

Tree Mold Evidence of Loulu Palm (*Pritchardia* sp.) Forest on the Kona Coast, Hawai'i¹

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Abstract: Lava flows at Pu'uhonua o Honaunau National Historical Park on the island of Hawai'i contain tree molds identified as native loulu (*Pritchardia* sp.) palms on the basis of gross morphology and surface features and patternings. The vegetation is reconstructed as loulu forest with an admixture of dicot species, represented by branched molds. Occurrence of loulu forest at ~1000 B.P. (calibrated radiocarbon dates on charcoal from beneath the flow) suggests that these palms persisted into the early period of Polynesian settlement on the Kona coast and that *Pritchardia* was an important component of precontact vegetation in this area.

TREE MOLDS FORM when sediments or lava bury or surround a tree and preserve its form. They are found in a variety of geologic settings. In Hawai'i, conditions are optimal for the formation of tree molds when flowing lava, usually of the more fluidic pāhoehoe type, moves through a forested area (Walker 1995). As hot lava engulfs a living tree, steam escaping from the tree keeps it from burning long enough to be impressed into the lava. The surrounding lava, which has been described as "a sheath of quenched basalt" (Lockwood and Williams 1978:69), often preserves the surface details of the tree even after the organic matter has burned or rotted away.

Tree molds are valuable scientifically for a variety of reasons. The shape and orientation of the molds can be used to establish locations of vents and direction and force of the flow (Lockwood and Williams 1978, Froggatt et al. 1981, Giannetti 1996). The charred wood

that can sometimes be recovered from the molds provides information about flow temperatures (Lockwood and Lipman 1980), vegetation present at the time of the eruption, and also the age of the flow if the material can be radiocarbon dated.

Identification of taxa based on the surface characteristics of the molds is sometimes possible. The lower vascular plants of the Paleozoic coal forests, for instance, had scalelike leaf attachments that formed characteristic patterns on the surface. Tree molds of the seed plants that dominate the later part of the rock record are generally more difficult to identify unless wood or charcoal can be recovered. The molds at Pu'uhonua are an exception; their identification was made possible owing to diagnostic features that can be recognized in the represented taxa.

MATERIALS AND METHODS

Tree molds are numerous in the volcanic terrain of the Big Island of Hawai'i, where the processes that formed the islands still send lava flowing down the volcano flanks toward the sea. Pu'uhonua o Honaunau National Historical Park lies along the Kona coast on the southwestern slope of Kīlauea Volcano. The molds we studied are along the coastline near an ancient Hawaiian fishing shrine, on the surface of a pāhoehoe flow (Figure 1). The age of the flow has been established by radiocarbon dating of charcoal from below the flow. The estimated age of 957–1061 B.P.

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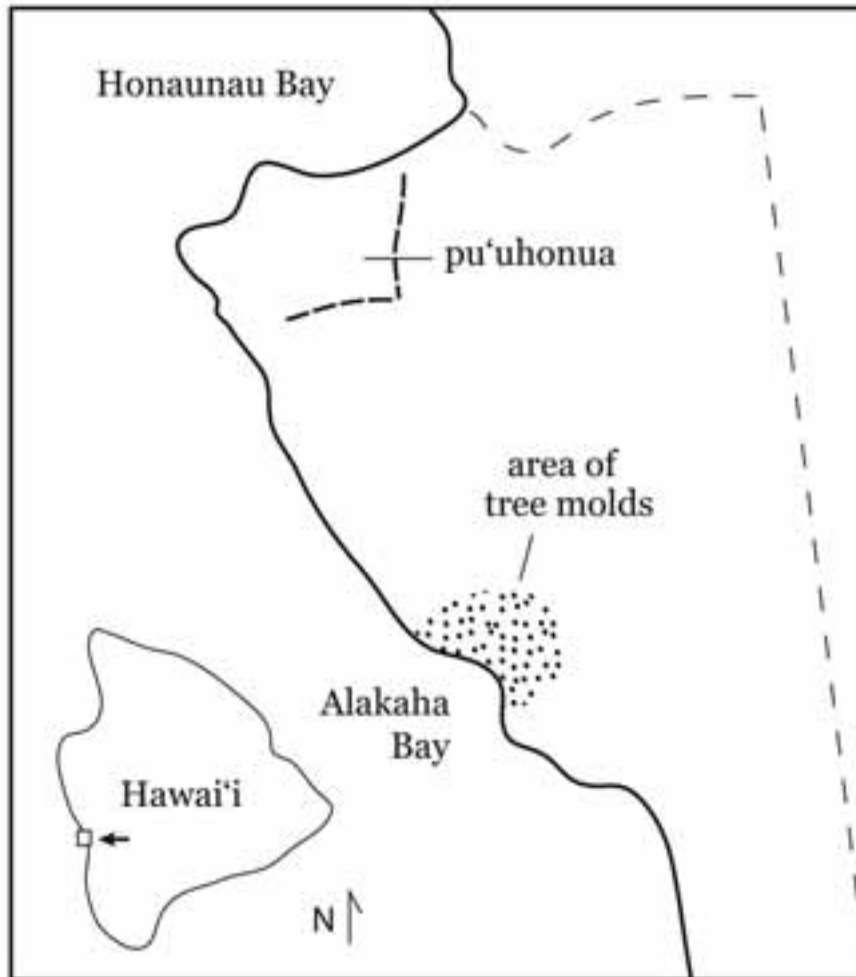


FIGURE 1. Pu'uhonua o Honaunau National Historical Park site with location of tree molds. Park boundary indicated by dashed line. Inset map shows area of detail.

(one sigma) represents a weighted average of two samples (1111 ± 51 B.P. [Lockwood 1995]) calibrated according to Stuiver and Reimer (1993) and Stuiver et al. (1998).

Our field study of all the tree molds observable on the surface of the 1000-B.P. flow ($n = 34$) included measuring dimensions of the branched ($n = 29$) and unbranched ($n = 6$) molds and making a detailed study of the surface features and patternings. None of the molds contained charcoal that could have been used for dating or identification.

RESULTS

The molds are found in relatively high abundance (at distances of 1–10 m) and are distributed relatively evenly where they occur. Many have an orange and brick red color that contrasts with the generally dark surface of the flow and is attributable to combustion of organic material (Lockwood and Lipman 1980). A common feature of the molds is lava infilling, a phenomenon in which molten material has been forced up through the



FIGURE 2. Unbranched tree mold with squeeze up in center.

solidifying surface of the flow through a fracture or weak spot, in this case the impression of the mold on the surface; these features are called “squeeze ups” and also “toothpaste lava” because they look like a line of toothpaste (Figure 2). Surface detail is lost in the area of squeeze ups, but these features generally occupy only a portion of the mold.

The many molds extending horizontally across the flow represent trees that fell into the lava and were carried along with the flow. The majority of the horizontal molds are unbranched, but some (6 of the 35 studied) show distinctive branching. In some cases, the lava moved around still-standing trees, producing vertical molds.

Diameter (or estimated diameter) of the horizontal unbranched molds averages 11–21 cm and does not vary much along the length. Median length of these molds is ~3 m. The longest mold has a length of 10.5 m and is considerably wider at one end, which

probably represents the base of the tree. The vertical molds also include larger-diameter specimens (25 and 37 cm).

The unbranched molds are straight-sided but have a characteristic surface texture. Walker (1995) described the surface of some Hawaiian tree molds as a “boxworks” of basalt septa and attributed the pattern to basalt infilling in cracks of charred wood. The description is apt—the Pu‘uhonua molds show a regular pattern of rectangular basalt septa much like a boxworks—but we doubt that all the specimens found in the park were necessarily charred at the time the molds formed. The surface in most cases has pronounced longitudinal septa that are 2–7 mm wide and relatively continuous along the length of the mold. Oriented perpendicularly are radial septa that are both less pronounced and less continuous. Together the septa form a rectangular pattern (Figure 3). Width and spacing of the septa vary from specimen to



FIGURE 3. Tree mold showing longitudinal and radial septa.

specimen and also often along the length of the mold. The variations observed may have been influenced by the pressure with which the molten lava forced itself into fissures in the tree or the degree to which trees cracked when coming in contact with the hot lava. A few of the unbranched molds (and all of the branched molds) do have a pattern suggesting charring, with wide septa that form large, fairly uniform rectangles.

There are a variety of indications that the unbranched molds are loulou (*Pritchardia*) palms, a genus including many species endemic to the Hawaiian Islands. The palmlike habit is best illustrated by one mold in particular that preserves the impressions of leaf bases and petioles (Figure 4). Impressions appearing to be the broad portion of the palm leaf base can also be seen at several locations. Identification as *Pritchardia* is based in part on morphological characters including a generally columnar form, although often with a

flared base in older individuals and sides that are straight and without pronounced leaf scars, persistent leaf bases, or other notable features (Figure 5). There is also a generalized correspondence between the septa visible on the molds and the surface patternings of living *Pritchardia* palms, which have prominent longitudinal furrows that are relatively continuous along the length of the tree and shorter, less well-developed radial furrows. The coconut palm (*Cocos*), in comparison, has a surface that is rougher, with less-continuous longitudinal furrows and more-evident leaf scars; is usually larger in diameter; and typically grows in a curved or slanting fashion rather than being straight-columnar.

The genus *Pritchardia* includes several species with diameters approximating that of the molds. The most likely candidate is *Pritchardia affinis* Becc., a species limited in its occurrence to leeward Hawai'i. Wagner et al.

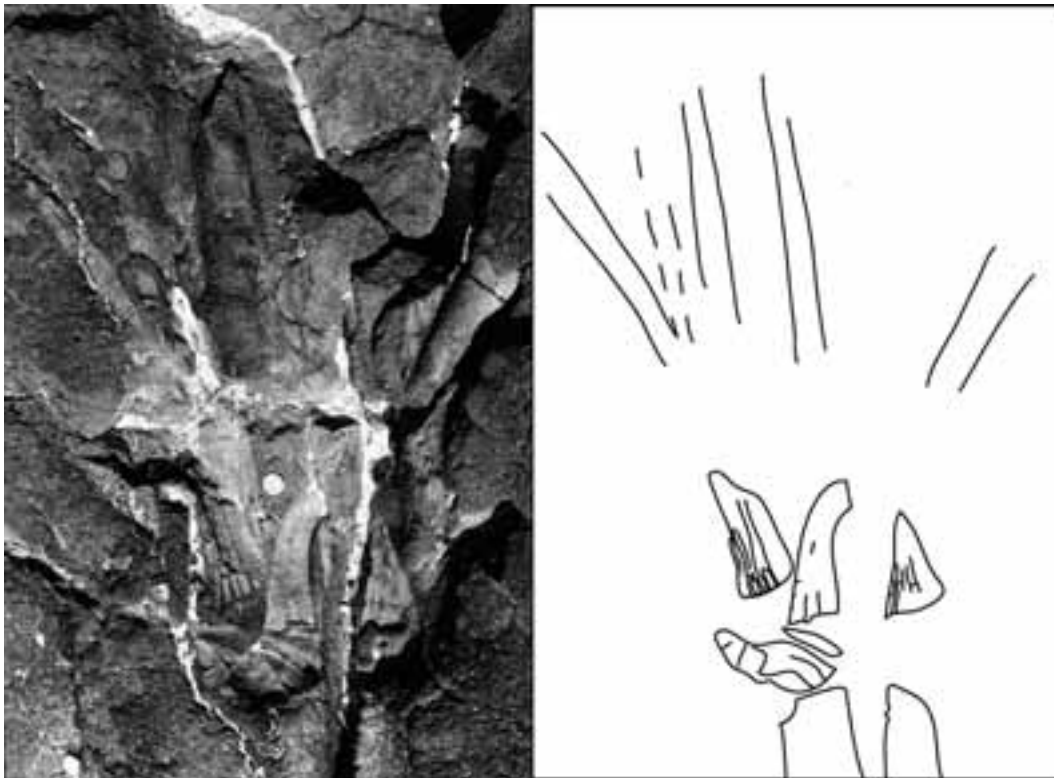


FIGURE 4. Tree mold with leaf bases/petioles.

(1999) described the range as coastal and extending inland into mesic forest. This species may have been more widespread along the Kona coast in recent historical times, based upon comments of Beccari and Rock (1921); however, there is some question about whether populations of this palm are (or were) wild or cultivated (Hodel 1980). Genetic plasticity and inadequate herbarium material have presented problems in establishing the taxonomic status and natural range of Hawaiian *Pritchardia* species (Wagner et al. 1999).

The prevalence of palm molds at the site suggests a stand dominated by *Pritchardia* with other trees present as occasional elements. Consistent with this interpretation are descriptions of remnant stands of coastal *Pritchardia* spp. in which the palms are mono-

dominant, growing close together and producing a thick layer of fronds in the litter layer (Gagné and Cuddihy 1999).

CONCLUSIONS

The tree molds at Pu'uhonua o Honaunau provide evidence of the abundance of native palms through the early period of Polynesian habitation along the Kona coast, an area known for its historical and remnant populations of loulu palms. Subsequently, populations of this and many other native plants declined precipitously through a combination of factors including landscape modification and introduced animal predators. The coastal palms are represented today by only a few small populations, and it is difficult to know whether these are naturally occurring since



FIGURE 5. Loulu palm near the park office. Diameter is ~12 cm at breast height.

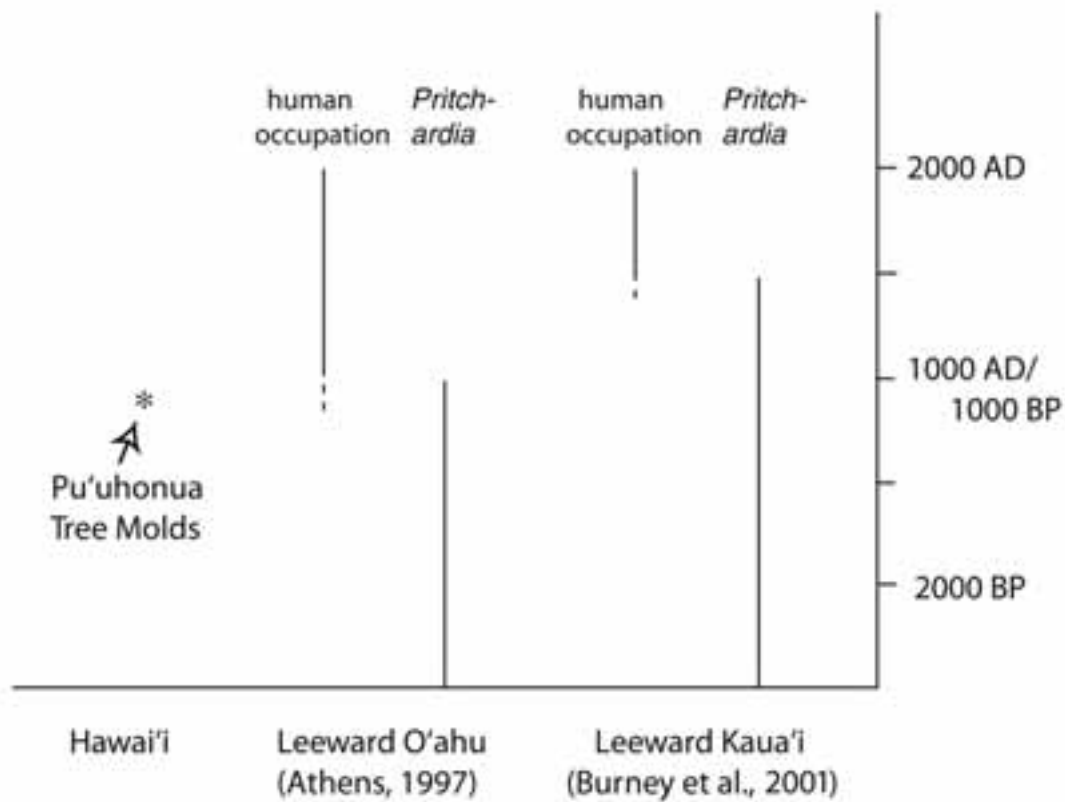


FIGURE 6. Correspondence between human occupation and *Pritchardia* occurrence.

Hawaiians may have planted these trees, which were valued for thatch and edible fruits, near their habitations (Beccari and Rock 1921).

Pollen and macrofossil records from lowland areas of O'ahu and Kaua'i show a clear correspondence between human occupation and subsequent decline of *Pritchardia* (Figure 6) (Athens 1997, Burney et al. 2001). The Pu'uhonua molds are an additional source of information about the rise and fall of coastal palm communities. Our study also suggests that tree molds may be an underutilized source of information about paleoecology and the chronology of landscape change in Hawai'i.

The tree molds are an easily viewed aspect of the site's natural history that are interesting both collectively and individually. Particularly notable are the specimen with leaf

bases evident at the apex; specimens showing "squeeze ups" where lava breached the mold from below; the longest mold with its flared base; the vertical molds that display a septum on one side showing how the lava flowed around the tree on its path toward the ocean; and the branched molds with their completely different morphology. Fortunately, the tree molds are not an especially fragile resource and are unlikely to be damaged by normal foot traffic. Thus there is no reason that visitors to the park should not be encouraged to view the tree molds at close hand because they have much to say about the dynamics of lava flows, the process of tree mold formation, and vegetation and landscape change in Hawai'i.

Pu'uhonua is one of the most historically significant and beautiful sites in the Islands. Standing on the lava flows along the coast-

line, with the broad slopes of Kīlauea rising to one side and the great stone walls of the refuge and the other archaeological features as backdrop, is an experience not to be forgotten. It also rather remarkable to find at one's feet the impressions of native palms that once thrived in this coastal area now dominated by introduced plants.

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