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# Untangling 'Uala:

# Toward re-diversifying and re-placing sweet potato in the Hawaiian landscape

August 2016

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Report commissioned by E Kūpaku Ka 'Āina – The Hawai'i Land Restoration Institute

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#### Preface and Acknowledgements

This report was written as a short synthesis of research on Hawaiian varieties of 'uala, sweet potato (Ipomoea batatas) which has a rich history in Hawai'i and Oceania. It is a living document and subject to revision/correction. Much of this work reviews, builds upon, and in some cases, re-interprets research by Edward Smith Craighill Handy and Mary Kawena Pukui published in 1940. I have added my own observations from several years of growing 'uala, talking to mahi 'ai (farmers), reading and cross-referencing articles, and listening to ongoing conversations on traditional agricultural systems. It is an attempt to update and contextualize Bulletin 161's section on 'uala for today's audiences and educators interested in crop diversity, nuances in Hawaiian language and traditional farming practice.

This is by no means a finished work, and many people have contributed, directly or indirectly. Many thanks to Peter Vitousek, who provided fertile ground for my fascination with 'uala at Puanui, Kohala in fall of 2008. Thanks also to Ala Lindsey, co-worker and also a kumu in his actions, who taught me about working smart and strategically. Marc Kinoshita's green thumbs and quiet ways taught me about patience when growing things. Mahina Patterson was an insightful and philosophical summer mentee; working in the field together, we co-developed our understanding of 'uala, education, Kohala, and nohona Hawai'i. She drafted the initial 'uala planting guide in 2009 which this research builds upon. Uncle Jerry Konanui planted the huli and initiated my interest in Hawaiian crop diversity at a kalo workshop at Amy Greenwell Ethnobotanical Garden in 2006. Aunty Penny Levin very patiently cultivated my continued learning about 'uala through some challenging seasons. Kaipo'i Kelling reminded me about kuleana by calling me, "eh, 'uala!" and shared insights through language, like "ho'omaha," that there is a time to fallow and a time to plant. Finally, thanks to Mom who instilled in me a love for books, plants, hand-weeding, family, and 'āina, and to Donn who supports my interests and never complains about me leaving the light on all night while reading.

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# Nā inoa 'uala

The following list of nearly 300 'uala names is a compilation of eleven resources. Some, such as Handy (1940) and Pukui and Elbert (1986) are combination of secondary and primary references, as they draw upon both authors' observations and others'. Some primary references list 'uala names (Kaaie 1860, Iokepa brothers interview nd, Mrs. Harris interview nd), include plant trait descriptions (Rooke 1855, Groth 1911, Kaaiakamanu and Akina 1922) or mention 'uala variety names in story (Napihelua 1857, Kealakai 1861, Fornander 1918). By comparing multiple references, we find 'uala names that surface repeatedly; these may have been particularly distinctive or popular. In the list below, two asterisks indicate names found in 8-10 references, and a single asterisk indicates names found in at least half (5) of the references. The following descriptions focus on these "greatest hits." Please note that in the list below, no diacritical markers are used since sources varied in spelling. We chose to leave spelling ambiguous to allow readers to interpret names based on their own knowledge of Hawaiian language and context. In the selected 'uala descriptions that follow this list, we use diacritical markers in names and quotes to allow readers to see the variations in spelling by different sources.

Aehaukae	Helapa	Kakake ili pohoee	Kehikehi	Kooka	Lopa	Mukoi	Palaai	Puakawaihae
Alala	Helelei	Kakakeilipohole	Kekake	Koume	Mahiki	Nakulehua	Palakaia	Puehuehu
Alamea	Helemalie	Kake	Kekake eleele	Koumi	Mahina	Nanani eneene	Palama	Puhi
Aliolio	Hepaa	Kakonakona	Kekawowo	Kuamalou	Mahina kehau	Nanani keokeo	Palamahiki	Pukiki keokeo
Apala	Heunaheuhu	Kala*	Kekoha	Kuapai	Maihui keokeo	Nau	Palani	Pukeleawe
Apauakeoe	Hiiaka	Kala keokeo	Kekoko a Keawe	Kui popo	Maihui ulaula	Neenee	Palikea	Pula ka maka
Apo**	Hilo	Kala poni	Keoe	Kuluehu	Maio	Neeneemai	Panikohe	Punana
Aumakiki	Hinalea	Kaleponi	Kepoe	Kupa	Maka	Nenewai	Panini	Puu
Auona	Hinapu	Kalia	Keponi	Kupala	Makakila	Nihi popo	Panioee	Puu keokeo
Auono	Hokeo*	Kalika	Kihe	Kuunahawela	Makakoali	Niihau	Paniole	Puuanahulu
Awapuhi	Holei	Kalika lau keokeo	Kihi	Laelae	Makanui	Nika	Paniolo	Uahi a Lapa
Awela	Holuee	Kalika ulaula	Kihikihi	Lahaina	Maka o Ku	Nika eleele	Papaa kowahi	Uahi a Pele**
Eepuu	Hoohamo	Kalikolehua	Kihi [lau] poepoe	Lahaloa	Makeawe	Nika keokeo	Pau	Ualahelelei
Eleele	Hookano	Kamalino	Kihi lau manamana	Laholile	Malihiniakawai	Nika nui	Pau o Hiiaka	Uhalula
Eleele kohola	Hookeo	Kamau	Kihi lau nui	Lailai	Manamana	Niumoe	Pauu	Uhanui
Eueu	Hoolulele	Kaneohe	Kihi poipoi	Lai o Kona	Manamana keokeo	Nukilani	Pehu	Uli
Haae	Hoomanamana	Kaneohe keokeo	Kihikihi poepoe	Laloloa	Manana	Nukukau	Pia	Ulu
Haawapuki	Hoomau	Kaneohe ulaula	Kihilauliilii	Lanai	Maniania	Nukulehu	Piapia*	Unahiuhu
Haelelepo	Hualani	Kanepuaa	Kihilaunui	Lapa*	Manini	Oheohe	Piko hao	Unahihu
Haloa	Hualiilii	Kaniala	Kiihekeke	Laumanamana	Manu	Okilipi	Piko manamana	Wahakale
Halonaipu*	Huamoa**	Kanika	Kilika melemele	Lau ulaula	Maoli	Okinawa	Piko nui*	Waianiani
Hamo	Huaono	Kaniko	Kilika poni	Lauoloa	Mapala keokeo	Okohola	Pilimai	Wailaulau
Hanawale	Ihumai	Kaomealani	Kina	Lawelawe	Mapela	Omealani	Poe	Wailua
Haoee	Ihunui	Kapanaia	Kiokio	Lehelehe nui	Maui	Onohinohi	Poepoe	Wainiha
Haole	Ipu o Lono	Kapapa	Kipapa	Lehilehi nui	Mauna pohaku	Paa	Pohe	Waipalupalu
Haueelani	Kae	Kapenakeoe	Kipawale	Lehua	Mauui	Paapaaina	Pohepohe	Wehiwa
Haulelani	Kaeumu	Kauaheahe	Koae	Lihau	Moe ahua	Paauhau	Pohina	Welowelo la
Hawai	Kahalaonaipu	Kauai	Koali	Lihilihi	Mohihi*	Pae	Pohuehue	
Hawaii	Kahiki (Irish)	Kaukaele	Kokokooha	Lihilihimolina	Mohihi keokeo	Paele	Pokiti	
Heakeaiule	Kahuli	Kawao	Kokokookeuhi	Lihilihipalu	Mohihi ulaula	Paelehilimanoanoa	Poni	
Heawe	Kahului	Kawelo**	Kola	Likolehua**	Moi	Paikukui	Poni loepaa	
Heeuau	Kahulunui	Kawelokupa	Kolo	Lilimolina	Mokeawe	Paiowea	Ponuhunuhu	
Hei	Kakaka	Kawowo	Kome ulaula	Limawiwi	Molina	Pakeke	Pu*	
Hekili	Kakakaokeawe	Keaumahina	Kona pakeke	Loepaa	Molokai	Pala	Pu hei	

# Selected 'uala descriptions

# Apo, 'apo, 'āpō

Dr. Thomas Charles Byde Rooke, hānai father of Queen Emma, describes this 'uala as having a dark exterior or '*ili* (skin) and *i* 'o (interior, flesh) that is reddish (Rooke, 1855). The leaf and stalk are purple and the root is firm. He observes from his collection grown at Pu'unui on O'ahu that this 'uala grows in moist soil.

In the book *Native Medicines*, first published in 1922, D.M. Kaaiakamanu and J.K. Akina describe 'uala *apo* similarly: "*He ano hauli ka i'o, like ka lau me ka uwala Kahalaonaipu:* The flesh is darkish, and the leaf is like that of 'uala Kahalaonaipu." Their description of *kahalaonaipu* indicates that the leaf is rounded: "*he poepoe ka lau o keia uwala.*" They add that *apo* was used to treat phlegm and its use and preparation was like that of 'uala *kawelo* and *piko nui.* 



Fig 1. 'uala *apo* (source: Handy, 1940)

The Iokepa brothers of Hilo,<sup>1</sup> interviewed by Theodore Kelsey likely in the early to mid-1900s, indicate that ' $\bar{a}p\bar{o}$  [sic] was a "purple uala used to color the poi of common people."

However, in *The Hawaiian Planter* published by Handy in 1940, the description of *apo* tuber flesh as white deviates from the earlier descriptions of *apo* as having purple or red *i* 'o (see Fig 1). While Handy's leaf description is consistent with other descriptions, the tuber flesh description differs. Is this 'uala *apo* distinct from the dark fleshed 'uala of Kaaiakamanu and Akina (*apo*) or the Iokepas ('apo)?

(source: Handy, 1940) This 'uala is also described by Abraham Fornander who interviewed many Hawaiians in the mid- to late 1800s. He documents *apo* as one of several 'uala to plant when Makali'i rises with the sun in spring: "*a hiki i na kakahiaka e puka mai ai na huihui, oia ka wa e kanu ai i na lau.*" (Fornander, 1918) To prepare, the farmer cuts mulch and waits for rains in the month of Welo. Fornander includes important detail on the planting practice, but the lack of information on location or identity of his interviewees complicates interpretation of the planting calendar; names of the *malama* (months in the Hawaiian lunar calendar) vary from place to place. If the puzzle of Fornander's described planting calendar can be unraveled, we might be

# Halonaipu, hālonaipu, (possibly also kahalaonaipu/kāhalaonāipu)

Napihelua (1857), in an article on 'uala at Kalaupapa, writes that of the nine "uala eleele" there, three are good: *apo, likolehua,* and *halonaipu. 'Ele'ele,* commonly interpreted today as black, is associated with a dark color in many 'uala descriptions. Napihelua's description clearly indicates these 'uala have dark *'ili* (skin), comparing *likolehua* and *halonaipu* to mountain apples on the beach with their purple skin on the pahoehoe lava: *"me he ohia pe la i kahakai, ka uliuli polohua i ka papa pahoehoe."* We are less clear whether *'ele'ele* also refers to the *i'o* (tuber flesh). We may suspect the flesh of *halonaipu* is dark since older descriptions of both *apo* and

able to infer the location and thus associations of named 'uala varieties with places in Hawai'i.

<sup>&</sup>lt;sup>1</sup> One brother's name is James

*likolehua* indicate they are dark-fleshed, but available descriptions for *halonaipu/kahalaonaipu* suggest instead a white to yellow flesh.

Kaaiakamanu and Akina in *Native Hawaiian Medicines*, write of *kahalaonaipu*: "*He poepoe ka lau o keia Uwala a he eleele ke ka, like ka momona me ka Uwala Apo, a like no hoi ma ka mea pili laau lapaau like keia Uwala me ka Uwala Huamoa*." The leaves of this 'uala are round and the stems are black (dark purple). The sweetness is like that of 'uala *apo* and medicinally it is used similarly to 'uala *huamoa*.

Rooke (1855) describes *halonaipu* as possessing a dark skin with yellow interior flesh. Yet he indicates that the leaf is divided, not *poepoe* (rounded) as Kaaiakamanu and Akina write for *kahalaonaipu*. Both sources indicate the stem is dark. A dark-colored stem is also consistent with a 1911 botanical description by Benno Humbert Alfred Groth, a University of Pennsylvania PhD student. He indicates that tuber skin is red/purple, and the tuber flesh is white, somewhat more consistent with Rooke (1855). His voucher specimen (Fig 2) shows a leaf shape that is broad, closer to Kaaiakamanu and Akina's description than Rooke's divided leaf. <sup>2</sup>



Fig 2. 'uala *halonaipu* (source: Groth, 1911)

These inconsistencies indicate *kahalaonaipu* may not be a synonym of the more ubiquitous *halonaipu*. We also cannot rule out the possibility of sample confusion; the *halonaipu* described by Groth was grown in New Jersey from a tuber sent from an unidentified Honolulu botanical garden. Practical experience indicates 'uala are notoriously easy to mix up when grown in a collection. Unfortunately, Handy's published works do not provide descriptions of *halonaipu* for cross-referencing.

We might pursue a hint left by Napihelua: that he has heard *halonaipu* is called "*mohihi*" on Kaua'i. Is it *mohihi ke 'oke 'o* described by Kaaiakamanu and Akina with purple skin and flesh that is yellowish (*lelo* = "yellowish, especially the hue imparted to a whaletooth pendant (lei palaoa) by smoking" in Pukui and Elbert)? Or is it *mohihi 'ula'ula*, which Handy describes as having purple veins and tuber with pink skin and purplish flesh. *Mohihi* leaves tend to be described as elongated, not round. Kaaiakamanu and Akina also write about both *kahalaonaipu* and *mohihi keokeo* separately, suggesting these cultivars are distinct. Clearly, more digging is needed!

# Hokeo, Hokeo, Hookeo

Dr. T.C.B. Rooke (1855) describes *hookeo* as having dark *'ili*, white *i 'o*, divided leaves and dark stalk, and growing in light soil. While the name *hokeo* is mentioned in several Hawaiian language articles (Kealakai, Kaaie, Fornander), no other descriptive characteristics were available to me at this time.

<sup>&</sup>lt;sup>2</sup> The leaves of Groth's specimen remind me of what we today call *'ele 'ele*, but unlike Groth's description of a white-fleshed tuber, the flesh of this moden *'ele 'ele* is deep purple, even when raw.

#### Huamoa



Fig 3. 'uala *huamoa* (source: Handy, 1940)

A famous 'uala, *huamoa* has deep yellow flesh like an egg yolk and white skin. Accounts by Dr. Rooke, D.M. Kaaiakamanu and J.K. Akina, interviewees of Theodore Kelsey (Iokepa brothers and Mrs. Harris), and E.S. Craighill Handy (Fig 3) consistently describe the leaf as round with a greenish white stem. The key distinguishing factor is the tuber resembling a hen egg in coloring. A friend who grew *huamoa* also shared that the tubers themselves are round like eggs and numerous. Kaaiakamanu and Akina write, "*he poepoe ka lau o keia uwala he ke oke o ke kā a loloa no ho 'i ka hihi ana.*" The leaf of this

sweet potato is round, the stems are white (light green) and run long and tangle. "*He keokeo no ho'i ka ili o waho o ka hua a he ula* 

*lelo o loko o ka i 'o o keia Uwala e like me ka Olena lelo, a i ole, me ka kauo hua Moa paha.*" The skin is white outside and and deep yellow inside, like the yellow of younger 'ōlena (turmeric), or the chicken egg yolk. These colors suggest the 'uala flesh is not merely cream or light yellow, but deeper in color, maybe even reddish orange.



Fig 4. "*huamoa?*" (source: Groth, 1911)

In the case of *huamoa*, Groth's description is wholly inconsistent. He describes a purple stem, divided leaf (Fig 4), yellow-red skin and pinkish white to pinkish yellow flesh. We are left wondering what the name of this Hawaiian 'uala is at right, since it is not *huamoa*.

#### Kala: kala ke'oke'o and kala poni



Fig 5. 'uala *kala* (source: Handy, 1940)

*Kala* is qualified as either *ke* '*oke* '*o* (white, more ubiquitous) or *poni* (purple, mentioned only once). Dr. T.C.B. Rooke describes *kala ke* '*oke* '*o* as having a reddish exterior and white interior, with divided leaves and a green stalk. Kaaiakamanu and Akina similarly write that the leaves of *kala* are divided like *uahi a Pele*, but they describe an 'uala with flesh similar to that of *apo*; it is *hauli*, or dark-colored. The *kala* Kaaiakamanu describes of may be *kala poni*. *Kala poni* may also be the full name of *poni*, another 'uala variety mentioned by Fornander (1918), but neither of these should be confused with *Kaleponi* ("California") described by Handy as a foreign variety on Maui.<sup>3</sup>

<sup>&</sup>lt;sup>3</sup> Handy documented *Kaleponi* may be the same variety as *Nukilani* ("New Zealand") grown at Kaupō, Maui, where it was also locally called *Neki* ("Ned Wilcox"), *Oliva* ("olive"), and *aehaukae* for the resemblance of its heart-shaped leaf with that of an old variety of the same name. (Handy, 1940 p. 139)

Existing collections of *kala* line up relatively well with Handy's 1940 depiction of *kala* (Fig 5). These also align with Rooke's 1855 *kala ke 'oke 'o* description, except where he describes a green stem, the  $k\bar{a}$  (stem) of the *kala* grown today fades from bright green at the tip to purple in older stems (Fig 6).

Groth's 1911 description is inconsistent with all others (either *kala ke 'oke 'o* or *kala poni*), describing tubers with yellowish to bronze instead of reddish skin. The leaves on his voucher specimen (Fig 7) are also much more finger-like (at right) than sharp or pointy as suggested by the name "kala."

While Rooke writes that his *kala* grows in taro patch banks, the *kala* I have grown is sturdy, grows upright, and seems to withstand dry conditions. Experiments to grow *kala* in different environments are currently being conducted by Dr. Theodore Radovich at the University of Hawai'i at Mānoa. The first two trials have produced only small 6-month yields for *kala*, and we suspect its value may be in properties other than tuber production. Indeed, Kaaiakamanu and Akina (1922) write of *kala* leaf bud and young leaves (p. 240):

...o ia no ke hanai i na keiki liilii ma ke ano laau Paaoao. A ina hui pu me hookahi kauna ao luau a me kohu waiu o hookahi kauna hua Kukui, kupono no ka hoonoha ana i na keiki a me kanaka makua. (p. 240)



Fig 6. 'uala *kala*, grown at Puowaina, Oahu 2010-2011 (author's photo)



Fig 7. "*kala?*" (source: Groth, 1911)

It is fed to babies as a kind of  $P\bar{a}$  'ao 'ao medicine and if it is mixed with four  $l\bar{u}$  'au leaves and the milky sap of four kukui nuts, then it is used as a purgative for children and adults.

# Kawelo



Fig 8. 'uala *kawelo* (source: Handy, 1940)

Kawelo is mentioned in all but one reference I examined, and across most descriptions, the leaf form and accounts of white flesh and light skin are consistent. Rooke (1855) writes that *kawelo* has orange skin with white flesh, divided leaves and light green stalks. Handy (1940) writes that *kawelo* tubers are white/white and the petiole and stem include reddish and purple colors. Groth (1911) indicates a leaf shape and leaf/petiole coloring consistent with Handy's description: green stems with purple around the leaf axils, purple



Fig 9. 'uala *kawelo* (source: Groth, 1911)

spot at the base of the midrib. His tuber skin description is closer to that of

Rooke: yellow-red to pinkish tuber skin, white tuber flesh. Groth writes that *koali* is a synonym for *kawelo* but this is inconsistent with Rooke's description of *koali* as having undivided leaves. Writing on cultivation, Handy notes that *kawelo* takes about 6-8 months to mature.

Kaaiakamanu and Akina's describe *kawelo* differently, that the *lau* is like that of 'uala  $p\bar{u}$ , which is round instead of divided, and that the flesh is like that of *piko nui*, which is yellowish instead of white. Handy's Bulletin 161 includes names *kawelo-kupa* and *kupa*, and a sketch of *kupa* indicates round leaves and yellowish flesh and skin. Perhaps Kaaiakamanu's *kawelo* is associated with Handy's *kawelo kupa/kupa*.

Yet another account describes the skin of *kawelo* as red; a certain Mrs. Harris describes to Theodore Kelsey: "*ke* 'oke 'o a pau loa, a pela ka i 'o, a 'ula'ula ka 'alu'alu (the skin) like *mohihi*." Completely white- that's the flesh, and red and wrinkled (the skin) like *mohihi*.

#### Lapa, helapa

*Lapa* is mentioned by Kaaie and Kealakai in lists of 'uala in 1860 and 1861, and again by Fornander (published posthumously in 1918). Rooke describes *helapa* (but not *lapa*) in 1855 as having white exterior, yellow interior, divided leaves, and light green stalk, grown in valleys and plains. Handy mentions but provides no description or collection of *lapa*.

## Likolehua (lehua?)

Rooke (1855) describes *likolehua* as having dark exterior, reddish flesh, divided and dark green leaves and stalk. This 'uala, he writes, is grown in good soil, and indeed, Napihelua writes of the abundance of *likolehua* at Kalaupapa: "... *o ka likolehua, a me ka halonaipu, i ka wa e kuai ai; ahu iho i ke awa ku moku; me he ohia pe la i kahakai, ka uliuli polohua i ka papa pahoehoe, ka holo no ia a ka onohi iluna i lalo, i ka makemake i ka hua o ka mahiai.*" Mary Kawena Pukui translates this: "The *likolehua* and *halonaipu* when ready to be sold are heaped at the seaport like bruised mountain apples on the beach, their purplish color lying against the pahoehoe lava. The eyes scan them up and down with desire for the tubers raised by the farmers." (Handy, 1940, p. 158) Rooke's collection includes varieties from Wai'anae but also from Ni'ihau and Kalaupapa, potentially overlapping with the stock in Napihelua's 1857 account.

Kaaiakamanu and Akina's description of *lehua* is consistent primarily on the red tuber skin, and they describe flesh like that of *mohihi*: "*he ulaula no hoi ka ili o waho o ka hua Uwala, like nae ka i'o o loko me ka Uwala Mohihi*." Their description of *mohihi* lines up best with *mohihi 'ula'ula* (see next 'uala). They indicate that the leaf of *lehua* is darkish and the stem is red. Handy's description of *likolehua* is much less detailed, and his drawing (Fig 9) is inconsistent with Rooke's divided leaf. Further research into both Handy's and Rooke's original notes might reveal the source of the discrepancy.

Despite differences, the red tuber skin color is consistent across the available descriptions. Depending on how we interpret Napihelua's praises of the 'uala eleele of Kalaupapa (*apo, likolehua, halonaipu*), we



Fig 9. 'uala *likolehua*? (source: Handy, 1940)

might infer that the flesh is purple-ish as Rooke suggests, or yellowish as is suggested by Kaaiakamanu and Akina's comparison to *mohihi (ke 'oke 'o)*.

# Mohihi, mōhihi, mōhihi ke'oke'o, mōhihi 'ula'ula

Finally we arrive at the famed *mohihi*, popular for use in 'uala awaawa, or sweet potato beer. The high sugar content of *mohihi* made it preferred for fermentation, and Handy writes "uala awaawa had a great vogue during the period of clearing forests in Hamakua, Hawaii, in the early days of sugar planting." Handy depicts *mōhihi ke 'oke 'o* as being white-fleshed, while *mōhihi 'ula 'ula* has purplish flesh and more purplish stem and veins.



Fig 10. *mōhihi ke 'oke 'o* (L), *mōhihi 'ula 'ula* (R) (Source: Handy, 1940)



Fig 11. 'uala *kauaheahe* (*=mohihi ke* '*oke* '*o*?) (Source: Groth, 1911)

Synonyms: While Napihelua

writes that *halonaipu* is called *mohihi* on Kauai, we are unclear as to whether *halonaipu* has white flesh like *mōhihi ke 'oke 'o* or red/purple flesh (*mōhihi 'ula 'ula*). Handy writes that *kauaheahe* (to gaze or stare) is a nickname for *mohihi*, referring to the effect of 'uala awaawa on its drinkers. Groth's *kauaheahe* specimen at left (Fig 11) and his written description seem to line up with Handy's description of *mohihi ke 'oke 'o* with purple skin and white flesh.

Kelsey, in his interview notes with a certain Mrs. Harris describes *mohihi* this way: "*manamana ka lau; ke* '*oke* '*o ke kā*, *he* '*ano* '*ula*'*ula ka midrib of leaves*," the leaf is divided, the stem is pale, and the leaf midribs are kind of red. This

description, too, seems most consistent with *mohihi ke 'oke 'o*, although "manamana" would suggest a more deeply divided, finger-like leaf than the pictures above. Kaaiakamanu and Akina's description of *mohihi* also lines up with *mohihi ke 'oke 'o*, with red skin, but yellowish instead of white flesh: "*He Uwala ulaula keia o ka ili a lelo o loko o ka i'o he momona no hoi ka* 

*ai ana o ka i'o o keia Uwala, he lau manumanu ano loloa a he ula no hoi ke ka a kiwalao ka hihi ana i o a ianei.*" The leaves are irregular and somewhat long, skin red, flesh inside yellowish and sweet, and the vine grows in an untidy and entangling manner.

# Piapia, pia

*Piapia* is remembered by the Iokepa brothers of Hilo as being a white variety, and is listed by Kaaie in 1860 among 60 other ancient and modern 'uala varieties. Handy writes that *pia*, which we might assume to be a synonym, is an ancient variety. One modern grower, researcher Ted Radovich, suspects that a Waimanalo ag station preserved cultivar known today as "kea" is in fact *pia*, with heart-shaped leaves and unusually



Fig 12. 'uala *pia* (source: Handy, 1940)

starchy white tubers, large and round in shape with white skin. This is consistent also with Kaaiakamanu and Akina's description of the *piapia* tuber being round-shaped like that of *piko nui*: "*Like ke ano o keia Uwala me ka Piko nui*..." The medicinal value of *piapia* is also similar to that of *piko nui*.

\**Pia* is also the name for arrowroot, *Tacca leontopetaloides*, used for starch, which also produces (much smaller) brown-skinned, white tubers. Similarly called *pi* '*a*, *Dioscorea pentaphylla*, is a yam with subterranean and aerial starchy tubers which is recorded growing uncultivated in forested areas, possibly serving as food in times of famine.

Piko nui (distinct from piko ha'o)



Fig 13. 'uala *piko nui* (source: Handy, 1940)

Another famous 'uala is *piko nui*. Unlike the *piko* varieties of kalo where the leaf cuts to the sinus, the *piko* here is said by Handy to describe primarily the tuber. The "flattish round tuber suggests a

giant swollen human navel." Kaaiakamanu and Akina again compare *piko nui* to *mohihi* (*ke* 'oke 'o) in its white flesh, but indicate the leaf is not as long as that of *mohihi* and the joints of the *piko nui* stem are darkened. Hawaiian language sources that I found did not include description of tuber skin color. Mrs. Harris reports a different shaped leaf than that described by others: "*poepoe kona lau, kona hua, ke* 'oke 'o kona i 'o, like Irish potato." The leaf and tuber are round, the flesh

white, like an Irish potato. The greatest consistency across descriptions is the white tuber flesh and round tuber shape. Groth (1911) again describes an 'uala that is inconsistent with other 'uala descriptions for the same name. His specimen (Fig 14) has a very different angular leaf shape and tubers with gold/bronze skin and pinkish white to yellow flesh.

Extant varieties called *piko* include one whose leaf form is more similar to that of *piko ha* 'o described by Handy (Fig 15), with a more strongly divided leaf and sharper points than suggested for *piko nui* (see Fig 16 below). However, these *piko* tubers have a dark skin and reddish cortex ('*ili kana*) with creamy white flesh, which deviates from Handy's depiction of whitish skin/white flesh tuber. The cortex of *piko* tubers tends to be fibrous and should be removed after cooking.



Fig 16. "piko" grown at Puanui, Hawai'i (author's photo)



Fig 14. "*piko nui?*" (source: Groth, 1911)



Fig 15. 'uala *piko ha'o* (source: Handy, 1940)

#### Pu, pū, pu-hei?



Fig 17. 'uala *pū* (source: Handy, 1940)

"He uwala ke 'oke 'o keia o ka ili o waho o ka hua he ano like no ka lau a me na ano a apua me ka Huamoa, a o ka i 'o o loko like loa no me ka i 'o o ke pu pala 'ai, he like ka momona o keia uwala me ka hei pala ku, a oi aku no paha." Kaaiakamanu and Akina provide us a

vivid description of this orange-fleshed 'uala with white skin, round leaves and parts similar to those of *huamoa*. They describe this 'uala as having flesh like pumpkin and sweetness like tree-ripened papaya; Mrs. Harris notes that the flesh is "pakēpakē" or crumbly. Both Handy (1940) and Groth (1911) describe an 'uala with broad leaves and tubers with pale skin and pinkish yellowish

flesh (Figs 17 and 18). Multiple interviews documented by Theodore Kelsey suggest this is an introduced variety, and the lack of mention by Hawaiians or Fornander in the 1800s seems to support this. Regardless of origin, we can be confident in the characteristics: rounded leaf shape with small points, green leaves with green and red stem, and light colored tuber skin with yellow to orange-red flesh.



Fig 18. 'uala *pū* (source: Groth, 1911)

The description of  $p\bar{u}$  is similar to what remains in collections today as *pala 'ai*, a name Handy indicates as ancient. *Pala 'ai*, (or  $p\bar{u}$  *pala 'ai*) listed in the Hawaiian dictionary as the original name for pumpkin, is a notably fragrant and flavorful yellow-fleshed 'uala which produces good yields.

#### Uahi a Pele



Fig 19. 'uala *Uahi a Pele* (source: Handy, 1940)

Like the kalo variety with smoky deep purple-green leaves, this 'uala variety is named for its dark, smoky characteristics. Dr. Rooke's 1855 account describe a tuber with dark skin, dark flesh, divided leaf, and dark stalk. Handy's depiction at left aligns with this. Kaaiakamanu writes, "*He manamana liilii ka lau he eleele ano kaiina ka i'o o keia ano Uwala, a ano oolea no hoi ka ai ana.*" The leaf is divided a little (as a hand); the flesh of this kind of 'uala is dark and hard ('i'ī) and a little tough to eat. The descriptions of this 'uala are again very consistent although it is surprising that the name is absent from Kaaie's 1860 list of 60 varieties. This 'uala looks most like what is grown in collections today as *Kaneohe 'ula'ula*.

# Reflection on varieties: plants, names, and places

The varieties described above are a small fraction of the 'uala names recorded; yet even among these popular varieties, we come across references to synonyms. Given the metaphor, poetry, and humor in Hawaiian language as well as the diversity of environments in which 'uala was grown, perhaps this is to be expected. Even today, when farmers and horticulturalists share

planting materials, names might be forgotten and renamed, often for their tuber or foliage color (Beach 'ohana's "melemele" or Waimanalo experiment station's "kea"), or where they came from ("Hale Kuahine" or "Mauna Pohaku" or "Okinawa" or "Pukiki," Portuguese). Tracing varieties is about untangling cultivar journeys and genealogies, much of which we may never know.

To begin to make sense of the names and unnamed and forgotten cultivars, we begin with detailed descriptions of both ancient and modern varieties and try to reconnect these with place. Handy writes that *Mauna Pohaku*, a widely popular introduced variety from Utah (Salt Lake), is called *Lahaina* and *Kahului* on Moloka'i; it is called *Maui* in Kona, Hawai'i. Perhaps it was introduced to Maui from someone returning or visiting from Utah and then spread across the islands from Maui during the 1800s when California demand drove agricultural production for export. Handy speculates that *kuluehu* of Ulupalakua is the same cultivar as *Mauna Pohaku/ Lahaina/ Kahului/ Maui*. He continues that a similar-looking potato is called *Kaleponi* (California) on Maui, described in an earlier footnote. "What appears to be the same variety was also referred to once in Kaupo, Maui, as *Nukilani*. Here I was told that this was also called *Neki* because it was



Fig 20. Above: *Mauna Pohaku* and below: *Kahului* (Source: Handy, 1940)

introduced by Ned Wilcox who lived at Makena, and that it was sometimes called *Oliva* (olive) and also *Aehaukae* (running wild), the name of an old Hawaiian variety with leaf similar to that of the introduced variety." (Handy, 1940)

To complicate matters, what is in botanical collections today as *mana*[sic] *pohaku* has a deeply divided leaf and an orange-fleshed tuber with buff skin. It grows vigorously above ground forming a thick mat of leaves and stems, but it is a poor yielder in terms of tubers. Another variety called *lanikeha* seems to better fit Handy's description of the once-popular *Mauna Pohaku* in terms of leaf shape, stem traits, and large buff-skinned tubers with yellow flesh and high productivity.



Fig 21. Counter clockwise from upper left: *mana pohaku* foliage and tuber cross-section; *lanikeha* tuber, cross section, tuber variability, foliage. Names *mana pohaku* and *lanikeha* are names associated with modern collections.

The apparent chaos of 'uala names highlights the importance of contextualizing 'uala names and cultivation. Nearly 75% of the list of names were cited once or twice. Only one name, *kawelo*, was mentioned in 11 references (10: *huamoa*, 9: *apo*, 8: *likolehua* and *uahi a Pele*). Some 'uala of old (and new) were, of course, famous and perhaps grown everywhere. Given Hawai'i's environmental diversity, we might hypothesize that most others were locale-specific and were incorporated into cultivation for 1) diversification of diet where 'uala was not the primary staple, 2) food security in more arid locations where it was the primary staple, with both fast and slower maturing cultivars.<sup>4</sup> The following section explores the spatial patterning of 'uala names and cultivation.

# Mapping 'uala

Where was 'uala grown across the Hawaiian Islands? Were specific 'uala grown in certain places, or were all cultivars everywhere? How might we disentangle synonyms in the list of names above?

<sup>&</sup>lt;sup>4</sup> In addition to ensuring a steady food supply through the year in variable-rainfall environments, 'uala was valued for its utility. *He 'uala ka 'ai ho 'ōla koke i ka wī*. The 'uala is the food that ends the famine quickly. (Pukui 1983)

While ES Craighill Handy's publications and sketches contain valuable information on different 'uala varieties, these descriptions have been detached from cultivar origins. In the 1930s, Handy collected 'uala specimens from across Hawai'i and documented cultivar names and descriptions when available.<sup>5</sup> The pressed voucher specimens (leaves and stems) are kept in the Bernice Pauahi Bishop Museum Herbarium and remain sorted by island. I used these as a basis to begin matching 'uala names to places. For each island below, I list a current compilation of names by islands and attempt to map Handy's written accounts of where 'uala was generally grown based on ethnographic research and interpretation of archaeological features. Bullet points reflect collectors' identification and notes, verbatim. In the maps, I included ahupua'a boundaries and stream features from the Hawai'i State GIS repository<sup>6</sup> and a GIS model predicting the probable distribution of traditional agricultural systems (Kurashima, 2016 and Kurashima and Kirch, 2011).

# Ni'ihau

E.S. Craighill Handy writes that 'uala was the staple of Ni'ihau along with uhi (*Dioscorea alata*) and 'ulu (*Artocarpus altilis*). Most planting would have included patches near houses, shores, and in low elevation fields. I have not yet found reliable information on the specific distribution of cultivation on the island (Map 1).

J.F. Stokes collected three 'uala on the southern half of the island in January of 1912. While he did not note cultivar names, Handy in reviewing Stokes' specimens later suggested cultivars names in pencil on the herbarium sheets.

- "looks like wai-aniani from Molokai,"
- "like *kala* from Maui,"
- "looks like *hua moa*" (later in 1949, Harold St. John writes, "more like *apo*")

A second collection of Ni'ihau 'uala made by E.S. Craighill Handy in August 1931 documented names at time of collection:

- Palani
- Manamana (= piko nui)
- Kamalino
- Eleele o kohola
- Wailua
- Papaa kowahi
- Molokai
- Kalia

# Kaua'i

The Bishop Museum Herbarium does not include any collections by Handy from Kaua'i, and so I have found little about Kaua'i names and varieties. Yet, I do know that 'uala was cultivated by fisher families including 'ohana at Wanini (Anini), even when they were in very close proximity to the great kalo growing areas of Hanalei. 'Uala played a more important role on the leeward

<sup>&</sup>lt;sup>5</sup> Leaf morphology is well represented, but colors and tuber characteristics not evident from these pressed specimens. Further research into Handy's notes may reveal more insights for tuber colors, a valuable diagnostic. <sup>6</sup> http://planning.hawaii.gov/gis/

ilig.ilawali.gov/gis/

sides of the island along the south and west shores in areas of low rainfall and only intermittent streams (see Map 1). Handy reminds us that the "upland *kula* lands" famous for potatoes include Kukuiolono and Waimea, but as with many *kula* lands, these have been converted to sugar plantations and developed. Very few Kaua'i 'uala specimens are held in the Bishop Museum Herbarium; the earliest is a 1976 collection by Derral Herbst. None included Hawaiian cultivar names.



Map 1. 'Uala cultivation on Ni'ihau and Kaua'i described by Handy (1940) as coastal cultivation (yellow boxes) and "upland kula" (green boxes).

## Oʻahu

The only named cultivars in the herbarium from O'ahu were collected by Gerrit P Wilder in 1923-1924:

- *mohihi*, collected at Mokuleia, cultivated (strongly divided leaf)
- *mohih*i, collected at Makiki, cultivated
- piko nui, collected at Makiki, cultivated
- huamoa, collected at Makiki, cultivated

Other 'uala specimens were collected but remained unnamed. This includes the earliest O'ahu 'uala voucher specimen collected by Joseph Rock (Punalu'u, 1908). Although Handy did not collect 'uala or interview on O'ahu, map 2 below indicates areas described (Handy 1940) as areas of 'uala cultivation.



Map 2. 'Uala cultivation on O'ahu described by Handy (1940) as coastal cultivation (yellow boxes) and "upland kula" (green boxes).

Dr. T.C.B. Rooke documented in 1855 many sweet potatoes from his collection at Waolani, O'ahu. He writes that on an 1840 trip to Wai'anae:

An old inhabitant there enumerated to me thirty-two varieties with which he was acquainted. I scarcely believed him at the time, but shortly after my return I had more than twenty of them growing at Waolani; and have since procured (in 1849) some very fine plants of other varieties from Kalaupapa, on the Island of Molokai, and others form the Island of Niihau, since which time I have not paid any attention to the subject... In submitting the following list, which is arranged alphabetically, I will remark that some of the varieties have different names on the various islands of the group; I have, therefore, been careful to confine myself to the names known on the Island of Oahu, and there even they have sometimes two or more names for the same variety, although synonymous, as for instance, Haulilani, (fallen from heaven,) is also called Helelei, (scattered, as in a shower) &c.

Oahu *Rooke, 1855 Transactions of the Royal Hawaiian Agricultural Society						
Apo	Нераа	Kekawowo	Lilimolina			
Auono	Heunaheuhu	Kekoha	Maunapohaku			
Awapuhi	Hookeo	Kekokoakeawe	Nukulehu			
Еерии	Hoolulelule	Kihipoipoi	Раии			
Okohola	Hualiilii	Kihilaumanamana	Paiowea			
Uahiapele	Ниатоа	Kipawale	Palakaia			
Ulu	Kalakeokeo	Koali	Palama			
Halonaipu	Kanika	Koumi	Puhi			
Hawaii	Kaukaele	Kuunahawela	Waipalupalu			
Heakeaiule	Kawao	Laholile	Wailaulau			
Нееиаи	Kawelo	Laholoa	Wehiwa			
Helapa	Kekakeeleele	Lihilihipalu				
Helelei	Kekake	Likolehua				

# Maui Nui

From Handy's Moloka'i collection, we have:

- Onohinohi
- Uahi o Pele
- Kahului
- Kalika
- Kauaheahe
- Lahaina
- Laupahoehoe

- Mahina kehau
- Mohihi a mohaluhalu
- Nika eleele
- Piko nui
- *Pu*
- Wai aniani

No data are available for Lāna'i, although Waimea Arboretum in 2008 was growing several cultivars found wild on the island (red skinned, white flesh).

One specimen from Kaho'olawe was recorded in 1900 from an unknown collector. Included was a black and white picture of a large tuber associated with the name "Pi'a," from which you can discern broad leaves with sharp points. The notes state, "Pi'a species of potatoe [sic] peculiar to the Island of Kahoolawe."

In 1931, Handy visited Kaupō, Maui. There, he documented and collected 33 named cultivar specimens, some of which may be synonyms.

- *Apo*
- Oheohe
- Huamoa ulaula
- Huamoa keokeo
- Kala
- Kaleponi
- Kalika lau keokeo
- Kalika ulaula
- Kaneohe keokeo
- Kaneohe ulaula
- Kapani'a

- Kawelo
- Kawowo
- Kiha
- Kuluehu
- Kupa
- Ma'ihui keokeo
- Ma'ihui ulaula
- Manamaka (ka'e)
- Manu
- Mauna pohaku
- Mohihi keokeo

- Mohihi ulaula
- Nika
- Nika keokeo
- Nika nui
- Nuki Lani (old)
- Panini
- Pa'u hiiaka
- Piko ha'o
- Piko manamana
- Piko nui
- Pukiki keokeo



Map 3. 'Uala cultivation on Moloka'i, Lāna'i, Kaho'olawe, and Maui described by Handy (1940) as coastal cultivation (yellow boxes) and "upland kula" (green boxes).

# Hawai'i

After visiting Maui in June 1931, Handy visited Honoka'a, Laupāhoehoe, and Kona. In Honoka'a, he documented an Okinawan and a Portuguese sweet potato. At Laupāhoehoe, he documented the following:

- Mohihi keokeo (from Waihe'e, Maui)
- Mohihi ulaula (from Waihe'e, Maui)
- Pia

At Laupāhoehoe, he also collected several 'uala which he described with multiple names:

- *"La'i o Kona*," Kona name; *"Aihau ka'e*," runs wild; *"Neki*," Ulupalakua, home of man, Ned, who worked for McKee, probably foreign
- "mohihi" = "kauaheahe" = "wainiha"

In Kona, Handy documented the following varieties. He did not specify whether these were from coastal areas, lowland fields, or upland fields, but it is possible that such details might be found in Handy's field notes if they still exist and are accessible.

- Aehau kae
- Heawe
- Kome
- Kon
- Kome ulaula
- Nika
  - Pakeke

Mohihi

- Pia
- Pohina
- Punana (=laʻi o Kona)

HuamoaKawelo



• Palahai [sic]



## 'Uala and aridity

Handy's 'uala growing regions tended to occur in relatively arid areas of the Hawaiian Islands. The map below (Map 5) indicates relative dryness using a ratio of modeled mean annual rainfall to annual Penman-Monteith potential evapotranspiration (data from Giambelluca *et al.* 2013, 2014). Coastal zones, especially leeward, tend to be semi-arid (yellow, 0.2-0.5), and "upland *kula*" areas include some dry sub-humid zones (green, 0.5-0.65). All islands include both coastal cultivation, especially near fishing villages, but only Maui and Hawai'i have extensive upland cultivation, likely due to a greater proportion of land area at elevation with sufficient moisture and younger substrate. Many lower elevation areas on windward slopes were utilized for sugar cultivation, thus archaeological evidence for 'uala cultivation in these areas is scant. Remaining field systems in uplands are often associated with ranching activities; these appear to have preserved the archaeology from more damaging forms of development from Kaua'i to Ka'ū.



From this map, we see areas where 'uala observations are conspicuously absent, as in Hilo and Puna. Handy writes that in Puna, the 'ulu reigns supreme, and Hilo's substrate and high rainfall meant other crops such as kalo, 'ulu, and mai'a were the staples. We begin to see the texture of Hawaiian food systems here by focusing on the more rugged nature of 'uala- as a staple in seasonally dry areas and a supplement to other crops where rainfall is abundant or irrigation is available.

# **Reflections and opportunities**

#### 'Uala varieties: What do we now know? Where do we go next?

This close examination of thirteen sets of 'uala descriptions reveals that descriptions of 'uala cultivars are not as clear cut and well-preserved as one might expect for a vegetatively propagated staple crop. In fact, 'uala names appear downright fluid in the most recent decades/century. However, an effort to re-diversify 'uala cultivation relies on knowledge of the cultivars and some understanding of each one's history, traits, and unique value. In untangling 'uala, we see that names and trait classification based on historical documentation alone is unsufficient. Other perspectives and tools are needed.

#### Into the lab and botanical collections

Modern molecular techniques may offer views into 'uala cultivar diversity more sensitive to differences than simple trait comparison. At present, UH Mānoa researcher Dr. Michael Kantar is working with students to isolate and examine genetic material from plants currently grown in botanical collections. His work will build upon the foundation established by Dr. Vincent Lebot, Dr. Caroline Roullier, and others who have studied, using molecular tools, the movements of sweet potato across Oceania. Using similar approaches, genetic relationships and movements of ancient and more recently introduced cultivars might also be teased apart.

#### Back to the archives

**'Ōlelo Hawai'i:** Further 'uala research in the archives should include exploration of native and foreign testimonies recorded in Land Commission Awards (LCA), many of which are now accessible through the website avakonohiki.org and the Papakilo database (papakilodatabase.com). These detailed testimonies often indicate whether and where petitioners were planting on their particular parcel(s) and may list varieties of 'uala grown in specific locales. Indeed, a māla 'uala at Anini experiences wetter conditions than one in Koloa; these conditions would be more appropriate for certain varieties than others. Additionally, such records provide high resolution information on where and how 'uala was cultivated and would likely expand our understanding of 'uala biogeography.

Students and speakers of Hawaiian language may be interested in delving further the Hawaiian newspapers, many of which are still not searchable. Other articles and interviews may still yield more names and specific descriptions for named 'uala varieties as well as other relevant information on cultivation, climate, and cosmology. Unexplored resources include recorded interviews of Mrs. Mary Kawena Puku'i with Hawaiians across the archipelago, stored at the Bishop Museum archives. Interviews with *manaleo* (native speakers) from Ni'ihau and other locales have been recorded and kept for Hawaiian language students on the UH Mānoa campus.

Such research would integrate Hawaiian language, history, botany, anthropology, geography, and any range of academic disciplines.

**English language resources:** Available notes or journals of T.C.B. Rooke and E.S.C. Handy with full and detailed plant coloring descriptions would be an invaluable find. In particular, tuber coloring and shape characteristics are absent from the herbarium voucher specimens and descriptions. These can be key distinguishing features, yet descriptions are frequently inconsistent/missing across the published descriptions of cultivars. In general, the common patterns for *'ili/i 'o* (skin/flesh) are: white/white, white/yellow, red/white, red/purple. Notably absent are the wet "yams" (sweet potato) with red skin and orange flesh, such as the commercial *Beauregard* or *Diane* varieties. The currently popular and preferred "Okinawan" type with both white skin and purple flesh also does not appear in descriptions of "ancient" varieties.

#### GIS modeling

Refining the GIS model of field systems to address different staple zones will improve capture of different staple cropping zones across the islands, both within and beyond the bounds defined by Kurashima (2016). Such modeling initiated for academic goals can then be easily extended to aid agricultural restoration efforts. However, the model in current state reveals some mismatch with Handy's descriptions. Notably for 'uala, coastal cultivation in dry is not predicted at all by the model. This may reflect the highly seasonal (versus more intensive) nature of these plantings associated with fishing villages on leeward coasts. Intensive mid-elevation 'uala cultivation also likely did not extend to 900 meters, the upper limit defined by the GIS model for dryland systems (Kurashima and Kirch, 2011). Handy interprets observed cultivation extending at most to 2500 ft (~760 m). His descriptions indicate that the sweet potato zone would end but that taro/breadfruit would continue in Kona and Ka'ū where the field systems extend to higher elevations.

The current GIS model is likely based on a permissive temperature criterion for sweet potato. Cold temperature at night during the 2008-2009 winter stalled growth of experimental plants in Kohala and Waimea (700-800m), though plants grew vigorously there once temperatures warmed. On the other hand, cultivation of a warmer but drier lower elevation leeward Kohala field site at 490m during was limited to the 2009-2010 winter when soil moisture was sufficiently high and sustained. Physiology aside, modeling based on temperature or precipitation must account for widely varying substrate types across the Hawaiian Islands. Such modeling efforts should also acknowledge the expansion of cultivation due to Hawaiian microsite innovations, from diverse mulching practices to walled enclosures at Kohanaiki and extensive kuaiwi in South Kona, leeward Kohala, and Kaʿū.

#### Into the field: Collaborations and knowledge co-production

Last but not least, the research work from the archives to biological and GIS labs should be both driven by and drive, should be informed by and inform, and should be tested by and test concurrent work and observations from the field. Field based activities include ongoing unirrigated 'uala growth experiments across rainfall and temperature gradients at Puanui, Kohala (led by Dr. Peter Vitousek and others). Variety trials at Waimānalo and Poamoho agricultural stations have allowed for comparison of yields and plant vigor at sites with contrasting soils (led

by Dr. Ted Radovich and others). These field-based activities provide opportunities for other growers and (non-university) experts to exchange knowledge and insights during harvests and site visits.

Reclaiming and re-diversifying 'uala goes beyond academic exercise. While the initial motive of this 'uala research was to get more varieties on tables, to understand 'uala requires multiple perspectives, from the farmers and growers who intimately know the plant's physiology and ecology from growing it, to the researchers who can unearth stories that inspire a family to grow it for home consumption and enable a farmer to support his/her family in today's cash economy by growing an heirloom traditional cultivar. The complicated identity of Hawaiian 'uala might just be a catalyst for collaboration. This report may be just one more element stimulating this ongoing, expanding 'uala conversation and collaboration.

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