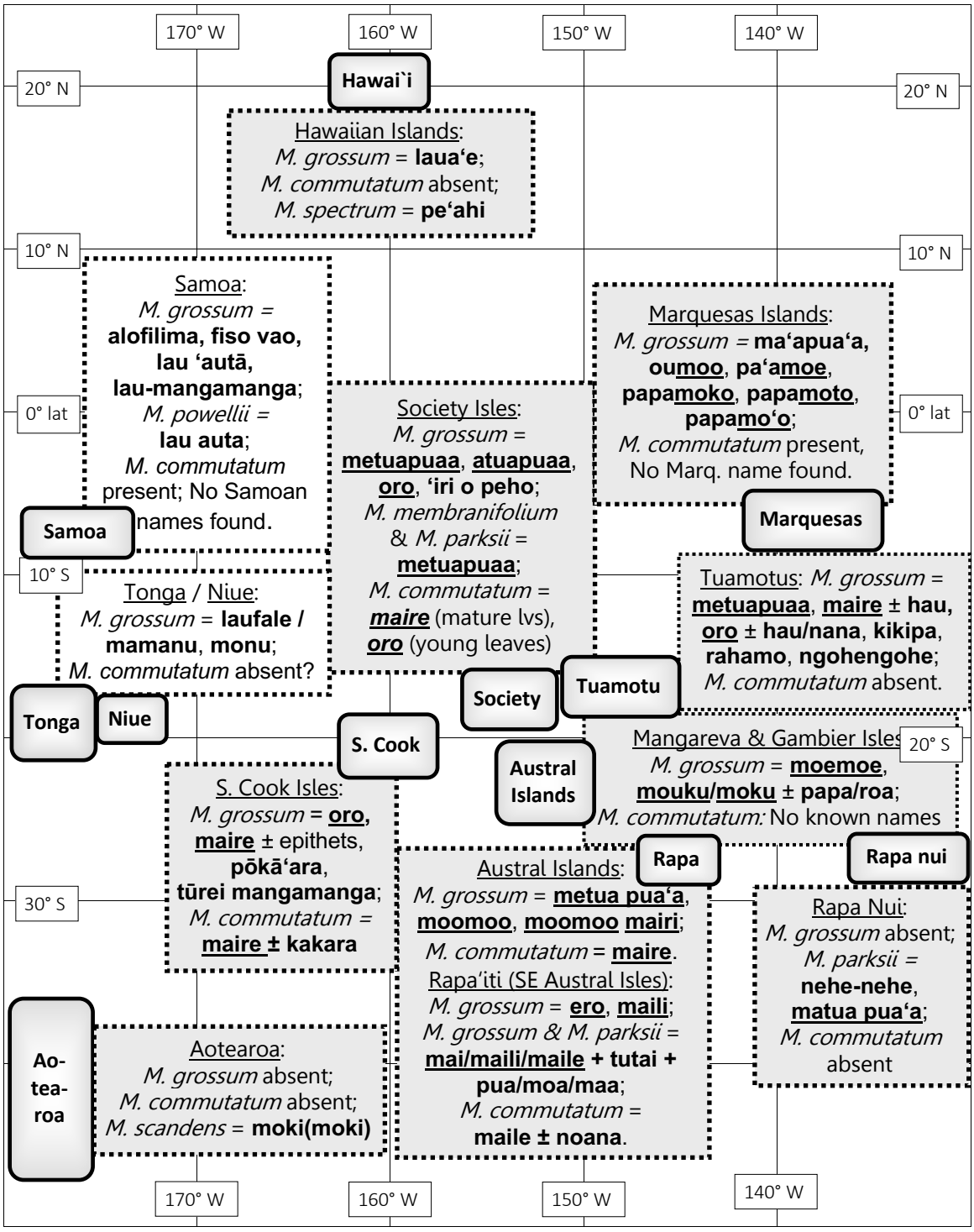

Figure 2. Polynesian names for *Microsorum* species.

Shaded text boxes contain East Polynesian names. Names occurring in more than one island group are underlined. Spellings are as provided by their sources. Not all spellings are shown. Positions of island groups are approximate. Aotearoa and Rapa Nui are not shown at the correct longitude.

Five Polynesian names for *Microsorum* species—underlined in Fig. 2—were recorded from more than one island group. Each of these names occurs as two or more linguistically related forms, and all identify *M. grossum.* Three of these names were also used to identify additional *Microsorum* species.

(A) In Central East Polynesia's Society, Tuamotu, Austral, S. Cook, and Rapanui Islands:
(1) **metuapua'a/(m)atuapua'a** name *M. grossum, M. membranifolium*, and *M. parksii;*
(2) **maire**, **mairi**, and **maili** name *M. grossum, M. commutatum,* and *M. parksii;* and
(3) **oro** and **ero** name *M. grossum* and *M. commutatum* and/or their young fronds.
(B) In Marquesas and Mangareva, of Far East Polynesia, and the Austral Isles,
(4) **moto**, **moko**, **moku**, **mouku, mo'o** and **mo'omo'o -** name *M. grossum;* and
(5) **moe —** which occurs as **moemoe** and **pa'amoe —** also names *M. grossum.*

None of these shared names, nor any of the other indigenous names recorded for Polynesian *Microsorum* (Tables A3-A5), can be considered cognates of HAW **laua'e** or words derived from cognates through changes such as the compounding and vowel shifts evidenced in the five shared plant names above.

It is inferred, therefore, that HAW **laua'e** is linguistically unrelated to all other East Polynesian names for *Microsorum*—a finding consistent with the hypothesis that *M. grossum* was not present in Hawai'i when its founding human populations arrived. If the species did not reach Hawai'i until after 1900, then the names given to *M. grossum* by the ancestors of the Hawaiian people would likely have been forgotten, and a different name would be used for the species. Admittedly, native species and plants introduced by arriving indigene are sometimes given unique names in their new Polynesian homelands. We may conclude, however, that neither Linnaean nor Polynesian taxonomy has provided evidence that *M. grossum* was present in Hawai'i before 1900, and move on to answer the second question.

Evidence for a plant named <lauae> in Hawai'i in the 19th century
*Result 3: The history of the word **laua'e** and the fern M. grossum in Hawai'i.* The chronology in Table 2 reveals the following. (1) Hawaiian <**lauae**>, naming 'an aromatic herb', and the unidentified plant names <**lauae kane**>'male **lauae**' and <**lauae wahine**> 'female **lauae**' were published in the 19th century, during a period when *M. grossum* had not been recorded or collected in Hawai'i. (2) It was not until the 20th century that *M. grossum* was: introduced to Hawai'i sometime after 1913; collected as a naturalized species in 1919; and referred to by the Hawaiian name <**lauae**> since 1923. (3) All literary references to HAW <**lauae**>, <**lawai**>, <**laua'e**>, or <**lauwa'e**> published after 1923—which also provided a Linnaean name for the taxon it identified—were defined as *M. grossum.* (4) No published reference was found to any variant spelling of HAW **laua'e** as a name for *M. spectrum* in either the 19th or 20th century literature.

*Result 4: The cultural significance of the 19th century <**lauae**>.* Literary excerpts attributable to an unidentified <**lauae**> of the 19th century were carefully evaluated (Tables A6-A7) and provide the following understanding of this <**lauae**>. Notably, some of these excerpts were *published* after 1900, but were attributed to the <**lauae**> of the 19th century for reasons explained in the appendix.

Chants recorded in the 19th century indicated that <**lauae**> produced a fragrance that "one could inhale" (Fornander 1920:472, 539)—a sentiment consistent with the saying, *"ke 'ala o ka laua'e, punia ai ka nahele,"* meaning 'the fragrance of **laua'e** permeates the forests'—a phrase from a chant that was used by *Hawaiian Dictionary* to define *punia* 'pervasive' (Pukui & Elbert 1986:355). Certain localities were heralded for their **lauae**—especially Makana and Hā'upu, on Kaua'i (Fornander 1920:539, Lili'uokalani 1878 *in* Liliuokalani et al. 1999). Famous, too, was Kakioe, "the woman who picks the **lauae**"—a well-known personality in the traditional stories of Kaua'i (Fornander 1920:472). This **lauae** was also used to scent coconut oil that was added to dyes used for *kapa* 'bark cloth', making them "delicately fragrant" (Kamakau 1870, translated *in* Kamakau 1976:111). Figuratively, the word <**lauae**> was often used to refer to a beloved person. Kiha (c. 1886), for example, used it to describe his <*ipo **lauae***> 'beloved sweetheart', and Leleiohoku II (c. 1870) used the phrase, *"O oe e ka Lauae ku kila i ka pali,"* which I translate as "(I address) you, the **Lauae** standing majestically on the mountain cliff," thus using the name metaphorically.

Finally, a passage, from the song *Ka Makani Lawakua,* composed in 1880 by Queen Lili'uokalani, provides definitive evidence that this 19th century **lauae** was a plant.

> "*Kilika i ka liko* ***lauae****, ke ala kai moani i o'u nei...*" (Liliuokalani *et al.* 1999), 'Showering lightly on the young leaves of the **lauae**, an ever so gentle breeze carries the fragrance to me' (translation by P. Anderson-Fung).

Notably, HAW *liko* 'young leaves' can also refer to 'a child or descendant, especially of a chief' (Pukui & Elbert 1986:205) and may have a double meaning in this context.

Cumulatively, these results and the 19th century entries in Table 2 corroborate the existence of a 19th century <**lauae**> with all of the attributes ascribed to the <**lauae**> of Hawaiian tradition (see Introduction). With this, we may proceed to the next task, recognizing, however, that there is still no evidence that this word is <**laua'e**>.

Table 2. English definitions and descriptions of HAW <**lauae**> and <**laua'e**> from literary sources, and names (Hawaiian and Linnaean) documented for *M. grossum*

Year	Name given	Definition or description given and its source
1865	**lauae**	"**An aromatic herb**" - Hawaiian Dictionary (Andrews 1865)
1893	**lauae kane lauae wahine**	These names are from *A List of Hawaiian Names of Plants* (Brigham 1893:52). No definition was given for either name.
1913	--	Robinson (1913) completed her review of Hawai'i's ferns, and concluded that ***M. grossum*** was not present in Hawai'i.
1919	--	The first collection of ***M. grossum*** as a naturalized species in Hawai'i was in December 1919 by C. N. Forbes (Coll. 1778.M)
1920	**lauae**	Two early Hawaiian chants (Fornander 1920:472,539), speak of the wind- and mist-borne fragrance of an unidentified <**lauae**> on Kaua'i. [See Appendix B for translations used.]
1922	**lauae** *(lā'u-a'e)*	"An aromatic herb. **A variety of fern**, very fragrant and used for decorative purposes" - Hawaiian Dictionary (A&P 1922:357). [This **lauae** was not identified.]
1923	**lauae**	A note on an herbarium specimen of ***M. grossum*** (K. P. Emory, 1923, BISH 8348) states: "nat. [native] name, "**lauae**," new not in dict. [dictionary]. Honolulu. In a fern basket."
1928	--	***Polypodium phymatodes*** [syn. *M. grossum*] was described as a "common ornamental garden fern" in *In Honolulu Gardens.* No Hawaiian name or cultural uses were mentioned. New Guinea was listed as its place of origin. (Neal 1928:8,310).
1936	**lawai**	An illustration of ***M. grossum*** in *Paradise of the Pacific* magazine was identified as "**lawai** fern" (West 1936).
1942	**lauae**	Leaves of <**lauae**>, identified as ***Polypodium phymatodes****,* were placed between the folds of finished *kapa* 'bark cloth' to give it a fragrance, like that of **maile** (Fosberg 1942:22).
1948	**laua'e**	***Polypodium phymatodes*** was identified as "**Laua'e**, Maile-scented fern" in *In Gardens of Hawaii,* which also referred to it as "the **laua'e** (fragrant leaf)" (Neal 1948:26, 1965:27).
1961-1986	**laua'e**, **lauwa'e**	"A fragrant fern [different Linnaean names for ***M. grossum*** were listed in each edition]; when crushed, its fragrance suggests that of *maile"* - *Hawaiian Dictionary* (P&E 1961, 1971, 1986). In each edition, the entry for *punia* quotes this line from a chant, *viz. "ke 'ala o ka laua'e, punia ai ka nahele,* the fragrance of **laua'e** fern permeates the forests."

Legend. Shaded rows mark the first documented evidence for: (1) HAW <**lauae**> as a plant name; (2) *M. grossum* as a naturalized species in Hawai'i; and (3) <**lauae**>as a name for *M. grossum.* **Abbreviations:** A&P-Andrews & Parker; P&E-Pukui & Elbert. **Key to symbols:** Angle brackets '< >' specify a particular spelling; '--' no Hawaiian name given; square brackets '[ ]' enclose comments made by this study.

Evidence for the identity of the 19th century laua'e

In order to identify the plant species known as **laua'e** in 19th century Hawai'i, it is optimal to find a source that spells the name **laua'e**—with a glottal stop. This is because the Polynesian glottal stop is not only a diacritic—a mark 'that separates or distinguishes' (Harper 2018) the sounds in a word—but is also a *consonant.* Thus *adding* a glottal stop to a Polynesian word not only changes its pronunciation but creates a *different word* (Schütz 1994:146). For example, HAW *kui,* a reflex of Proto-Austronesian (PAN) ***tui,*** means 'to thread pierced objects on a string', while HAW *ku'i,* a reflex of PAN ***tuki,*** means 'to pound, beat' (Greenhill & Clark 2011). Thus, HAW <**laua'e**> is a different word than HAW <**lauae**>.

The 19th century Hawaiian dictionary listed "an aromatic herb" with the Hawaiian name <**lauae**> (Andrews 1865:323). However, its pronunciation was not indicated. Fifty-seven years later, the revised Hawaiian dictionary expanded on the earlier gloss, stating that <**lauae**> was a "variety of fern, very fragrant, and used for decorative purposes" (Andrews & Parker

1922:357). The entry also indicated that the name was pronounced (*lā'u-a'e*), where (*ā*) marks a long vowel [actually an accented vowel and not a long vowel, see Schütz (2020:124)], (') denotes a stressed syllable, and (ʻ) represents 'the glottal closure' (Andrews & Parker 1922:xix). Today, this would be written <**laua'e**>. We cannot, however, be certain if this 1922 definition refers to the precursory <**laua'e**>, or to *M. grossum,* since the dictionary was revised between 1915 and 1920, and *M. grossum* was first documented as a naturalized species in Hawai'i in 1919, and its Hawaiian name was first recorded as <**lauae**> on an herbarium specimen collected in 1923 (Table 2). It is possible, then, that *M. grossum* could have been named <**lauae**> before the dictionary was published in 1922.

*Result 5: Clues from hypothetical Polynesian cognates of HAW **laua'e**.* None of the hypothetical Polynesian cognates constructed for HAW **laua'e** were found in any of the Polynesian dictionaries or online databases consulted (Table A8). This suggests that HAW **laua'e** originated in the Hawaiian Islands and was not brought there with emigrating or visiting Polynesian populations.

*Result 6: Clues from Polynesian cognates of HAW **a'e**.* Cognates of HAW **a'e**, referring to plants and their attributes, occur in seven Polynesian languages, in both simple and reduplicated forms, *viz.* **ake(ake)** and **a'e(a'e)**. These words (Table A9) were used to evaluate three possible etymologies for HAW **laua'e**, based on the hypothetical compounding of HAW *lau* 'leaf' + HAW **a'e** 'plant name or attribute'.

*(1) Was HAW **laua'e** the 'leaf of the **a'e** plant'?* In Tonga, Niue, Marquesas, Tahiti, and Rarotonga, cognates of HAW **a'e** name tree species in one or more of four genera—*viz. Zanthoxylum, Dodonaea, Sapindus,* and *Xylosma.* In Aotearoa, cognates of HAW **a'e** name tree species in *Dodonaea* and *Olearia,* and in Hawai'i, **a'e** names certain species of *Zanthoxylum, Sapindus,* and *Xylosma*. HAW **laua'e** is unlikely to refer to the *lau* 'leaves' of the **a'e** tree, however, since HAW <**lauae**> was defined as 'an aromatic herb' (Andrews 1865:323). This hypothesis, then, is unsupported.

*(2) Was HAW **laua'e** 'a leafy sort of **a'e** plant'?* Evidence supporting this hypothesis was found in a 19th century dictionary which provided the only definition for a plant name cognate with HAW **a'e** that was *not* the name of a tree. Davies (1851:6) defined Tahitian (TAH) <**ae**> as "the name of [an unidentified] sweet-scented plant, used for the sweet *monoi* or native oil." Assuming this is TAH <**a'e**> using contemporary Tahitian orthography, the name would be a reflex of Proto-Tahitic (PTa) ***ake**—suggesting the following etymology. It is inferred that Tahitian emigrants to Hawai'i encountered a plant species reminiscent of their 'sweet-scented' ***ake** and named it PTa ***rau ake**—literally '**ake** leaf'—referring to it as a leafy type of PTa ***ake** 'sweet-scented plant'. Later, PTa ***rauake** underwent the sound changes characteristic of the Hawaiian language, and became HAW **laua'e**, which was documented by Andrews (1865:323) as HAW <**lauae**> 'an aromatic herb'; and PTa ***ake** became Tah **a'e**, which was rendered as TAH <**ae**> 'the name of a sweet-scented plant ...' by Davies (1851:6).

(3) *Was HAW **laua'e** 'a leaf that is a'e' , where a'e refers to 'fragrant' or some other plant quality?* Among the 12 Polynesian languages perused, neither HAW **a'e** nor any of its cognates were defined as 'fragrant' or any other plant quality (Table A9), leaving this hypothesis unsupported.

*Result 7: Inferring the identity of the precursory Hawaiian **laua'e**.*
None of the cultural or natural history specialists consulted for this study (see Acknowledgements) expressed any awareness of a **laua'e** other than *M. grossum*. However, a study of fern use in Hawaiian culture (Fosberg 1942:22) mentioned that:

> A subtle fragrance, similar to that of ***maile*** (*Alyxia*), was imparted to *kapa* by storing it with fronds of ***lauae*** (*Polypodium scolopendria*) pressed between its folds. Certain other ferns possess a pleasing odor and may have been used in similar ways. Mrs. Pukui says that it was the commoner and coarser *P. phymatodes* [*P. scolopendria*] which was the more fragrant, despite the efforts of informants to give the honor to *P. spectrum* et al. (p.22)

I reasoned that if the endemic *M. spectrum* (Kaulf.) Copel. (previously known as *Polypodium spectrum* Kaulf.), was more fragrant than *M. grossum* (previously identified as *P. phymatodes* and *P. scolopendria* in Hawai'i), it might well be the <**lauae**> mentioned in the early Hawaiian literature, which was described as having a scent so pervasive that it could permeate a forest.

When asked to describe the fragrance of *M. spectrum,* biologist Sam M. "'Ohu" Gon III (personal communication, 1999) stated that it had a very strong scent, similar to that of the **maile**, *Alyxia stellata*. Botanist Tim Flynn (pers. comm. 2000) related that when he guided pteridologist W. H. "Herb" Wagner Jr. to a patch of *M. spectrum* on Kaua'i, Wagner had

remarked that it, *M. spectrum,* would be his candidate for a native **laua‘e**—based on the similarity of its fragrance to that of *M. grossum.*

Corroboration of the inferred identity. An unpublished list of plant names, compiled by botanist Joseph Rock in 1920, was made known to me by Gon, who was then working on an annotated version of the original manuscript. I obtained a copy of the unedited manuscript (Rock 1920) from the Bishop Museum library, and in it found this entry: “**Lauae** - *Polypodium spectrum*, the Hawaiian Ivy fern of the lower forest zone, a creeping fern” (Rock 1920:37). Notably, Joseph Rock did not use glottal stops or macrons when spelling Hawaiian names in his manuscript, and respectfully explained his choice, stating that “such delicate work which presupposes intimate knowledge of the Hawaiian language the writer will leave for Hawaiian scholars...” (Rock 1920:i). This meant that his entry, <**lauae**>, could reflect several spellings, including **lauae**, **laua‘e**, **lau‘ae**, or **lau‘a‘e**.

Encouraged by these multiple corroborations, I examined all herbarium specimens of *M. spectrum* deposited at Herbarium Pacificum (BISH). Several specimens gave the name **pe‘ahi** for the species, but two provided evidence that the species had also been known as **laua‘e**. Joseph Rock and Harold Lyon collected *M. spectrum* (BISH 8625) on Hawai‘i Island in 1909 and wrote on the specimen label, “**Lau ae** (or **rau**) [implying the word **rau ae**] … nat. [native] name by David P. Kalani.” In 1933, E. S. Handy (BISH 149392) collected *M. spectrum* at Hana, Maui, at an altitude of 1100 m, and wrote “native name **LAUA’E**,” on the label—with the glottal stop, represented by an apostrophe, indented deeply into the paper, suggesting deliberate care, and providing the first evidence—and, as far as I know, *the only documented evidence*—that the Hawaiian name for the species was actually <**laua‘e**>.

Figure 3. Growth habit and venation of the native laua‘e, *M. spectrum,* in the Ko‘olau Mountains, O‘ahu. Photos by Clyde T. Imada (left) and the author (right).

Discussion

Designating the laua'e *'M. grossum'* a 20th century introduction to Hawai'i

This study found no evidence to support the hypothesis that *M. grossum* grew in the Hawaiian Islands before 1900. (1) The species was not recorded or collected during any of the eleven American and European botanical surveys conducted in Hawai'i between 1779 and 1900 (Table 1). (2) Despite the fact that *M. grossum* is a common, widely dispersed native species elsewhere in East Polynesia, none of the Polynesian names used for *M. grossum,* or any of Polynesia's other deeply pinnatifid *Microsorum* species, are cognate with HAW **laua'e** (Fig. 2). (3) There is no record of *M. grossum* in Hawai'i before 1919, when it was first collected there as a naturalized species, and HAW <**lauae**> was not documented as a name for *M. grossum* until 1923 (Table 2). These results are exactly what one would expect if *M. grossum* had not been present in Hawai'i until centuries after the arrival of the Polynesian people. Native Hawaiians would have forgotten the Polynesian names their founding ancestors had used to name *M. grossum* by the time the species arrived in Hawai'i in the twentieth century. It would be reasonable then, for Hawaiians to use the name **laua'e** for *M. grossum,* since its scent is very similar to that of its original namesake, *M. spectrum.*

Could European and American botanists have overlooked M. grossum? After the results of this study were presented at conferences (Anderson-Wong 2001), some people still found it hard to believe that *M. grossum* had not been present in Hawai'i before 1900, and wondered if botanists could have overlooked the species during their surveys. This is highly improbable, for many reasons.

The growth habit of *M. grossum* makes it very unlikely that this fern could have been overlooked by even the most amateur collector. This invasive species has large, distinctive fronds and a rather stout rhizome. It is abundant in disturbed, slightly open, lower forests, and is often found creeping on the ground in full sunlight (Brownlie 1977:386, Global Invasive Species Database 2010, Palmer 2003:205). Lyon stated that it "spreads rapidly in [Hawai'i] gardens where it is sometimes a nuisance" (Wagner 1950:111).

Early botanists spent decades exploring Hawaiian ecosystems. Most of the botanical surveys listed in Table 1 were conducted over long periods of time. As examples: Menzies spent four months in the islands in the 1790s (St. John 1977); Mann (1867) and Brigham (1893) spent a year botanizing on the five largest islands; Heller (1897) spent many months on Kaua'i and O'ahu; and Hillebrand (1888)—a real fern enthusiast—spent twenty years botanizing all of the islands.

Evidence is provided also by the Hawaiian language literature and its many references to the pervasive fragrance of <**lauae**> (Tables A6-A7). This implies that there must have been some fairly large populations of <**lauae**> in the 19th century. If this had been *M. grossum,* it would be extremely unlikely that the species would have been overlooked by naturalists of that time.

The Victorian Fern Craze (1830-1914) assured that many avid amateur fern hunters were out searching for ferns to add to their collections. The intensity of this fad in England was evidenced in a letter written in 1834 by an exasperated Shropshire botanist who complained that, because of this "rabid rage," he had been "... pestered to distraction with letters from the learned and the unlearned, the young and the old, the masculine, feminine, neuter, and epicene genders" (Allen 1969:25).

Fern collecting was also very popular in Hawai'i in the 1800s, as evidenced by a voucher of *M. spectrum* deposited at the Herbarium Pacificum (BISH). A special label on the specimen explained that it was one of 86 fern species and varieties collected in 1888 by a Punahou School student, James R. Judd, who won first prize in their competition. Despite this obvious enthusiasm for fern collecting in Hawai'i in the 19th century, the very conspicuous *M. grossum* was not collected.

Finally, Robinson (1912, 1913) reviewed all fern specimens collected in Hawai'i between 1779 and 1912. In her own words, "The method in this study has been to examine the specimens as if they represented undescribed species, then to compare them with types so far as possible and with published descriptions" (Robinson 1912:231). As a result, a species that had been misidentified, would have been correctly named by Robinson, and the species, if previously unreported, would have been added to the list of ferns known from Hawai'i. Still, *M. grossum* was not found.

Additional support for M. grossum's 20th century introduction to Hawai'i. Ethnobotanical studies describe *M. grossum* as an important medicinal plant throughout Polynesia—from Futuna, Sāmoa, Tonga, and Niue, to the Cook, Society, Austral, and Marquesas Islands (Girardi *et al.* 2015, Whistler 1992). Despite this, *M. grossum* was not included by Handy *et al.* (1934) in

their list of 395 plants used for medicine in Hawai'i. If *M. grossum* had been present in Hawai'i when the Polynesians arrived, it is unlikely they would have stopped using it for medicine.

Designating *Microsorum spectrum* the native laua'e of Hawai'i

There can be little doubt that *M. spectrum* is the **laua'e** of ancient Hawai'i, in part because it epitomizes everything this study has gleaned from the literature about the **laua'e** of the 19th century. Additionally, data collected from herbarium specimens of *M. spectrum* deposited in Herbarium Pacificum (BISH), indicate that the species was collected from all six of the largest Hawaiian Islands prior to 1913, including all of the localities once famous for the scent of their **laua'e** (Herbarium Pacificum 2019). Furthermore, *M. spectrum* was described as "not uncommon on trees and rocks" in the latter half of the 19th century (Hillebrand 1888: 560). Together, these observations suggest that *M. spectrum* was sufficiently abundant and distributed widely enough to have been known to Hawaiians throughout the islands, as suggested by the early literature. Finally, definitive evidence that *M. spectrum* was known as **laua'e** was hand-written on two herbarium specimens of *M. spectrum* deposited at BISH. Botanists Rock and Lyon noted the name as "**lau ae** (or **rau**)" on a specimen collected on Hawai'i Island in 1909, and E. S. Craighill Handy's specimen, collected on Maui in 1933, wrote the name as "**LAUA'E.**" Unfortunately, this name for *M. spectrum* does seem to have been published in the 20th century—a circumstance that contributed to the near expunction of this knowledge from Hawaiian cultural memory.

Commingling historical and contemporary spellings of Polynesian plant names

The occurrence. Unfortunately, Joseph Rock was inadvertently given credit for documenting the Hawaiian word (HAW) <**laua'e**> as a name for *M. spectrum*—a distinction that correctly belongs to E. S. C. Handy. This occurred when the previously unpublished *Revised List of Hawaiian Names of Plants* (Rock 1920) was annotated and published 88 years later, and the original entry, "**Lauae** - *Polypodium spectrum*" (Rock 1920) was replaced by "**Laua'e** - *Polypodium spectrum* Kaulf. [*Microsorum spectrum* (Kaulf.) Copel. in Palmer (2003)] ..." (Gon 2008:424).

Notably, the latter entry includes the Linnaean name given by Rock (1920), as well as the contemporary Linnaean name, cited in Palmer (2003:188), but the Hawaiian name was treated differently, and <**Lauae**>, from the original manuscript (Rock 1920), was replaced—rather than supplemented—by <**laua'e**>, without citation of a source that documented <**laua'e**> as a name for *M. spectrum*. This created the anachronistic entry, *viz.* "**Laua'e** - *Polypodium spectrum* Kaulf." in Gon (2008), which seems to attribute HAW <**laua'e**> to Rock (1920).

As stated previously, Rock (1920) chose not to use glottal stops or macrons in his rendering of Hawaiian names, preferring to leave "such delicate work ... for Hawaiian scholars" (Rock 1920:i). It was appropriate, then, for editor Gon to use *Hawaiian Dictionary*—compiled by Hawaiian language scholars Pukui and Elbert (1986)—to "evaluate spellings [of Hawaiian words in Rock (1920)] and apply diacritical marks [to them]" (Gon 2008:406). In this instance, however, Pukui and Elbert (1961, 1971, 1986) could not be used to verify <**laua'e**> as a name for *M. spectrum,* since all of their editions define <**laua'e**> as a name for two introduced ferns species, currently known as *M. grossum* and *P. aureum*—the latter of which is more commonly known as **laua'e haole** (Pukui & Elbert 1986:194).

Gon (2008:406) also stipulated that, "Where it was not possible to deduce the appropriate Hawaiian spelling I have left the name unmodified." How, then, was <**laua'e**> chosen as the "appropriate" [modified] spelling for this word? The answer is from oral presentations of this study (including Anderson-Wong 2001), the results of which were published in Palmer (2003:207)—the source Gon used for contemporary Linnaean names of Hawai'i's fern species. It is inferred, then, that the spelling <**laua'e**> was chosen to reflect the most current disquisition on the name, and that the lack of a citation for the name <**laua'e**> in Gon (2008), was an oversight. Notably, however, this inadvertent attribution of the spelling <**laua'e**> to Rock (1920) would not have occurred if the source of each Hawaiian name—original and contemporary—had been cited. Doing so is not, to my knowledge, expected nor is it currently standard practice in botanical nomenclature, but perhaps it should be.

A suggested emendation. The following emendation to Gon's (2008) entry illustrates this principle, *viz.* "**Lauae -** *Polypodium spectrum* (Rock 1920) [**Laua'e** (Anderson-Wong in Palmer 2003:207) - *Microsorum spectrum* (Kaulf.) Copel. (Palmer 2003:188)]." This listing preserves the integrity of the original data from Rock (1920) and so avoids the unintentional, mistaken inference that Rock (1920) provided HAW <**laua'e**> as a name for *M. spectrum.* It also appropriately references Palmer (2003) as the only publication that cited research evidencing <**laua'e**> as a name for *M. spectrum.*

Spellings for Polynesian plant names: Historical and Optimal

This intricate example renders us the opportunity to examine constructively our understandings of certain linguistic concepts and documentary practices that can affect the integrity of indigenous plant name data.

First, Joseph Rock's (1920) practice of spelling Hawaiian plant names—including HAW <**lauae**> naming '*M. spectrum'*—without glottal stops or macrons, was consistent with the writing practices of that time (Schütz 1994:141-149) and is not, therefore, construed as a mistake. In fact, both English and Hawaiian language publications spelled the name as <**lauae**> until the mid-1940s (Table 2, Tables A6-A7). The first publication of HAW <**laua'e**> (Table 2) appears to have been in Neal (1948:26), a botanical work that gave <**laua'e**> as a name for *Polypodium phymatodes*—a name previously used for Hawai'i's *M. grossum*—just three years after Judd, Pukui, and Stokes (1945) became the first Hawaiian dictionary to *consistently* mark glottal stops in Hawaiian words (Schütz 1994:146). Thus, Neal's (1948) use of the spelling <**laua'e**> was consistent with the practices of *those* times.

Second, when Polynesians are no longer familiar with a plant name from their own language—which was documented in a source that did not use glottal stops and macrons—we cannot be sure of its pronunciation. In such cases, the best approach for determining the most appropriate spelling of the name "can be inferred from a comparison with cognates in neighbouring [sic] languages" (Rensch 2005:iii). As shown by this study, however, cognates of HAW **laua'e** do not occur in any other Polynesian language. In cases like this, only a historical reconstruction of the name in its native language—such as the one provided here—can provide sufficient evidence to support the conclusion that HAW <**laua'e**> was once a name for *M. spectrum.*

In my view, when original renderings of plant names are omitted from early historical works, and replaced with more recent spellings, historical information is lost, which, as shown here, can be vital to the reconstruction of indigenous names and restoration of indigenous knowledge. Early vocabulary lists and dictionaries are important works because they provide the raw materials used by 20th century lexicographers who, like Pukui and Elbert, were enabled by a full complement of phonemes—which was unavailable to earlier workers. These scholars "field checked" the meanings and pronunciation of these words before using the latter to determine what the authors described as the "preferred spelling" for each (Pukui & Elbert 1971:vii-xxxiv). When additional information became available, however, especially from linguistic reconstructions, the authors modified their spellings accordingly (Pukui & Elbert 1986:vii-x). It would seem advisable, then, to cite the sources of both Linnaean and Polynesian names, since either may change due to future findings.

The efficacy of using 19th century sources and a dual-disciplinary approach

This study demonstrates the efficacy of using early, 19th century sources, for a historical reconstruction—especially Polynesian dictionaries, plant name lists, and herbarium specimens. These materials provided indigenous knowledge and plant names unavailable elsewhere and were crucial to the success of this study. Also vital was the use of a dual-disciplinary approach, which combined knowledge referenced by both global Linnaean and indigenous Polynesian plant names and resulted in a fuller and more satisfying resolution to the questions underlying this investigation. Without evidence from Hawaiian culture, the study might have concluded that: *Science has found no evidence that the **laua'e** M. grossum was present in Hawai'i before 1900; moreover, <**laua'e**> was documented on an herbarium specimen as a Hawaiian name for the fragrant, endemic M. spectrum*. In this case, our indigenous culture is divorced from these findings which, if accepted, will require us to reassess the understanding we have had of **laua'e** for almost a century.

In my view, using evidence from *both* global and indigenous science means that we, as Hawaiians, are also invested in the process which led to the conclusion that *M. grossum* was not the fern our ancestors knew as **laua'e**. And, while the literature of both cultures tells us that the **laua'e** of the nineteenth century was very fragrant, only Hawaiian literature captures the essence of its pervasive fragrance and the metaphorical allusions it engendered—rendering us sensuous access to the lived past. I suggest that since our Hawaiian *tradition* of conveying TEK through narrative has been respected, we are more likely to appreciate that, if it had not been for one of the *protocols* of Linnaean science—in this case documenting indigenous names on voucher specimens—we may not have been able to reattach our name **laua'e** with its original meaning, '*M. spectrum'*. As we reacquaint ourselves with the native **laua'e** *M. spectrum,* we may find ourselves considering it a better fit for the prose of the Hawaiian poet-scientists and a source of inspiration for contemporary cultural practices, including the conservation of native species precious to our ancestors.

Hawaiian laua'e and Polynesian taxonomy of the past, present, and future

The origin of HAW **laua'e** reconstructed here and that of *M. spectrum's* alternate name, HAW **pe'ahi**, is consistent with our understanding of indigenous taxonomy and Polynesian history. The prior tells us that when indigenous botanists emigrated,

they sometimes gave pre-existing names to previously unknown taxa that were similar in form or function to the species they named in their original homeland (Berlin 1992, Turner 2014, Whistler 1995). The latter attests to the founding of the Hawaiian Islands by indigenous emigrants from both the Marquesas and Society (Tahitian) Islands (Allen 2014, Kirch 2011, 2017).

***Laua'e** and **pe'ahi:** The earliest Hawaiian names for M. spectrum.* This work proposes a Tahitian origin for HAW **laua'e**, and infers that ancient Tahitian emigrants to Hawai'i created the compound name PTa ***rau**-**ake** 'leaf ***ake**' for the endemic Hawaiian *M. spectrum*, because they perceived it as a leafy type of the [unidentified] species which they had referred to as PTa ***ake** in their Tahitian homeland. It is inferred that PTa ***ake** became TAH **a'e**, which Davies (1851:6) defined as "<**ae**>," the name of a sweet-scented plant, used for the sweet *monoi* or native oil," and that PTa ***rau**-**ake** became HAW **laua'e**, which was described by Andrews (1865:323) as "<**lauae**>, an aromatic herb." It is inferred that the name PTa ***ake** was given to both species because each is "sweet-scented" and was used to scent coconut oil (Results 4 & 6).

HAW **pe'ahi**, on the other hand, has a distinctly Marquesan pedigree. Its presumed ancestor, Proto-Marquesic (PMq) ***pekahi**, with the gloss 'fan' (Greenhill & Clark 2011), has reflexes in Marquesas, Mangareva, and Hawai'i. It is only in Hawai'i, however, that this word also names a plant species, *viz. M. spectrum*—presumably because the general outline of the Hawaiian **pe'ahi** fan is reminiscent of the shape of *M. spectrum* leaves, which, although variable, are most often palmately 3-lobed (Palmer 2003:188), with two lobes at the top—earning it the appellation "the Hawaiian Ivy fern of the lower forest zone" (Rock 1920:37).

Notably, cognates of HAW **laua'e** and **pe'ahi** were not found as plant names in other Polynesian languages, suggesting that both are unique to Hawai'i. It is reasonable to infer that Hawaiian indigene created new names for *M. spectrum,* because its distinctive morphology made it unlike other fern species they had known—especially its conspicuous leaf venation, the atypical shape of its fronds, and the way they are well separated on long, slender, creeping rhizomes (Palmer 2003: 188).

Laua'e wahine** and **laua'e kāne**: indigenous binomials for the original **laua'e**.* Two 19th century Hawaiian binomials, <**lauae wahine**> and <**lauae kane**> (Brigham 1893), were brought out of obscurity by this study (Table 2), the resolution of which informs us that they are two "types" of the native **laua'e**, *M. spectrum.* The names are inferred here as ***laua'e wahine 'female ***laua'e***' and ***laua'e kāne*** 'male ***laua'e***', but no information was found regarding how these types were distinguished.

***Laua'e** as a name for fern species introduced to Hawai'i in the 20th century.* The name **laua'e** was also used to name two 20th century introductions, *M. grossum* and *P. aureum.* It is inferred that *M. grossum* was the first of these to be named **laua'e**, and that it was so named because its scent is similar to that of *M. spectrum,* which has a very different morphology than *M. grossum.* The native **laua'e**, *M. spectrum,* has palmately-lobed leaves, with 3 to 11 irregularly-shaped segments, prominent veins, and small *sori,* while the leaves of *M. grossum* are deeply pinnately-lobed, with 2 to 10 pairs of oppositely arranged lobes, obscure veins, and large *sori*—which are embedded deeply into the leaves (Palmer 2003:188,205). Similarly, the woody vine, *Alyxia stellata*, and the ferns *M. grossum* and *M. commutatum,* have similar scents and share names cognate with **maire** and **oro** in some parts of East Polynesia (Fig. 2).

Logical inference suggests that the name **laua'e** was subsequently given to the unscented *P. aureum* because its leaves, which are deeply pinnatifid, are superficially similar to those of *M. grossum*—from which it can be distinguished by its "dull, bluish green fronds, creeping rhizomes densely covered with golden scales ... bluish veins and yellow sori" (Palmer 2003:203). This species, also known as **laua'e haole**, was first collected as a naturalized species in Hawai'i in 1910 (*Forbes 308* BM) (Robinson 1913: 202)—nine years before *M. grossum* was initially documented as a naturalized species, in 1919 (*Forbes 1778.M,* BISH) (Wilson 1996:134). It may be that *P. aureum* was not given a Hawaiian name until it needed to be distinguished from the scented *M. grossum,* which, as mentioned previously, was already known as HAW **laua'e** in 1923. It is inferred also that the name **laua'e haole**, meaning 'foreign', or 'non-Hawaiian' **laua'e** was given to the species because it was not scented, thus identifying it as something foreign to the Hawaiian conceptualization of **laua'e**.

***Laua'e**-nomials proposed for the 21st century.* The following binomial names are proposed to distinguish between the two scented, culturally important fern species known as **laua'e** in Hawai'i today—*viz.* **laua'e maoli**, 'native **laua'e**' for *M. spectrum* and **laua'e hānai** 'adopted **laua'e** for the alien *M. grossum.* The qualifier *hānai* is especially apt for *M. grossum* because this plant was not only *hānai* 'adopted' by our ancestors, but eventually became the *hānai* 'caretaker or sustainer' of our cultural attachment to the original **laua'e**. The word *hānai* 'adopted' also communicates the meaning 'non-native' while conveying

the fern's intimate connection to Hawaiian culture. These proposed names also distinguish the two scented **laua'e** from the unscented **laua'e haole** 'foreign/non-Hawaiian **laua'e**', *P. aureum.*

Cultural assimilation of *M. grossum*

It is well known that introduced species have become salient to cultures worldwide (Anderson 1967, Garibaldi & Turner 2004, Sauer 1969). The **laua'e** *M. grossum* seems to have been assimilated into Hawaiian culture very rapidly—in a single decade—probably because a niche had already been carved for it by its predecessor, *M. spectrum.* Eventually, it became a *lā'au hānai* 'adopted plant'—a designation I propose to distinguish species introduced after European contact that have become widely recognized as a part of Hawaiian culture. What makes the **laua'e** *M. grossum* remarkable among these, however, is not the introduction of something new for our senses to enjoy, but rather the fact that it has allowed us, as Hawaiians, to perpetuate our relationship with the native **laua'e** by acting as its surrogate, both materially—as a scented leaf, and emotionally—as a representation of the 'beloved' **laua'e** of our ancestral chants and stories.

Laua'e, cultural memory, and biocultural diversity

From our perspective, in the early part of the twenty-first century, it seems that the significance of the native **laua'e**, *M. spectrum,* was passed to the alien **laua'e**, *M. grossum,* seamlessly and almost imperceptibly. After 1920, awareness of two different **laua'e** ferns declined as populations of the native **laua'e** shrank, and as Hawaiian lifestyles involved less and less interaction with native forests. By the time this study was undertaken, there were very few elders who could still describe a **laua'e** other than *M. grossum.* Nancy, of Hā'ena, Kaua'i, was one who could.

> … My brother use to go get the **laua'e***,* Hawaiian **laua'e** … Oh, you can smell the **laua'e***.* No more over there any more. I never did see any more **laua'e***.* They're not real big, they short, they fat, but sweet smell. When you go in you smell only the aroma. You know smell only the aroma, and the Hawaiian **laua'e** strong, when on your neck like just like how you smell the **mokihana***,* the **laua'e***,* Hawaiian **laua'e** is just like that (Andrade 2008:39).

This study demonstrates that cultural memory can be ambivalent, i.e., possessing 'both [opposing] strengths' (Harper 2016). On one hand, cultural memory allowed the surrogate, *M. grossum,* to signify—and so perpetuate—the emotional significance of the native **laua'e**, *M. spectrum,* in contemporary environs, where Hawaiians are no longer surrounded by the native species and ecosystems that inspired our ancestors. On the other hand, memory of the original **laua'e** was almost completely expunged from our collective memories. Had it not been for the controversy that sparked this study, knowledge of a native **laua'e** might have passed into obscurity.

Even more sobering is the realization that the **laua'e** story told here is just one example of how native species loss and environmental change can lead to losses in cultural knowledge and language—a global phenomenon that has become an important focus in the emerging field of biocultural diversity (Loh & Harmon 2014, Maffi 2005, Nettle & Romaine 2000, Pretty *et al.* 2009).

Laua'e and conservation

Using alien **laua'e***, M. grossum,* for cultural activities, in lieu of the native *M. spectrum,* is a "conservation friendly" choice in certain respects. Populations of the endemic **laua'e***, M. spectrum,* are difficult to find these days, and cannot sustain harvesting, since the species was recently designated an "imperiled taxon," with only about 250 plants remaining in the wild (Keir & Weisenberger 2014). In contrast, *M. grossum* spreads rapidly in disturbed lowland forests and in cultivation, putting up a crowded mass of fronds on its sturdy rhizomes. It can survive salt spray, if irrigated, and is only temporarily inconvenienced by repeated mowing (personal observation). Even the large quantity of **ti** leaf and **laua'e** (*M. grossum*) needed to make lei **laua'e** for a hula festival could be cultivated near human habitations and harvested sustainably. However, *M. grossum* is an invasive species, and its salience to Hawaiian culture should be weighed against "the risks that [it] entails for native habitats" (Nuñez & Simberloff 2004).

This study also demonstrates that the conservation of native species is important to the retention of indigenous knowledge (Anderson-Fung & Maly 2002), since a dramatic decline in the abundance and distribution of *M. spectrum* predated the nearly-irreversible loss of our awareness that HAW **laua'e** once named *M. spectrum*. Conversely, restoration of this indigenous knowledge should bolster efforts to conserve *M. spectrum now that* its importance to Hawaiian culture is again realized.

This **laua'e** story is a detective mystery with a dramatic conclusion, in which memory of the native **laua'e** is snatched from the brink of extinction, giving us another chance to build a relationship with our first love. As we pause to reflect, in the denouement, on what we almost lost, we should ask ourselves: (1) What factors caused native **laua'e** populations to be reduced in abundance and distribution? (2) Should we support efforts to reduce or remove those factors from native ecosystems? (3) Shall we join efforts to protect, cultivate, outplant, and restore this species?

In a broader context, the **laua'e** *M. spectrum* can serve as an example of the silent loss of things known, loved, and celebrated by earlier peoples. Cultural memory allows culture to adapt, survive and continue in current circumstances, but we humans can adapt. What is our obligation to the native species that cannot adapt to the kinds of changes we have brought?

Conclusions

Key methods, results, and findings. This study resolved a quandary posed by two seemingly incompatible perspectives, *viz.* had the **laua'e**, *M. grossum,* been introduced to Hawai'i after 1900, as stated by fern taxonomists, or had it been part of Hawaiian culture since earliest times, as asserted by certain cultural specialists? Assuming both expert opinions were correct, I posited a third possibility, i.e. that there must have been a different species known as **laua'e** in Hawai'i before 1900. Resolution was achieved by reconstructing the history of Hawaiian **laua'e** from 1779-2000 and restoring indigenous knowledge of the species it originally named.

(1) No evidence was found to support the view that *M. grossum* was present in Hawai'i before 1900. (a) Records of all Polypodiaceae species documented in the Hawaiian Islands between 1779-1900 did not include *M. grossum* (Result 1). (b) Indigenous names recorded for the *Microsorum* species of Polynesia were also consistent with this finding (Result 2). (2) Both English and Hawaiian literature of the 19th century attested to the existence of a fragrant plant named <**lauae**> in the Hawaiian Islands at that time. (a) A 19th century Hawaiian-English dictionary specified that <**lauae**> was "an aromatic *herb*" [emphasis added] (Andrews 1865:323) (Result 3), and (b) the Hawaiian literature described its cultural salience—especially its use in scenting oils for dyes and its pervasive fragrance—which was associated with particular localities and persons much loved (Result 4).

(3) To determine if the 19th century plant name <**lauae**> would be spelled <**laua'e**> using contemporary orthography, and to seek clues to the identity of the species it named, linguistic cognates of HAW **laua'e** and **a'e**—naming plant species—were sought among 12 Polynesian languages. (a) No cognates of HAW **laua'e** were found elsewhere in Polynesia, suggesting that the name was unique to Hawai'i (Result 5). (b) Cognates of HAW <**a'e**>, however, were present in six other Polynesian languages, wherein they name one or more of five tree genera, as is the case in Hawai'i. One unique meaning, from a 19th century dictionary, defined Tahitian <**ae**>—inferred here as the cognate **a'e**—as "the name of [an unidentified] sweet-scented plant, used for the sweet *monoi* or native oil" (Davies 1851:6) (Result 6). This suggested that HAW **laua'e** may have been constructed in Hawai'i to name a species that was a *lau* 'leaf' or 'leafy' plant which, like TAH **a'e**, was sweet-scented and used to scent oil. If this etymology is correct, then the 19th century HAW <**lauae**> naming 'an aromatic herb' (Andrews 1865) most likely references the contemporary spelling <**laua'e**>. (4) Qualities attributed to <**lauae**> in the 19th century literature were discussed with others knowledgeable about native Hawaiian plants, yielding the inference that it was likely the endemic Hawaiian fern, *M. spectrum.* This supposition was verified by hand-written notations on two herbarium specimens of *M. spectrum*—one of which recorded the name "**lau ae** (or **rau**)" from Hawai'i Island in 1909 (J. Rock & H. Lyon, BISH 8625) and a second, collected at Hana, Maui, in 1933, that specified <**laua'e**> as the name of the species (E. S. Handy, BISH 149392) (Result 7).

Meeting the challenge. This study's resolution not only restored the original connotation of HAW **laua'e** as a name for *M. spectrum,* but it also identified the confluence of events that led to the obfuscation of this understanding. (1) Biocultural change in the composition and use of native forests resulted in a marked decline in the abundance and distribution of *M. spectrum* during the 20th century. In the 1880s, the species was "not uncommon on trees and rocks" on the six largest Hawaiian islands (Hillebrand 1888), after which, its populations declined, to the point of its being designated an "imperiled taxon" in 2014. (2) Botanical records indicate that the similarly-scented *M. grossum* was: introduced to Hawai'i after 1913; known to have been naturalized by 1919; and documented as HAW <**lauae**> in 1923 (Table 2). The species spread rapidly in lowland ecosystems, became popular in residential and commercial landscaping, and grew quickly in popularity and usefulness in both Hawaiian and non-Hawaiian communities. (3) After 1936, all published references found for a plant named **laua'e**—using this or a variant spelling—referred only to *M. grossum.* Additionally, **laua'e** appears never to have been published as a name for the native *M. spectrum* fern, in either the 19th or 20th century. (4) By the 1990s, *M. grossum* was the *only* scented **laua'e** known to most Hawaiians, and the assertion that it had been introduced to Hawai'i after 1900 resulted

in consternation by cultural experts who understandably—but erroneously—believed that the **laua'e**, *M. grossum,* had been part of Hawaiian culture since long before 1900.

*Protecting **laua'e** lore for the future.* This study proposes that **laua'e maoli** and **laua'e hānai** would be suitable and effective names for *M. spectrum* and *M. grossum,* respectively—uniquely identifying each species, honoring its role in Hawaiian culture, and helping to perpetuate the knowledge that there are two scented **laua'e** in Hawai'i—the **maoli** 'native' and the **hānai** 'adoptee'. These binomials also distinguish the species from the unscented **laua'e haole** 'foreign **laua'e**', *P. aureum.*

Broader relevance. This tale of Hawai'i's two fragrant **laua'e** ferns exemplifies the constructive adaptability of cultural memory to wide-spread changes in the biocultural environment, while also demonstrating that changes like these can precipitate a loss of indigenous knowledge. Here, Hawaiian cultural memory adapted so well that the introduced **laua'e**, *M. grossum,* subsumed the cultural significance of the native **laua'e**, *M. spectrum,* and awareness of a precursory **laua'e** was nearly extinct by the time this investigation was impelled (Anderson-Wong 2001). The story is also heartening, however—demonstrating that indigenous knowledge can also be restored, by reconstructing the history of an indigenous plant name and the Linnaean species it identifies, using a dual disciplinary approach that combines knowledge referenced by global Linnaean and indigenous Polynesian plant names, English and Hawaiian literature, comparative Polynesian linguistics, and herbarium specimens.

Declarations

***Abbreviations**:* HAW - prefix for Hawaiian words; iK - indigenous knowledge; TAH - prefix for Tahitian words; TEK - Traditional ecological knowledge.

Ethics approval and consent to participate: All cultural and botanical specialists provided prior informed consent before being interviewed.

***Consent for publication**:* Kai Markel and Clyde Imada gave consent to publish their photos in this work, and Ku'uleilaua'e Fung gave permission to have her image taken and published.

***Availability of data and materials**:* Data from literary sources were recorded in an appendix that will be made available with the manuscript at *Ethnobotany Research and Applications* and at the Scholar Space website at the University of Hawai'i at Mānoa (https://scholarspace.manoa.hawaii.edu/home).

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Appendix for the tale of Hawai'i's two scented laua'e, *Microsorum spectrum* and *M. grossum.*

Data used to reconstruct the history of the Hawaiian plant name laua'e and determine its relatedness to Polynesian names for *Microsorum* or other plant species.

Part I. Polynesian languages and consonant correspondences.

Table A1. Consonant correspondences for Polynesian languages in this study

Language													
PPN	**p*	**t*	**k*	**m*	**n*	**ng*	*ʻ*	**f*	**s*	**h*	**w*	**l*	**r*
Ton (Tongan)	*p*	*t, s*[a]	*k*	*m*	*n*	*ng*	*ʻ*	*f*	*h* [d]	*h*	*v*	*l*	*Ø, l*
Niu (Niuean)	*p*	*t* [b]	*k*	*m*	*n*	*ng*	*Ø*	*f*	*h*	*h*	*v*	*l*	*Ø, l*
PNP	**p*	**t*	**k*	**m*	**n*	**ng*	**q*	**f*	**s*	*Ø/*h*	**w*	**l*	**l*
EUv (East Uvean)	*p*	*t*	*k*	*m*	*n*	*ng*	*ʻ*	*f*	*h*	*Ø/h*	*v*	*l*	*l*
EFu (East Futunan)	*p*	*t*	*k*	*m*	*n*	*ng*	*ʻ*	*f*	*s*	*Ø/s*	*v*	*l*	*l*
PEc	**p*	**t*	**k*	**m*	**n*	**ng*	**q*	**f*	**s*	*Ø/*h*	**w*	**l*	**l*
Sam (Samoan)	*p*	*t*	*ʻ*	*m*	*n*	*ng*	*Ø*	*f*	*s*	*Ø/s*	*v*	*l*	*l*
PEcO	**p*	**t*	**k*	**m*	**n*	**ng*	*Ø*	**f*	**s*	*Ø/*h*	**v*	**l*	**l*
Tok (Tokelauan)	*p*	*t*	*k*	*m*	*n*	*ng*	*Ø*	*f*	*h*	*Ø/h*	*v*	*l*	*l*
PEP	**p*	**t*	**k*	**m*	**n*	**ng*	**q* [c]	**f*	**s*	*Ø/*h*	**w*	**r*	**r*
Eas (Rapanuian)	*p*	*t*	*k*	*m*	*n*	*ng*	*ʻ*	*h*	*h*	*Ø*	*v*	*r*	*r*
PCE	**p*	**t*	**k*	**m*	**n*	**ng*	*Ø*	**f*	**s*	*Ø*	**w*	**r*	**r*
PMq (from PCE)	**p*	**t*	**k*	**m*	**n*	**ng*	*Ø*	**f*	**h*	*Ø*	**w*	**r*	**r*
Haw (Hawaiian)	*p*	*k*	*ʻ*	*m*	*n*	*n*	*Ø*	*h*	*h*	*Ø*	*w*	*l*	*l*
PNM (from PMq)	**p*	**t*	**k*	**m*	**n*	**ng*	*Ø*	**f*	**h*	*Ø*	**w*	**r*	**r*
MqS (S. Marq.)	*p*	*t*	*ʻ*	*m*	*n*	*n*	*Ø*	*f*	*h*	*Ø*	*v*	*ʻ*	*ʻ*
MqN (N. Marq.)	*p*	*t*	*k*	*m*	*n*	*k*	*Ø*	*h*	*h*	*Ø*	*v*	*ʻ*	*ʻ*
Mva (Mangarev.)	*p*	*t*	*k*	*m*	*n*	*ng*	*Ø*	*ʻ*	*ʻ*	*Ø*	*v*	*r*	*r*
PTa (from PCE)	**p*	**t*	**k*	**m*	**n*	**ng*	*Ø*	**f*	**s*	*Ø*	**w*	**r*	**r*
Mao (NZ Maori)	*p*	*t*	*k*	*m*	*n*	*ng*	*Ø*	*wh, h*	*h*	*Ø*	*w*	*r*	*r*
Rar (Rarotongan)	*p*	*t*	*k*	*m*	*n*	*ng*	*Ø*	*ʻ*	*ʻ*	*Ø*	*v*	*r*	*r*
Rur (Rurutuan)	*p*	*t*	*ʻ*	*m*	*n*	*ng*	*Ø*	*ʻ*	*ʻ*	*Ø*	*v*	*r*	*r*
Tub (Tubuaian)	*p*	*t*	*ʻ*	*m*	*n*	*ʻ/ng*	*Ø*	*h*	*h*	*Ø*	*v*	*r*	*r*
Tah (Tahitian)	*p*	*t*	*ʻ*	*m*	*n*	*ʻ*	*Ø*	*f, h*	*h*	*Ø*	*v*	*r*	*r*
Tua (Tuamotuan)	*p*	*t*	*k*	*m*	*n*	*ng*	*Ø*	*f, h*	*h*	*Ø*	*v*	*r*	*r*

Legend. Consonant correspondences follow Marck (2000). Abbreviations for extant and proto-languages are given in Table A2. Proto-consonants are preceded by an '*' asterisk. Glottal stops are shown as **q* in proto-languages and a single opening quotation mark (**ʻ**) in living languages. Superscripts: (a) Tongan [s] before *i* ; (b) Niuean [ts] or [s] before *e* and *i* ; (c) In EP, the PPN glottal stop is retained only in Rapanui; (d) Rensch (1987:577) shows some forms with *s.*

Table A2. Polynesian language abbreviations and inferred relationships

Western Polynesia

WP proto-languages:	**WP extant languages:**
• **PPN-** Proto-Polynesian - became two proto-languages:	
• **PTo-** Proto-Tongic - which became: →	**Ton** (Tongan) and
	Niu (Niuean).
• **PNP**- Proto-Nuclear Polynesian - which became:	
• the Futunic languages, including: →	**EUv** (E. Uvean),
	EFu (E. Futunan),
	Puk (Pukapukan), and
• the Futunic Outlier languages* and	
• **PEc** - Proto-Ellicean - which became:	
• the Samoan language: →	**Sam** (Samoan), and
• **PEcO**-Proto-Ellicean Outlier, ancestor to Ellicean Outlier languages, including: →	**Tok** (Tokelauan), and
• **PEP** - Proto-East Polynesian. ancestor to EP languages.	

East Polynesia

EP proto-languages:	**EP extant languages**:
• **PEP**- Proto-East Polynesian - became: →	**Eas** (Easter Is./Rapanuian) and
• **PCE**- Proto-Central Eastern Polynesian which split into two proto-languages:	
• **PTa**- Proto-Tahitic - became languages of:	
Aotearoa (N.Z.), including: →	**Mao** (N.Z. Māori, broadly),
	Rar (Rarotongan), and
the Cook Islands, including: →	**Ckm*** (Cook Is. Māori, broadly)
the Tuamotu Islands, i.e. →	**Tua** (Tuamotuan), and
the Society Islands, i.e. →	**Tah** (Tahitian), and
the Austral Isles, including: →	**Rur** (Rurutuan), and
	Tub (Tubuaian), and
	Rap (Rapan).
• **PMq** Proto-Marquesic - which became:	**Haw** (Hawaiian) and
• **PNM** Proto-Nuclear Marquesic - which became:	**Mqa** (Marquesan, broadly),
	MqS (Southern Marquesan),
	MqN (Northern Marquesan),
	Mva (Mangarevan).

Legend. Language abbreviations and inferred relationships follow Marck (2000). *Note: This study did not include Futunic Outlier languages or Ellicean Outlier languages, with the exception of Tokelauan (TOK). **Ckm** (Cook Is. Māori) does not include **Pen** (Tongarevan) and **Puk** (Pukapukan) in the Northern Cook Islands.

Part II. Polynesian names for *Microsorum* species (Tables A3-A5)
Table A3. Polynesian and Linnaean names for *Microsorum grossum*.

At this writing, *Microsorum grossum* (Langsd. & Fisch.) S. B. Andrews and *Microsorum scolopendria* (Burm. f.) Copel (syn. *Polypodium phymatodes* L.) are considered two very closely related species—based on the results of molecular studies (Krier *et al.* 2008:1165).[1] It has also been determined recently that, of these two species, the one that occurs in Polynesia—as an alien species in the Hawaiian Islands and as an indigenous species throughout the rest of its range—is actually *M. grossum*,[2] which has, for decades, been misidentified as *M. scolopendria* (see text). This does not include *Polypodium phymatodes auct.: E. Drake* from the Society Islands, or *Polypodium phymatodes* from Rapanui.[3]

Island group	**Source**	**Linnaean name given by source**	**Indigenous name for the fern** (as given in source)	**Fra-grant ?**
Haw	See text	See text	***lauaʻe***	Yes
Mqa	Jardin 1858	*Polypodium phymatodes*	**papamoko**	n.m.
Mqa	Drake del Castro 1893	*Polypodium phymatodes*	**papamoto**	n.m.
Mqa	Dordillon 1904 Dictionary	*Polypodium phymatodes*	**papamoko, papamoʻo**	n.m.
Mqa	Handy 1923 (p. 79)	*Polypodium phymitodes*	**papamoʻo**	n.m.
Mqa	Brown and Brown 1931	*Polypodium phymatodes*	Fatuhiva: **oumoo**, Nukuhiva: **paamoe**, Hivaoa: **maapuaa**	n.m.
Mqa	Emory 1947	*Polypodium phymatodes*	Fatuhiva: **oumoo, maʻapuaʻa** Nukuhiva: **paʻamoe**.	n.m.
Mva	Tregear 1899 Dictionary	No Latin name given.	**mouku:** ‘a species of scented fern’ [No Latin name given.]	**Yes**
Mva	St. John 1988 [collected 1934]	*Microsorum scolopendria*	**moku papa, potini**; [n.b. The name **potini** was given to many fern species.]	n.m.
Mva	Emory 1947	*Polypodium phymatodes*	**moku papa** (when young), **moku roa** (when mature)	n.m.
Mva	Rensch 1991	*Phymatosorus scolopendria*	**moemoe**	n.m.
Mva	Rensch 1991	*Polypodium phymatodes*	**mouku roa** ‘fougère odoriférante’	**Yes**
Mva	Butaud 2013	*Microsorum grossum*	**moku papa, moku roa, potini**	n.m.
Tah	Guillemin 1837	*Polypodium phymatodes*	**atua buaa** [Perhaps meaning *atu-a-puaa* ‘from pigs’ (Anderson-Fung)]	n.m.
Tah	Davies 1851 Dictionary	No Linnaean names given	No **atua buaa** or **metua puaa** in dictionary **oro** ‘the leaves of a little sweet-scented plant’	NR
Tah	Nadeaud 1864	*Polypodium alternifolium*	**metua-puaa** *Polypodium alternifolium* Wild.	
Tah	Sachet & Lemaître 1983; Fosberg & Sachet 1987	*Polypodium scolopendria*	**metua puaʻa, ʻiri o peho**	n.m.
Tah	Sachet 1983[1]	*Polypodium scolopendria*	**oro, iriopeho, atuapuaa** (on Tupai Is., but see note below)	n.m.
Tah	Pétard 2011[2] (p. 77)	*Phymtosorus gross./scolo.*[2]	**metuapuaa,** an excellent fern for medicine.	n.m.
Tua Isles	Tregear 1895 Dictionary	No Linnaean names given	**kikipa** defined ‘fern, bracken’ No other names for this sp.	n.m.

Tua NW	Wilder 1934	*Polypodium phymatodes* L.	**metua puaa** (on Makatea)	n.m.
Tua NE	Emory 1947	*Polypodium phymatodes*	**rahamo** (at Napuka)	n.m.
Tua various	Emory 1947	*Polypodium phymatodes*	**oro** when sprouting (Anaa, Napuka, Tatakoto, Vahitahi)	n.m.
Tua various	Emory 1947	*Polypodium phymatodes*	**kikipa** (Anaa, Fangatau, Hao, Takaroa, Vahitahi)	n.m.
Tua various	Emory 1947	*Polypodium phymatodes*	**ngohengohe** (at Fangatau, Napuka, Tatakoto)	n.m.
Tua Reao	Emory 1947	*Polypodium phymatodes*	**maire** when mature (Reao); **orohau** if sprouting (Reao)	n.m.
Tua middle	Wilson 1954	*Microsorum scolopendria*	**kikipa** (Raroia)	n.m.
Tua	Stimson & Marshall 1964	*Polypodium scolopendrium*	**kikipa** (general Tua term);	**Yes**
Tua 2 isles	Stimson & Marshall 1964	*Polypodium scolopendrium*	**maire** on (Reao, Vahitahi) **maire hau** (Vahitahi)	**Yes**
Tua Vahi.	Stimson & Marshall 1964	*Polypodium scolopendrium*	When young: **oro**, or **oronana** (Vahitahi)	**Yes**
Tua	Florence 2021 [In Press]	*Microsorum grossum*	*M. grossum* is the only species of *Microsorum* at Tuamotus.	n.m.
Austrl 2 isles	Brown and Brown 1931	*Polypodium phymatodes*	Rurutu: **moomoo**, **moomoo mairi**; Tubuai: **metua pua'a**	n.m.
Austrl Rapalti	Brown and Brown 1931	*Polypodium phymatodes*	**ero**, **mailitutaipua, maili, maitutaimoa,**	n.m.
CkS Rar	Wilder 1931[3] ; Savage 1962	*Polypodium scolopendria*	Rarotonga: **maire** [source: "fragrant after wilting"[3]]	**Yes**[3]
CkS Rar	Whistler 1990	*Phymatosorus scolopendria*	**maire, maire tūtae puaka**, Note: **maire** is "a general Rarotongan name for ferns," but most often used to name this species (p. 374)	n.m.
CkS	Whistler 1990 McCorm. 2007	*Microsorum grossum*	**maile, maile lau kōtaha,** **maire, maire rau kōtaha**	**!!**
CkS	Whistler 1990 McCorm.2007	*Microsorum grossum*	**oro, maire, maire 'enua, pōkā'ara** **tūrei mangamanga, maire tūtae-puaka**	
CkS	Whistler 1990	*Phymatosorus scolopendria*	Mangaia: **poka'ara**, Ngaputoru: **turei mangamanga**	**Yes**, n.m.
CkS	Sykes & Game 1996	*Phymatosorus grossus*	**maire, maire tutae puaka,** **poka'ara, turei mangamanga**	n.m.
Nzm	Breitwieser 2016	Not present	Not present in Aotearoa	--
Eas	Meyer 2013	Not present	Not present in Rapa Nui	--

Sam	Bryan 1935	*Polypodium scolopendria*	var. *longipes* is: **lau-mangamanga**	n.m.
Sam	Bryan 1935; Parham 1972	*Microsorum scolopendria*	**fiso vao**	n.m.
Sam	Whistler 1996, 2000	*Phymatosorus scolopendria*	**alofilima, lau ʻautā** **lau magamaga**	n.m.
EFu	St. John & Smith 1971	*Phymatodes scolopendria*	E. Futuna: **tigaʻa niu**	n.m.
Ton	Whistler 1991	*Phymatosorus scolopendria*	Tonga isles: **laufale**; Niuatoputapu: **matui**; Niuafoʻou: **akaʻi tui, tui,**	n.m.
Niu	Sykes 1970	*Phymatodes scolopendria*	**mamanu; monu**	n.m.

Legend. **Abbreviations:** Austrl-Austral Isles; Ckm-Cook Isles (generally); CkS-Southern Cook Islands; Eas-Easter Island (Rapanui); EFu-E. Futuna; Haw-Hawaiʻi; Mqa-Marquesas Islands (generally); Mva-Mangareva; Niu-Niue; Nzm-New Zealand Islands (generally); Rar-Rarotongan; Sam-Samoa; Tah-Tahiti; Tok-Tokelau; Ton-Tonga; Tua-Tuamotu. **Zig-zag lines** separate island groups. **Notes: [1]Note 1:** In earlier work, Nooteboom (1997:361-362) concluded that *M. scolopendria* (Burm. f.) Copel, *P. phymatodes* L., and *M. grossum* (Langsd. & Fisch.) S. B. Andrews were one species, which he synonymized as *M. scolopendria.* According to Krier *et al.* (2008:1165), "The current data suggest a separation between *M. grossum* and *M. scolopendrium* [sic] but it is not clear if this separation reflects a speciation event or intraspecific phylogeographic variation in a single species, *M. scolopendrium.*" Further molecular studies could, therefore, substantiate Nooteboom's (1997) conclusion. **[2]Note 2:** In Polynesia, *M. grossum* has been identified and misidentified as the following species (Florence 2021): *Polypodium alternifolium* auct. pl.; *Polypodium phymatodes* auct. pl.; *Drynaria vulgaris* auct.: W. D. Brackenridge; *Pleopeltis phymatodes* auct.: W. Carruthers, in B.C. Seemann, Fl. Vit.: 364 (1873); *Polypodium scolopendria* auct. pl.; *Polypodium vitiense* auct.: E.B. Copeland, *Bernice P. Bishop Mus. Bull*. 93:73 (1932); *Microsorum scolopendria* auct. pl.; and *Phymatodes scolopendria* auct. pl. This does not include: *Microsorum scolopendria* auct.: E.B. Copeland, *Occ. Pap. Bernice P. Bishop Mus*. 14(5):73 (1938) or *Phymatodes scolopendria* auct.: N. Hallé, *Cah. Indo-Pacif*. 2(3):127 (1980). **[3]Note 3:** Additional synonymy for *Microsorum grossum* was provided by these sources: Hawaiʻi (Palmer 2003, Wagner et al. 2005); Marquesas, Mangareva, Society, Tuamotu, Austral (Florence et al. 2007, Florence 2021); Cook Islands (McCormack 2007); NZM-New Zealand (Breitwieser et al. 2016); EAS-Rapanui-Easter Island (Meyer 2013); Samoa, Tonga, Niue (Whistler 2000).

Table A4. Polynesian and Linnaean names for *Microsorum commutatum* and *Alyxia* spp.

Species listed here were designated *Microsorum commutatum* (C. L. Blume) E. B. Copeland by Nooteboom (1997)[1]. Polynesian species in *Alyxia* Banks ex R. Br. are listed also, since they often share the Polynesian name **maile/maire** with this fern.

Island group	**Source** (Source of *Alyxia* name in parentheses, if different)	**Linnaean name given by source**	**Indigenous name for the fern** (as given in source)	**Fra-grant?**	Name for ***Alyxia***
Haw	Palmer 2003	Not present	NR	NR	**maile**
Mqa	Jardin 1858:9	NR	This fern species not listed. This entry is for name given *Alyxia.*	NR	*Alyxia* = **katea**
Mqa	Brown and Brown 1931; (Brown 1935)	*Polypodium euryphyllum* var. *marquesense*	None name given. This variety at Tahuata Is.	Yes	*Alyxia* = **mehe, mei'e**
Tah	Davies 1851	No Linnaean name given.	**maire** 'a sweet scented fern' **oro** 'the leaves of a little sweet-scented plant'	Yes	Not given
Tah	Nadeaud 1864	*Polypodium scandens* (note)[2]	**maire** (mature fronds) **oro** (when newly emerged)	Yes	--
Tah	Nadeaud 1873	*Polypodium pustulatum*	**maire** (when fronds mature); **oro** (when fronds young)	Yes	*Alyxia* = ***maire***
Tah	Henry 1928[3]	*Polypodium*[3] *pustulatum?* [as written by the author]	**maire** (mature) used to perfume coconut hair oil, to make wreaths **oro** (very small leaflets), tied into rosettes called by the same name.	Yes	No name for *Alyxia*
Tah	Papy 1955	*Polypodium societense*	**maire**	n.m.	*Alyxia* = **monoi maire**
Tah	Pétard 2011	*Polypodium vitiense*	**maire**. Leaves a favorite for making **horo** & weaving crowns.	Yes	*Alyxia* = **maire**
Tua	Florence 2021	Not present	NR	NR	NR
Austrl Rurutu Raivav	Brown and Brown 1931; (Brown 1935)	*Polypodium euryphyllum* var. *rapense*	Raivavae and Rurutu Island: **maire**.	Yes	*Alyxia* = **ati** (at Raivavae)
Austrl Rapa	Brown and Brown 1931; (Brown 1935)	*Polypodium euryphyllum* var. *rapense*	Rapa Island: **maile**, **mailenoana**	Yes	*Alyxia* = **maile raau**
Ckm	Whistler 1990	*Microsorum sylvaticum*	**maire kakara** fragrant maile	Yes	**Maire rākau**
Ckm	Sykes & Game 1996	*Phymatosorus commutatus*	**maire, maire kakara**	Yes	**Maire rākau**
Nzm	Breitw. 2016	Not present	NR	NR	--
Eas	Meyer 2013	Not present	NR	NR	--
Sam	Brackenridge 1854	*Drynaria acuminata* Brackenridge	No Samoan name given. Type specimen of *M. commutatum* was collected from Savai'i in 1854.	Yes	*Alyxia* = **lau mai'e, lau maile**
Sam	Whitmee 1875 (Herb. spec. KEW)	*Polypodium expansum* Baker *nom. illeg.*	No Samoan name given.	n.m.	n.m.

Sam	Sykes & Game 1996	*Phymatosorus commutatus*	No Samoan name given.	n.m.	n.m.
Ton	None found.	Status uncertain in Tonga	No Tongan name known. No source found that listed species.	NR	*Alyxia* = **maile**

Legend: **Abbreviations:** Island name abbreviations follow Table A3; NR-not relevant; n.g.-not given; n.m.-not mentioned. **Zig-zag lines** separate island groups.

Notes: [1]**Note 1:** Species included in this group by Nooteboom (1997) include: *Drynaria acuminata* Brack.; *D. sylvatica* Brack.; *Polypodium affine* Blume *nom. illeg.*; *P. euryphyllum* C. F. Christensen; *P. eurphyllum* var. *marquesense, rapense, hendersoniana* E. D. Brown*; P. expansum* J. G. Baker, *nom. illeg.*; *P. societense* J. W. Moore; *P. vitiense* J. G. Baker; as well as these taxa from Florence (2021): *Polypodium pustulatum* auct. : J. Nadeaud, Énum. pl. Tahiti: 29 (1873) *p.p.* ; *non* J.G. Forster (1786); *Phymatosorus grossus* auct. N. Hallé, *Cah. Indo-Pacif*. 2(3): 127 (1980), non (G.H. Langsdorff & F.E. Fischer) G. Brownlie (1977). [2]**Note 2:** Large et al. (1992) explain and clarify the confusion between *Polypodium pustulatum* Forst. f. and *P. scandens* Forst. f. This name, *P. scandens* given by Nadeaud (1864), is certainly *P. pustulatum,* the name later used by Nadeaud (1873) for this same species. [3]**Note 3:** Henry (1928) gave fern name as "*Polypodium pustulatum?*" with a question mark. Florence et al. (2007) list *Polypodium pustulatum* auct.:J. Nadeaud as a synonym for *M. commutatum*. Henry (1928) stated (p. 65), "Alyxia stellata is also associated with the maire fern. The maire fern was used in sacred rites," and (p. 143) "this fern was regarded as sacred and as possessing auspicious influences at such a time, for it was believed to have sprung from the umbilical cord of Tane's messenger god, Ro'o, which became entangled on a fara tree and grew there."

Table A5. Polynesian and Linnaean names for other *Microsorum* species[1] arranged alphabetically by current Linnaean name

Island group	**Source**	**Linnaean name given by source**	**Current Linnaean name** (Source, if not same as entry)	**Indigenous Polynesian name**	**Fra-grant?**
Ckm	Sykes & Game 1996	*Phymatosorus katuii*	*Microsorum katuii*	No names given. Endemic to Cook Is.	n.m. **DPf**
Tah Mau-piti	Sachet & Lemaît. 1983; Fosberg & Sachet 1987	*Polypodium maximum*	*M.* x *maximum* [a hybrid][2]	**metua pua'a 'ata ho'e** ['*metua pua'a* with a unique stem'] Maupiti.	n.m. Vari-able
Tah	Nadeaud 1873	*Polypodium nigrescens*	*Microsorum membranifolium*	**metua puaa**	n.m. **DPf**
Tah	Henry 1928[3]	*Polypodium nigrescens*	*Microsorum membranifolium*	**metua-pua'a**, leaves have "no sweet odor"	No **DPf**
Tah	Papy 1955	*Polypodium nigrescens*	*Microsorum membranifolium*	**metua puaa**	No **DPf**
Tah	Pétard 2011: 77	*Phymatosorus nigrescens*	*Microsorum membranifolium*	**metuapuaa,** This fern usu. at higher altitudes	n.m. **DPf**
Tah Raiatea	Jacq and Butaud 2013	*Microsorum membranifolium*	*Microsorum membranifolium*	**metuapua'a** (Raiatea)	n.m. **DPf**
Ton	Yuncker 1959:39	*Polypodium nigrescens*	*Microsorum membranifolium*	No name given.	n.m. **DPf**
Nzm	Brownsey & Perrie 2014	*Microsorum n.-zealandiae;*	*Microsorum n.-zealandiae;*	No name given.	n.m. **DPf**
Tah Raiatea	Jacq and Butaud 2013	*Microsorum parksii*	*Microsorum parksii*	**metuapua'a** (Raiatea)	n.m. **DPf**
Austrl Rapalti	Florence 2021 [In Press]	*Microsorum parksii*	*Microsorum parksii*	**maile tutaimaa** (Rapa) **maile tutaipua** (Rapa) [Trans:"often smelling of coumarin when dry"]	**Yes DPf**
Eas Rapa-nui	Christensen & Skottsberg 1920	*Polypodium phymatodes* (misapplied)[5]	Correct name *M. parksii* (Meyer 2013)[5]	Not given.	n.m. **DPf**
Eas	Dubois et al. 2013: 62[4]	*Microsorum parksii*[4]	*Microsorum parksii*	**matua pua'a**	n.m. **DPf**
Eas	Meyer 2013[5] (One species)	*Microsorum parksii*	*Microsorum parksii*	**matu'a pua'a nehe-nehe**	n.m. **DPf**
Tah Moo-rea	Murdock and Hinkle 1999 (Mo'orea Flora)	*Microsorum powellii*	*Microsorum powellii*	No indig. name given (Mo'orea); Species not listed in Florence (2021)	n.m. **DPf**
Ckm	Sykes & Game 1996	*Phymatosorus powellii*	*Microsorum powellii*	No names given. Indigenous to: Tahiti, Cook, Samoa Islands.	n.m. **DPf**
Sam Sāmoa	Parham 1972 (one indig.)	*Polypodium powellii*	*Microsorum powellii*	**lau auta**	n.m. **DPf**
Sam	Sykes & Game 1996	*Phymatosorus powellii*	*Microsorum powellii*	No name given.	n.m. **DPf**
Tah Mau-piti	Sachet & Lemaît. 1983; Fosberg & Sachet 1987	*Polypodium punctatum*	*Microsorum punctatum*	**'irio peho** (Maupiti)	n.m. **NDP**

Tah	Florence 2021 [In Press]	*Microsorum punctatum*	*Microsorum punctatum*	**o'oapa, oaha** (Raiatea) **oa** (Tahiti)	n.m. **NDP**
Nzm Aotea-roa	Beever 1991	*Phymatosorus diversifolius*	*Microsorum pustulatum*	**koowaowao** [**kōwao-wao**], **maratata, paaraha,** [**pāraha**] **paaraharaha,** [**pāraha-raha**], **raumanga**	n.m. **DPf**
Nzm	Beever 1991	*Phymatosorus scandens*	*M. scandens* (Breitw. 2016)	**mokimoki, moki**	**Yes DPf**
Haw	Palmer 2003	*Microsorum spectrum*	*Microsorum spectrum*	**pe'ahi**	Yes **NDP**

Legend: **Abbreviations:** Island name abbreviations follow Table A3; Leaf form **DPf -** Deeply Pinnatifid or **NDP -** Not Deeply Pinnatifid; n.m.-not mentioned. **Double lines** separate species; **zig-zag lines** separate island groups within species. **Notes:** [1]**Note 1:** Species listed alphabetically, by current Linnaean name. [2]**Note 2:** Murdock and Smith (2003) list *M. maximum* as a hybrid of *M. punctatum* and *M. grossum.* They, like Florence (2021, In press) identify this as a separate taxon on checklists. [3]**Note 3:** Henry (1928:65) says this fern was not fragrant. Andrews and Andrews (1944:215) say this name, *metua pua'a*, was associated with "an odorless variety of P. nigrescens." [4]**Note 4:** Dubois et al. (2013:24) list these synonyms for *M. parksii*: *Polypodium phymatodes* L.; *Phymatodes scolopendria* (Burm.) Ching; and *Microsorum scolopendria* (Burm. F.) Copel. [5]**Note 5:** J.-Y. Meyer (2013) clarified that the synonyms listed by Dubois et al. (2013) are not synonyms *sensu stricto,* but are names that have been misapplied to *M. parksii* in the past.

Part III. References to the names HAW <lauae> and <laua'e> from 19th and 20th century literature
Table A6. Literary excerpts, published prior to 1900, that pertain to <*lauae*>

Year	**Word given, source, excerpt and translation** (Shaded excerpts refer to a plant)
1865	<**LAU-AE>** (Andrews 1865) "*s.* [substantif] An aromatic herb" [Definitely a plant]
1870	**<lauae>** From *Ke Au 'Oko'a* Hawaiian newspaper [microfilm] (27 January 1870) "*Ka mo'olelo Hawai'i. Helu 15*" by Kamakau: "… a o ka hope o ka hooluu i na waiala i puholo ia me na pohaku wela iloko o ke ahi, a pela e maikai ai na waihooluu, a o ka lilo ana o ka niu o ka **lauae**, o ke kupaoa i mau waihooluu e kaomi ia ana e ka momona o ka niu maloo i pulehu papaa ia a kaomi ia iloko o kona waihooluu, a ua lilo i mea aala koaheahe huihui, me he waikuheaanu la…." (Kamakau 1870:1) Translation by M. K. Puku'i (Kamakau 1976:111): "The last thing was to immerse in the dyes the perfumes which had been steamed with rocks heated in a fire. This enhanced the dyes. Oil pressed from dry, broiled coconut meat was worked into *niu,* ***laua'e,*** or *kupaoa,* and [the dyes into which they were added] became as delicately fragrant as a cool morning." [Most likely a plant.]
Before 1877	**<lauae>** From a hand-written manuscript entitled *Kau mea Hoinainau Song (He Inoa no Keelikolani)* by W. P. Leleiohoku II (born 1854 - died 1877): "*Eia ke kuko ka halia i ka manawa; He hiamoe kou hoala ana oe, O oe e ka* ***Lauae*** *ku kila i ka pali; Ke hoe manu ea ola i ke kuahiwi."* Line 3 translation by Anderson-Fung: "(I address) you, the ***Laua'e*** standing high upon the mountain cliff." [*Lauae* used as a name for a 'beloved' person.]
1878, 1880	**<lauae>** From *The Queen's Songbook* (Liliuokalani et al. 1999): [Excerpts are from previously unpublished songs, composed 1878-1880 by Queen Lili'uokalani.] (1) *He inoa no Ka'iulani* (composed 1878): "*Kiina ka wehi o ke kama la …* ***Lauae*** *aala o Makana.* Fetch the adornment for the princess [Ka'iulani] …The fragrant ***laua'e*** of Makana." [Translation by Hui Hānai.][Likely a plant.] (2) From *Kuu Lei Mokihana* (composed 1878): *"Anuhea ke ala o ka* ***lauae****, Moani i na pali o Haupu.* Cool fragrance of the ***laua'e,*** Scents the air at the cliffs of Hā'upu." [Translation by Hui Hānai.][Likely a plant.] (3) From *Ka Makani Lawakua* (composed 1880): "*Kilika i ka* ***liko lauae****, ke ala kai moani i o'u nei*. Yet it moves lightly through the young ***laua'e*** fern, And its sweet scent is carried in the air to me." [Translation by Hui Hānai.] [***Liko laua'e*** literally refers to 'the young leaves of the ***laua'e***', making this a definite reference to a plant. It is also likely being used metaphorically, to refer to a *liko* 'young person or a young chief' that is *laua'e* 'beloved'.
Before 1886	**<lauae>** From a handwritten manuscript titled *Ka Ipo Lauae Song* (W. A. Kiha, No date. [Before 1886]). [The manuscript was undated, but a musical score, published by H. Berger, with Kiha's lyrics, was marked, "Copyright 1886."] "*Auhea wale oe e ka Ipo* ***lauae****; Kuu hoa haihai lau olelo."* Where are you, my ***laua'e*** [beloved] sweetheart? My friend [with whom I] often speak flirtatiously. [Translation by P. Anderson-Fung. Here *lauae* used as an adjective for a 'beloved' person.]
1893	**<lauae kane, lauae wahine>** From "A List of Hawaiian Names of Plants with Botanical Equivalents" (Brigham 1893: 52). These names occur together in the list, but are not defined or described in any way. [Definitely a plant]

Table A7. Literary excerpts, published after 1900, that are likely to refer to a plant named <lauae> or <laua'e>, in 19th century Hawai'i

Year	<Word as written>, source, excerpt, translation and interpretation.
1920	***<lauae>*** Verse 10, line 5 of the chant *Moeholua* (Fornander 1920:539): "*Noenoe mokihana ka ihu anu* ***lauae*** *o Makana,*" which Fornander translates: "Odorous mokihana, the fragrant plant of Makana." [I suggest that this translation may not be accurate, for two reasons. (1) In old Hawaiian, the word *mokihana* was also used to refer to 'a fragrance' (Andrews 1865: 398); (2) Further, Andrews (1865:76) defines *ihu anu* as "Name of an odoriferous tree or shrub ***of that place***." The last three words, emphasis added, were omitted from the definition in Pukui and Elbert (1986: 95), but are important here because they suggest that Makana is known for its <***lauae***>. Translating *mokihana* as 'a fragrance', I suggest that the following translation is a better fit for the phrase: '***lauae,*** the scented plant of Makana, is a fragrant mist'.]
1920	***<lauae>*** From verse 65 of the chant *No Kamehameha* (Fornander 1920:472): "*(1) He* ***lauae*** [fn 52] *mokihana ihu hanu.* One can inhale the fragrance if he breathes at all … *(2) Ka hua 'la o Kakioe na wahine* ***ako lauae****;* The sweet-scented product of Kahioe [sic], the women who braid the **lauae**. Footnotes: [52] Naenae, **lauae** and mokihana, odoriferous shrubs." [Note that: Fornander may have gotten the word "shrub" from Andrews' (1865:398) definition of *ihu anu* (above). Andrews (1865:218) defines *hua* thusly: "The effect, product or consequence of an action; *ka naaupo, he hua ia na ka ino,* ignorance is the result (fruit) of evil practices." Again, defining *mokihana* as 'a fragrance' (see above) I suggest the following translation: 'Breathing brings the fragrance of ***lauae,*** a result of the labor of Kakioe, the woman who pick the ***lauae****.'* I have changed Fornander's ""the women" to "the woman," since Kakioe was a known personality in traditional stories of Kaua'i. (P. Anderson-Fung).]
1922	***<lauae>*** From *A Dictionary of the Hawaiian Language* (Andrews and Parker 1922:357) "An aromatic herb. A variety of fern, very fragrant and used for decorative purposes." [***lā'u-a'e*** is given as a guide to pronunciation; see text.]
1942	***<lauae>*** From the article "Uses of Hawaiian Ferns" (Fosberg 1942:22): "A subtle fragrance, similar to that of *maile* (*Alyxia*), was imparted to kapa by storing it with fronds of ***lauae*** (*Polypodium scolopendria*) pressed between its folds. Certain other ferns possess a pleasing odor, and may have been used in similar ways. Mrs. Pukui says that it was the commoner and coarser *P. phymatodes* [*P. scolopendria*] which was the more fragrant, despite the efforts of informants to give the honor to *P. spectrum* et. al." [Note that "informants" have said that *P. spectrum,* a fern, is more fragrant than *P. scolopendria* [*M. grossum*]. [*P. spectrum* is named *Microsorum spectrum* today.]
1986	***<laua'e>*** From *Hawaiian Dictionary* (Pukui and Elbert 1986:355): "*Ke 'ala o ka* ***laua'e****, punia ai ka nahele.* Translation by Pukui and Elbert: "The fragrance of ***laua'e*** fern permeates the forest." [Note: *Punia* is the past imperfect of *puni,* defined as 'to overcome, as … by emotion; to pervade….' In my view, this is unlikely to be *M. grossum*, because its fragrance is not very strong.]

Part IV. Polynesian cognates of HAW <laua‘e> and HAW <a‘e>.

Table A8. Sources searched for plant names cognate with HAW laua‘e and lauwa‘e[1]

Polynesian language	***Hypo-thetical cognates**	**Taxon identified by source**	**Sources used** including dictionaries and online databases
Hawaiian	***lau(w)a‘e**	See Table 2	See Table 2
N. Marquesan	***‘au(v)ake**	--	(Dordillon 1904, 1931)
S. Marquesan	***‘au(v)a‘e**	--	(Dordillon 1904, 1931)
Mangarevan	***rau(v)ake**	--	(Tregear 1899)
Rapanui	***rau(v)ake**	--	(Churchill 1912, Englert 1948)
Tahitian	***rau(v)a‘e**	--	(Davies 1851; Fare Vāna‘a 2017)
Tuamotuan	***rau(v)ake**	--	(Tregear 1895).
Cook Maori	***rau(v)ake**	--	(McCormack 2007)
N. Z. Maori	***rau(w)ake**	--	(Tregear 1891, Williams 1971[1844]).
Samoan	***lau(v)a‘e**	--	(Pratt 1893, revised ed.).
Tongan	***(l)auake**	--	(Baker 1897, Churchward 1959)
Niuean	***(l)auake**	--	(Tregear and Smith 1907; Sperlich 1997)

Legend: An asterisk ‘*’ precedes hypothetical forms; ‘--’ indicates ‘name not found’.

Note: [1]*Hawaiian Dictionary* (Pukui & Elbert 1961, 1971, 1986) listed <lauwa‘e> as an alternate spelling of <laua‘e>, prompting construction of hypothetical cognates for each.

Table A9. Polynesian cognates ake and a‘e, referring to plants and their properties

Language	*Hypothetical cognate: <name provided>	Summarized definition combined from (dictionaries ± botanical sources) pertaining to plants & their properties	Ake/a‘e means fragrant ?
Hawaiian	***a‘e: <a‘e>, <hea‘e>***	**a‘e** and **hea‘e** - name 5 spp. *Zanthoxylum* *S. saponaria* - named **a‘e** on Mauna Loa; and **manele** on Hualalai (Rock 1913)	No
	a‘e: <a‘e>	Trees: *S. saponaria,* all spp. *Zanthoxylum,* “Maui name for ... *Xylosma hawaiiense”* (A&P ʿ1922; P&E ʿ1961, ʿ1971, ʿ1986)	No
Marquesan	***ake: <ake>***	“*s. sorte d'arbre tres dur”* [‘noun. type of tree, very hard’] (Dordillon ʿ1904:107)	No
Mangarevan	***ake: Ø***	No <ake> pert. to plants (Tregear 1899)	No
Tahitian	***a‘e: <ae>***	“name of a sweet-scented plant, used for ... sweet *monoi* or native oil” (Davies 1851)	‘fragrant plant’
	a‘e: <aeae>	“the name of a tree used only for fuel” (Davies 1851:6) [Inferred here as **a‘ea‘e**, an attested name for *Sapindus saponaria*.]	No
	a‘e: <aeae>	“*s. matahyba -- sapind.*” (Jaussen 1898:84) [Meaning: ‘noun. *Matayba - Sapindaceae’* (*Matayba stipitata* is syn. of *S. saponaria*)]	No
Tuamotuan	***ake: Ø***	No <**ake**> pert. to plants (Tregear 1895)	No
Cook Is. Maori	***ake: <ake>, <akeake>***	**ake** - Shrub: *Dodonaea viscosa;* and **akeake** - *Xylosma gracile* and *Sapindus* sp. (Buse ʿ1995; Savage ʿ1962)	No
N. Z. Maori	***ake: <ake>, <akeake>***	**ake, akeake, akerautangi**: - *D. viscosa*; **akeake** or **ake** + epithet: *Olearia* spp. (Best 1942; Tregear ʿ1891; Williams ʿ1971)	No
Rapanui	***ake: Ø***	None. (Churchill 1912; Englert 1948)	No
Samoan	***a‘e: Ø***	No <**ae**>/<**a‘e**> pertaining to plants (Pratt ʿ1893)	No
Tokelauan	***ake: <akeake>***	Simona (1986) lists this plant name. However, Art Whistler (pers. comm. 2013), asserted that “There are no Tokelau plants named **akeake**. If this name refers to the same species as Samoan **ateate**, then it is **ateate** in Tokelauan, and not **akeake**.”]	No
Tongan	***ake: <ake>***	The name of a hardwood tree that grows at Vava‘u (Baker 1897; Churchward ʿ1959)	No
	ake: <ake>	*Zanthoxylum pinnatum* (Yuncker 1959)	No
Niue	***ake: Ø***	None found in dictionary (Sperlich 1997)	No
	ake: <akeake>	*D. viscosa* (Sykes 1970)	No

Legend: *precedes hypothetical forms; ‘< >’ refers to a particular spelling; Ø means the word was not found; ‘ʿ’ marks the year of sources that indicate the position of the glottal stop; [ ] enclose my comments, translations, and interpretations; A&P = Andrews & Parker; P&E = Pukui & Elbert.

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