A Hypothesis Regarding the Absence of the Pecking Technique in Hawaiian Adze Making

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Introduction

The absence of the pecking technique in adze manufacture in Hawai'i is a curious anomaly in East Polynesia. By the late 18th century, pecking was used to some degree in adze making almost throughout East Polynesia, but in Hawai'i it was completely absent. Different models have been suggested to account for the distribution of the pecking technique in Polynesia, but the issue remains unresolved. Although not employed in Hawaiian adze manufacture, the technology of pecking was known there, as it was throughout Polynesia, for the manufacture of artifacts such as sinkers, food (*poi*) pounders (in East Polynesia) and *'ulu maika* gaming stones (specific to Hawai'i). It was not an innovative technology that somehow never reached Hawai'i, but rather a manufacturing method deliberately not applied to Hawaiian adzes.

Let us define the terms used in the process of adze manufacture as set forth by Buck et al. (1930:180). *Chipping* is defined as "The process of removal, by blows, of flakes large or small." Here the term "chipping" is used rather than "flaking," although the two are largely interchangeable. *Pecking* is defined as "The process of striking blows on a surface with a pointed implement, each blow leaving a small pit." *Grinding* is defined as "The process of removing roughness by rubbing with sandstone or similar material." The additional processes of *bruising* (a form of pecking) and *polishing* are not applicable in the present study.

Stokes (1930:139–140) was first to address the problem in detail:

> Pecking is absent or very rare in Hawaiian, Samoan, and Pitcairn Island adzes, so far as well authenticated specimens indicate [in fact, it is completely absent in Hawaiian adzes]; it is present, but rare in Tongan and Marquesan adzes;

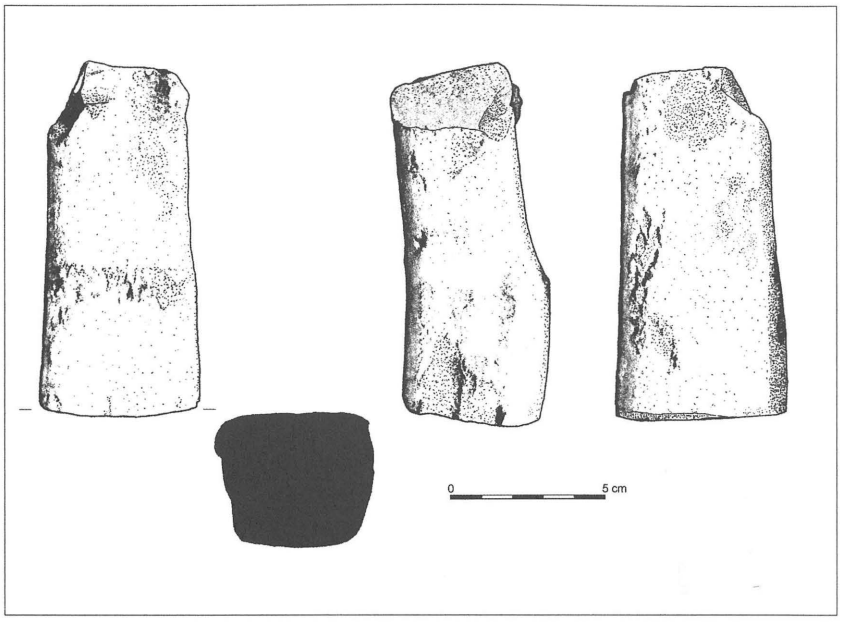

Figure 1. Butt of pecked Duff Type 1A adze with lugs on poll (Bollt 2005a:Figure 9.3).

> both technics [sic] are present, though pecking is dominant, in adzes from Easter Island, the Society Islands, Tubuai, Rapa, the Cook Islands, and New Zealand. In islands where pecking predominates, most of the pecked adzes are superior in form, symmetry and finish to the unpecked ones.
>
> This distribution may indicate different cultural elements in Polynesia. The focus of the pecking process seems to have been the Cook, Austral, or Society islands, where it accompanies a non-pecking process surviving in some marginal areas like Samoa. On the other hand, adzes show that the pecking process was important in Easter Island . . . a marginal point screened, as it were, from the Society Islands, by non-pecking localities such as Pitcairn, Mangareva, and possibly the Marquesas. [Pecking was definitely present in the Marquesas; see Figueroa and Sanchez 1965:201] However, Polynesia cannot be regarded as an isolated area, for in Melanesia, from Fiji westward, both technics [sic] were present, but Melanesian adzes are characterized by an excess of grinding, so that the importance of the pecking process, where present, cannot well be determined.

Figueroa and Sanchez (1965:200) used Stokes' hypothesis as a starting point in an analysis of 971 surface collected adzes from Easter Island, Pitcairn, Ra'ivavae, Mangareva, Rapa, and the Marquesas. They found that pecked adzes tend to have a rounded cross section and are of rather limited distribution compared to those with more angular cross sections, mostly unpecked (Figueroa and Sanchez 1965:200–201; see also Sinoto 1970). Basically confirming what Stokes (1930) had proposed, Figueroa and Sanchez (1965) concluded that pecking originated in central East Polynesia (Tahiti, Southern Cooks, Australs) in the late prehistoric period and then diffused outward while remaining predominant in the central area. The antiquity of the pecking technique in central East Polynesia dates at least to the 13th to 14th centuries A.D., as attested by at least one excavated example of a pecked Type 1A adze butt recovered from Rurutu in the Austral Islands (Figure 1; see Bollt 2005a, 2005b).

By the 1980s, experimental archaeology began to suggest independent invention rather than diffusion of Polynesian adze manufacture techniques, especially in Hawai'i. Cleghorn (1984:410) noted, "Even accepting Stokes' distribution (which is difficult to evaluate as sample sizes are not given), an alternative explanation might be found by looking for a correlation between the distribution of the pecking technique and the distribution of raw materials that are difficult to flake. A positive correlation between these factors might best be explained by independent solutions to similar problems, rather than by cultural relationships." Cleghorn (1984:411) concluded from his experiments that "it requires much less effort to shape a water-worn basalt cobble by pecking than by flaking; the rounded contours make the flaking of tough basalt difficult. Thus, if water-worn cobbles are the dominant form of material associated with the pecking technique, then the form of the raw material might be used as an explanation for the distribution of this manufacturing technique." In addition to these observations, the type of raw material may be a factor in determining adze form, in terms of a rounded or more angular cross section (Cleghorn 1982, 1984:411; see also Bellwood 1970:98). Figueroa and Sanchez (1965:200) had earlier addressed the availability of different types of stone in determining the presence or absence of pecking, but concluded that "the nature of the stone employed does not seem to have been important in determining the distribution of the two basic adze

manufacturing techniques. Rather, this distribution apparently is the result of complex cultural and historical causes."

Hypothesis of the Present Study

The distribution of pecking throughout East Polynesia is very likely linked to both basalt type and adze form (e.g., cross section), as Cleghorn (1982, 1984) and Bellwood (1970) previously noted. A comparative study of assemblages from multiple island groups would be very useful in this respect, but it is far beyond the scope of the present study. Also, it would not explain why pecking was not used for adze making in Hawai'i. Could the choice have been related less to the raw stone material than to the material used to grind it? Why is Hawai'i an anomaly? Could it have been, as Figueroa and Sanchez (1965: 201) suggested, that "central area developments" did not reach Hawai'i, or were other factors that make Hawai'i unique involved? Our hypothesis takes such factors into account, focusing on black sand and possibly olivine sand.

Black sand beaches exist in a variety of types. McDonald et al. (1983:272) wrote:

> Some black sand beaches, for example those of Kalapana (Kaimu) and Punaluu on Hawaii, consist of glassy volcanic debris from littoral explosions. Others, however, such as some on the south shore of Molokai, consist of the grains of the heavy black minerals magnetite and ilmenite, eroded out of the lava rocks. Still other black, gray, and brownish gray beaches consist largely of fragments of lava rock.

In West Polynesia, black sand is present in limited quantities in Fiji (Viti Levu) and Samoa (Upolu). Figueroa and Sanchez (1965:200) noted that in West Polynesia "pecking is rare and probably diffused from Fiji." If adze-pecking was an East Polynesian innovation as Stokes (1930) and Figueroa and Sanchez (1965) suggested, then its near-absence in West Polynesia is to be expected and may not be connected to the presence of black sand.

In terms of East Polynesia, however, the entire absence of pecking in Hawai'i is difficult to explain, given its presence (if not dominance) in virtually every other part of East Polynesia. Black sand is most abundant in Hawai'i, is limited in both the Societies (Tahiti) and the Marquesas (Nuku Hiva, Hiva Oa), and totally absent in the Cooks, Australs, and Tuamotus. New Zealand, which has black sand, will remain outside the scope of the present study because the types of stone there, such as greenstone and greywacke, are far more varied than elsewhere in East Polynesia, opening an entirely different set of questions regarding manufacturing technique.

Olivine sand also is restricted to the Hawaiian archipelago, most notably at Hanauma Bay (O'ahu) and Papakolea (5 km northeast of South Point, Hawai'i Island). McDonald et al. (1983:272–3) wrote:

> At both places the sand consists primarily of green crystals of olivine, separated out of the volcanic rocks by erosion. At Hanauma Bay the rock supplying the olivine is tuff belonging to the row of cones extending northeastward from Koko Head. At Papakolea the olivine is derived from Puu Mahana, a littoral cinder cone formed where an ancient aa lava flow entered the ocean.

Is it possible that the abrasive quality of these noncalcareous sand types made pecking virtually obsolete for adze making in Hawai'i? Could black or olivine sand have been prized enough to become an item of trade between islands and valleys?

The Experiment

To test our hypothesis, we constructed an experiment to compare the abrasiveness of black, olivine, and calcareous white sand, by means of a weight-reduction experiment. The experiment took place on the University of Hawai'i at Mānoa campus in April 2006 (Table 1; Figures 2 and 3). We prepared a basalt grinding stone with a surface area of approximately 50 cm^2 on which we ground a variety of adze preforms, flattening and smoothing the surface. A quadrangular piece of fine-grained tabular prismatic basalt was then selected for the experiment from the Kapa'a quarry area on O'ahu. One surface was ground flat and smooth before the formal experimentation began in order to obtain a uniform surface. The sides were then ground flat to ensure uniform reduction.

Table 1. Results of weight reduction experiment.

Sand type	Starting weight (g)	Weight of stone after 20 minutes (g)	Total weight reduction (g)
Olivine sand	183.26	181.26	1.80
Black sand	181.26	178.93	2.53
White sand	178.93	178.34	0.59

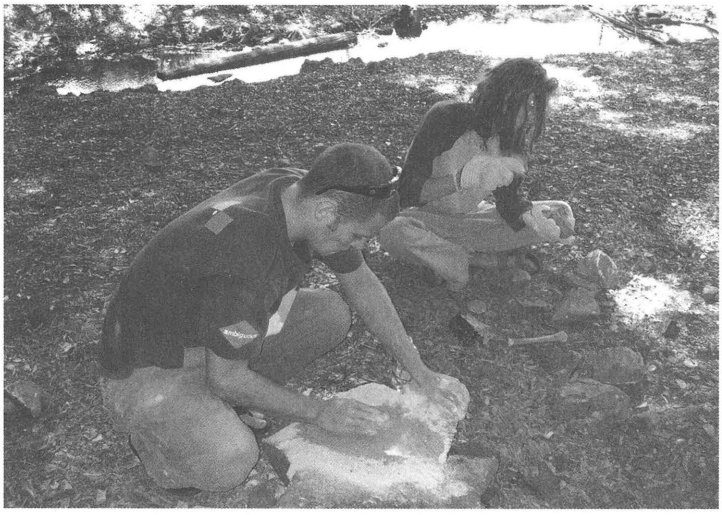

Figure 2. Porter (left) grinds the sample while Ferraro (right) works on a preform.

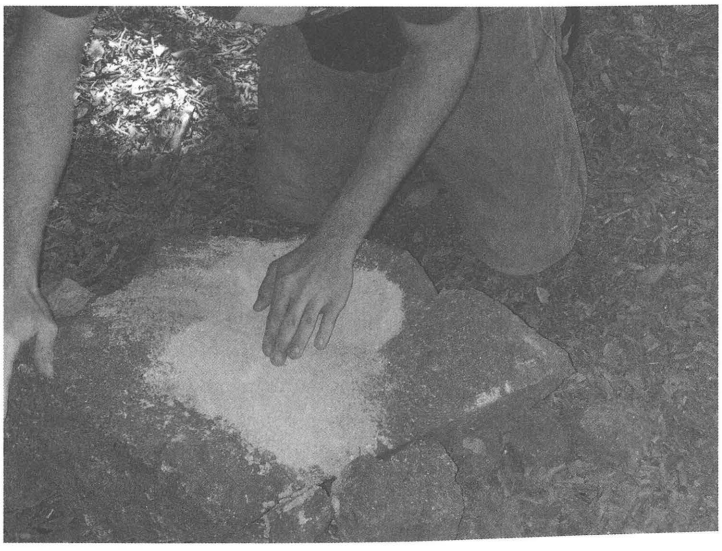

Figure 3. Close-up of Porter grinding the sample.

By the end of preparation, the specimen weighed 183.26 g.

Grinding of the stone proceeded in 20-minute sessions with the three different types of sand: olivine sand (from Green Sand Beach, Hawai'i Island), pure black sand (from Punalu'u Beach, Hawai'i Island), and calcareous white sand (from Hawai'i Kai, O'ahu Island). The grinding time was divided between Ferraro and Porter, each grinding for ten minutes. To begin, 500 g of sand was spread over the surface of the grinding stone. Following this, 100 ml of fresh water was added and mixed by hand over the grinding surface. Neither the sand nor water was renewed during the 20-minute period. During the course of the three grinding phases, every effort was made to grind in as even a pace as possible. At first, we attempted to establish a set tempo using a metronome, but this proved cumbersome and produced an unnatural rhythm. We decided that monitoring one another by sight was preferable. To ensure relatively even pressure during the sessions, the stone was ground with one hand at a time using the same body position so that body weight was distributed the same way. Grinding was done in a back and forth motion, as opposed to circular, to ensure consistency in the amount of surface area of the grindstone being covered by each stroke (see Figures 2 and 3). However, during our earlier informal experiments with grinding, we soon learned that every different motion type is actually used in practice. Grinding is an extremely monotonous activity, and changing motions regularly makes it less so. Ideally, the grinding in an experiment such as ours should be done with a mechanical device whose rate and pressure could be precisely measured and controlled, but such was beyond our resources. At the end of each grinding session, the specimen was washed and weighed. One potential problem can arise from this procedure: given that we smoothed the surface of the piece before the experiment, the efficiency of each sand type may be under-represented, as there were no "high" points or irregularities to be removed. However, this potential under-representation should apply to all three types of sand, and thus the overall bias should be lessened. The results are listed in Table 1.

Results and Discussion

Black sand was the most successful abrader, reducing the weight of the specimen nearly five times more effectively than white sand. Olivine sand was almost four times more effective than white sand, and it rendered a smoother, more polished surface than black sand. Our personal, informal impressions of the different types of sand should also be noted. Grinding with black sand, especially of the Punalu'u Beach type (glassy volcanic debris), feels very different than white sand. The black sand crunches like glass underneath the preform, and it remains coarse much longer than white sand. Olivine sand does not have the same glassy quality, but it also remains coarse longer than white sand. Both black and olivine sand *feel* more effective than white sand while grinding, making the tedious process seem faster and more bearable. The subjective experience of producing a stone tool cannot be emphasized enough.

Our results suggest the possibility that black sand may have been favored as an abrader in prehistoric Polynesia. As black sand is more abundant in Hawai'i than anywhere else in Polynesia, it conceivably contributed to the absence of the pecking technique in adze making there. However, the fact that black sand is unevenly distributed among the Hawaiian Islands, being abundant on Hawai'i Island and scarce on the others, complicates the issue. Significantly, black sand is not readily available in central East Polynesia where pecking became the predominant technique (e.g., the Cooks, Societies, and Australs), being extremely limited in its distribution (Tahiti). The availability of black sand in Hawai'i may also have contributed to the predominance of the quadrangular adze there, whose flat surfaces are far more easily ground than pecked. Other, subtler factors may have been present, perhaps including cultural preference, pride of workmanship, and display of skill.

This experiment is a pilot study intended to open new avenues of research into an issue that warrants further investigation. The abrasive qualities of different types of sand should be tested under more controlled conditions, mechanically if possible, and for longer grinding times. Additionally, a wide variety of basalt from quarries around Polynesia should be used.

Acknowledgements

This study grew from a class (Lithic Analysis in Archaeology) taught by lead author at the University of Hawai'i at Mānoa in Spring 2006. We thank Paul Cleghorn for providing some of the inspiration for this project and for giving us the olivine sand for our experiment. We thank Jo Lynn Gunness for her ideas, input, and assistance in helping us coordinate our activities during the semester. We thank Mike Carson for his comments and suggestions during the experimentation process and for his editorial labors. Finally, we thank Michael Graves who put sufficient departmental funds at our disposal for this project.

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