NEW ZEALAND JOURNAL OF ARCHAEOLOGY

A Hawaiian Adze Sequence or Just Different Kinds of Adzes?

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ABSTRACT

Previous arguments about formal variability of Hawaiian stone adzes through time have been based on a paucity of data. Dated archaeological adze assemblages are now available to test previous notions about change in adze form through time. This paper presents the results of analyses of 147 adzes in the Bishop Museum from dated archaeological contexts in 21 sites on 5 islands. The results do not support the argument that there was a change from an early variable adze kit to a later standardised form. It appears that adze forms were variable throughout the Hawaiian prehistoric sequence.

Key Words: ADZES, ARCHAEOLOGY, HAWAI'I, RADIOCARBON DATES.

INTRODUCTION

Stone adze heads, commonly referred to as adzes, were arguably one of the most important items in the tool kit of ancient Hawaiians, as well as other Polynesians. Adzes were used for a wide variety of wood working tasks, including clearing forests and felling large trees, hollowing out logs for canoes, fashioning house posts and wooden bowls, and carving images of the gods. Hawaiian adzes show considerable variability in size and form. They range in length from less than a centimetre to over 50 centimetres. Some adzes were tanged, with the butt end reduced so that there was a pronounced angle between the butt and the blade portions, and others were not; some had straight cutting edges and some were curved; some had parallel sides and others had either expanding or tapering sides (note: all adze terminology follows Emory 1968). Adze cross-sections are extremely variable, and include rectangular, trapezoidal, triangular, plano-convex, and lenticular forms.

Adzes have long been a favoured object of study for archaeologists in Polynesia. Adzes have been used to develop culture historical sequences within island groups and to postulate relationships between island groups (Cleghorn 1984). Archaeologists in Hawai'i are no exception to this general trend. Several authors have looked at the forms of adzes in Hawai'i and discussed the meaning of adze form variability. Some have argued that adze forms have changed through time and thus that there is an adze sequence. Others have argued that adze forms may correlate with different functions or raw materials and that there were various forms of adzes throughout the pre-Contact period.

This paper will first briefly review these arguments and show that they are based on a paucity of empirical data. Then the formal variability of Hawaiian adzes through time will be explored by analysing adzes from securely dated archaeological contexts. The variables used in this study have been chosen to document the formal and size variability that exists

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in Hawaiian adzes. Changes in adze forms over time will be explored by these analyses and the observed variability explained.

BACKGROUND

Emory, in 1968, was the first researcher to explain Hawaiian adze form variability in chronological terms. He examined 265 adzes from Bishop Museum and private collections, the majority of which came from undated archaeological contexts. Adzes from dated archaeological contexts came from the H1 sand dune site on Hawai'i Island (Site 50-HA-B21-6, N=14) and from site K3 on Kaua'i (Site 50-KA-C10-2, N=26) (Emory 1968: 163). At the time, the H1 site was regarded as the oldest site on Hawai'i Island, although this has since been shown to be incorrect (Dye, this volume). Emory dated the Kaua'i site to the mid fourteenth century A.D., which still seems correct (see Appendix 1).

Emory concluded that the early Hawaiian adze kit was quite varied, having quadrangular, plano-convex, triangular, and reverse triangular cross-sections; some of these early forms were tanged (1968: 164). Of these various forms, only the quadrangular adzes persisted; most of these were tanged. Emory sums up his thoughts by stating:

> No place in East Polynesia exhibits such a steadfast adherence to one form of adze as Hawaii. Hawaiian adzes are usually quadrangular (or rectangular) in cross-section and, except for some small specimens and a few of medium size, are tanged (1968: 162–163).

Kirch (1972, 1985), without the benefit of a detailed analysis of dated adzes, continues the argument that Emory initiated. He states that late prehistoric Hawaiian adzes are highly standardised, being usually tanged and rectangular in cross-section (1985: 184). He also states that the early assemblages of adzes are much more varied in form, with cross-sections that include plano-convex, trapezoidal, triangular, and reverse triangular. Kirch thinks that the early and varied cross-section forms show culture-historical links with central East Polynesia. He suggests that the change from a varied adze kit to a highly standardised one may be due to functional changes such as those Best (1977) has proposed for New Zealand, or could reflect the rise of adze-making specialists. Kirch postulates that this change from a varied adze kit to a standardised one occurred during his proposed Developmental Period between A.D. 600 and 1100 (1985: 302–303).

Dye, Weisler and Riford, in 1985, studied adze quarries on the islands of Moloka'i and O'ahu. They show in their analysis that a high percentage (16%) of adzes being made at the Mo'omomi Adze Quarry were reverse triangular in form (Dye *et al.* 1985: 92). The Mo'omomi adze quarry was probably not used until A.D. 1000 (Dye *et al.* 1985: 89–90). The authors questioned why there was such a relatively high percentage of an 'early' reverse triangular form of adze in a quarry that dates predominantly to a period when tanged quadrangular adzes should have been produced. The logical extension of the authors' questioning is that adzes with varied cross-sections existed throughout much of the Hawaiian sequence. The possibility of having varied cross-sectioned adzes co-existing throughout the Hawaiian sequence is precisely what is being examined in this paper.

VARIABLES

The following metrical and non-metrical variables were recorded on complete and fragmentary finished adzes and preforms. Terms for parts of adzes follow the terminology advanced by Buck *et al.* (1930).

Three measurements were recorded: length, width, and thickness. Length was measured only on specimens exhibiting a complete length, from the cutting edge to the poll. Width was measured from side to side on the face or upper surface of the adze, perpendicular to the length; it was measured at the shoulder of tanged adzes and at the mid-point of untanged adzes. Adze thickness was measured from the face to the base of the adze at the position where the width was measured.

Four non-metrical attributes were recorded: cross-section, presence of a tang, plan shape, and cutting edge shape. The cross-section is determined by viewing the adze from the bevel end, face up, and viewing the cross-section at the shoulder or the mid-section. Cross-section forms follow those proposed and defined by Emory (1968) and include rectangular, trapezoidal (base width exceeds face width), reverse trapezoidal (face width exceeds base width), triangular, reverse triangular, plano-convex, reverse plano-convex, and lenticular.

Each adze was examined to see if a tang was present, where the butt portion was reduced forming a distinct angle between the blade and butt portions. The literature has numerous references to 'incipiently tanged adzes' where the butt portion is only slightly reduced. In the current study, all adzes with any butt reduction have been classified as tanged. Adzes without this reduction are classified as untanged.

The shape of the cutting edge was examined to see if it was straight across from side to side, when viewed from the front surface, or if it was curved or convex, extending outward from the sides.

The plan view shape of the adze was noted as being parallel sided, expanding, or tapering. Expanding sided adzes have a cutting edge that is wider than the poll, and tapering is where the poll is wider than the cutting edge.

In the description of the assemblages below, it will be noted that the total number of adzes described for a variable (e.g., plan view shape) may not equal the total number of adzes in the assemblage. This is because there are adzes for which certain variables cannot be determined. Rather than listing the number of indeterminate adzes for each variable, only the adzes that can be positively determined are enumerated.

ASSEMBLAGES

The archaeology collections of the Bishop Museum were searched for adzes that came from dated contexts. The current study is limited to adze assemblages that are curated at the Bishop Museum. The site numbers used in this paper are Bishop Museum site designations. Adze assemblages from dated archaeological contexts have been found on five of the seven main Hawaiian islands (Table 1 and Fig. 1).

All of the sites used in this study are habitation sites. Most were located near the shore, though there are several from inland valley locations. No quarry sites were included, because chronological control of specimens at quarry sites tends to be more complex and because it is often difficult to determine with the same degree of confidence what the final forms of the adzes were to be. It is particularly difficult to distinguish between rectangular and trapezoidal forms (and reverse trapezoidal forms); triangular and reverse triangular

forms are generally clearly distinguishable even at the early stages in the manufacturing process.

TABLE 1
HAWAIIAN ADZE ASSEMBLAGES

Island	Number of sites	Number of adzes
Kaua'i	1	43
O'ahu	14	68
Moloka'i	1	4
Maui	1	1
Hawai'i	4	31
TOTAL	21	147

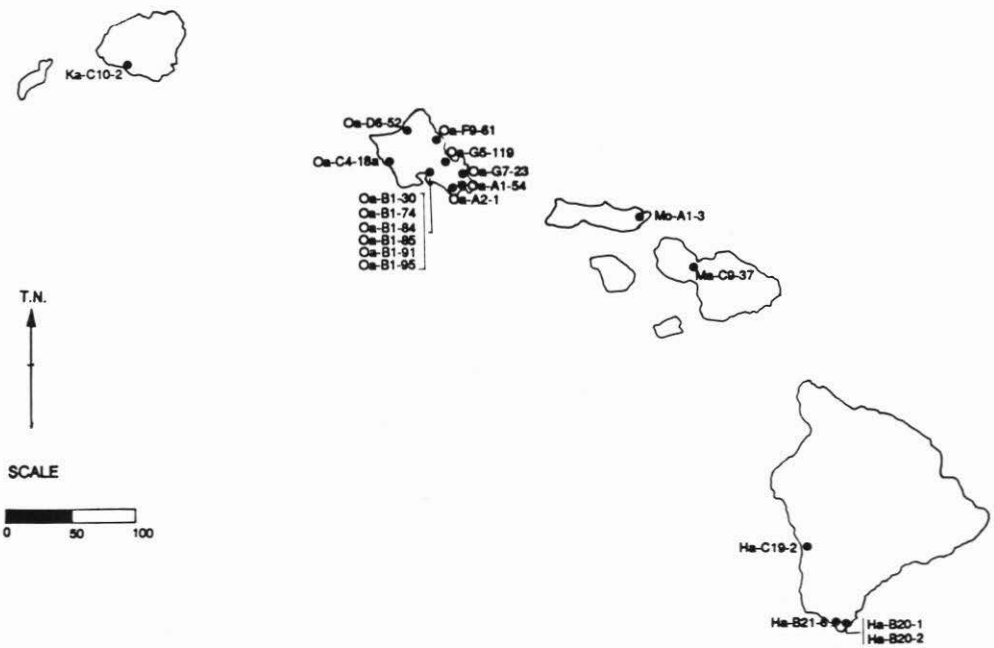

Figure 1: Location of sites with dated adze assemblages.

CHRONOLOGY

Seventy-one radiocarbon dates have been used to date these 21 adze assemblages (Appendix 1 and 2). Appendix 1 presents calendrical age ranges of dated Hawaiian adze assemblages, and Appendix 2 presents the data for unpublished samples. The number of radiocarbon dates per site ranges from 1 to 20, with the majority of sites having more than one date. Although most of the sites had radiocarbon dates directly associated with adzes, i.e., from the same layer, there were instances where this was not the case. Sometimes adzes were found in stratigraphic contexts above or below a radiocarbon date. These adzes are included in this study and are listed as either earlier or later than a certain date.

Most of the sites (14) in this study date to the time period after A.D. 1500 (Appendix 1); this total includes Layer I of Site 50-HA-B21-6. Four sites, including Layer II of Site 50-HA-B21-6, probably date to a time period earlier than A.D. 1000, with the earliest assemblages going back possibly as early as A.D. 500. Finally, four sites probably date to the time period between A.D. 1000 and 1500. All pre-Contact time periods are thus represented in this sample.

DESCRIPTION OF ASSEMBLAGES

KAUA'I

Only one site was found to contain adzes from dated archaeological contexts.

Site 50-Ka-C10-2

Forty-three adzes were recovered from Layers I–XII at depths above the level of 152–183 cm below surface. Five radiocarbon dates were obtained from provenances below the adzes. These dates range from A.D. 1110 to 1510, so the adzes are likely to originate from a period more recent than A.D. 1500.

The following cross-sections are represented in this assemblage: rectangular (N=31), reverse trapezoidal (N=10), reverse triangular (N=1), and possibly plano-convex (N=1). Fifteen adzes are tanged and seven are untanged. Twenty-one have parallel sides, eight have expanding sides, and one has tapering sides. Twenty-three have straight cutting edges and three have curved edges. The size ranges are: length, 37.3–142.0 mm (mean 63.9 mm); width, 18.5–70.5 mm (mean 32.8 mm); thickness, 5.5–37.5 mm (mean 17.1 mm).

O'AHU

Fourteen archaeological sites from O'ahu contained adzes from dated contexts.

Site 50-Oa-A1-54

One adze was recovered from the upper levels of this site. One radiocarbon date of A.D. 1600–1800 dates this upper occupation. The adze is an untanged reverse trapezoidal fragment with parallel sides and a straight cutting edge.

Site 50-Oa-A2-1

Six adzes were recovered from this site, five from Layer I and one from Layer III. Two radiocarbon dates, A.D. 824–1184 and A.D. 1580–1880, were obtained from below these layers. All of the adzes are probably from contexts more recent than A.D. 1600.

Five of the adzes are reverse trapezoidal and one is reverse triangular; two are tanged and one is untanged. One has parallel sides and one has expanding sides. Two have straight cutting edges. There was only one complete specimen, which measures 31.0 by 13.5 by 7.5 mm thick.

Site 50-Oa-B1-85

One adze was found in the mound fill above two radiocarbon dates from Layer II that date to A.D. 1270–1470 and A.D. 1680–1800. The adze probably post-dates A.D. 1700. It is a tanged reverse trapezoidal fragment.

Site 50-Oa-B1-30

Thirteen adzes were recovered from subsurface contexts and one was collected from the surface at this site. Three radiocarbon dates are associated with the subsurface adzes; these are A.D. 995–1325, A.D. 1245–1495, and A.D. 1250–1500. All of the subsurface adzes probably date to the period between A.D. 1200 and 1500. The surface adze probably post-dates this period.

Twelve of the subsurface adzes are rectangular in cross-section and one is reverse trapezoidal; six are tanged and one is untanged. Seven have parallel sides and one has expanding sides; seven have straight cutting edges and one has a curved edge. The size ranges are: length, 51.0–93.0 mm (mean 126.6 mm); width, 22.0–46.5 mm (mean 31.7 mm); thickness, 9.0–35.1 mm (mean 17.1 mm).

The surface adze is a rectangular cross-sectioned fragment with parallel sides and a straight cutting edge. It is 23.5 mm wide and 12.5 mm thick.

Site 50-Oa-B1-74

Seven adzes from this site are used in this study. The deposit in which they were found has been dated by two radiocarbon dates of A.D. 1590–1710 and A.D. 1600–1800; the adzes are thus from deposits dating to *c.* A.D. 1600–1800.

Six of the adzes have rectangular cross-sections and one is reverse trapezoidal; four are tanged and one is untanged. Three have parallel sides and one has expanding sides. Three

have straight cutting edges. The size ranges are: length, 45.0–114.5 mm (mean 70.0 mm); width, 18.0–45.0 mm (mean 28.4 mm); thickness, 5.5-30.0 mm (mean 15.6 mm).

Site 50-Oa-B1-84

Fourteen adzes were found at this site, eight of which are used in this study. Five radiocarbon samples date this adze assemblage to the period A.D. 1600–1800.

Four of the adzes have rectangular cross-sections and four are reverse trapezoidal. Six have parallel sides and one has expanding sides. Seven have straight cutting edges. The size ranges are: length, 37.0–91.1 mm (mean 60.6 mm); width, 12.5–42.5 mm (mean 27.9 mm); thickness, 6.5–34.0 mm (mean 16.5 mm).

Site 50-Oa-B1-91

Three adzes from this site are used in this study. This assemblage has been dated by six radiocarbon dates to the period A.D. 1600–1800.

All of the adzes are reverse trapezoidal in cross-section, and two are tanged. Two have parallel sides and all have straight cutting edges. Size ranges are: length, 46.5–52.5 mm (mean 49.5 mm); width, 17.0–27.5 mm (mean 20.5 mm); thickness, 10.0–17.0 mm (mean 12.4 mm).

Site 50-Oa-B1-95

One adze was recovered from Layer I. A radiocarbon date of A.D. 1670–1810 comes from Layer II. The adze thus probably dates to a post A.D. 1700 context. It is a tanged reverse trapezoidal fragment.

Site 50-Oa-B1-104

Twelve adzes were found at this site, two of which were excluded from this study because of provenance problems. Nine of the analysed adzes were from Layer II, which has been radiocarbon dated to A.D. 1750--1870. One is from Layer III.

Five of the Layer II adzes are rectangular in cross-section, one is trapezoidal, one is reverse trapezoidal, and one is reverse triangular; four are tanged and one is untanged. Two have expanding sides; two have straight cutting edges. The size ranges are: length, 6.0–71.0 mm (mean 48.0 mm); width, 21.5–37.5 mm (mean 25.6 mm).

The single adze from Layer III is a rectangular cross-sectioned preform fragment.

Site 50-Oa-C4-18a

One adze was found under a surface stone wall. A subsurface fireplace produced a single radiocarbon date of A.D. 1125–1335. The adze is likely to be much more recent than this

feature and probably dates to post A.D. 1500 contexts. It is a tanged reverse trapezoidal specimen with parallel sides and a straight bevel. It measures 212.0 by 42.0 by 47.0 mm.

Site 50-Oa-D6-52

Two adzes were found in Layer II, which was dated by a single date of A.D. 1685–1845. The adzes are small rectangular fragments, one of which is tanged; one probably has parallel sides and the other slightly expanding sides; one has a straight cutting edge.

Site 50-Oa-F9-61

One adze was recovered from a depth of 203–206 cm below surface. Three radiocarbon dates were obtained from higher levels in the site. Two from 80–90 cm below surface are recent, and there is one from 115 cm below surface of A.D. 675–845. The adze probably dates to an earlier time period.

The adze is tanged, reverse trapezoidal, with slightly expanding sides, and a slightly curved bevel. It measures 34.0 by 15.0 by 8.0 mm thick.

Site 50-Oa-G5-119

Six adzes were recovered from this site, which was dated by two radiocarbon dates from Layer II. These dates range from A.D. 1330–1470 to A.D. 1690–1790. Four of the adzes were from contexts that probably date to after A.D. 1500 and two are probably from contexts that are earlier than A.D. 1400.

The two adzes that are from pre A.D. 1400 contexts are rectangular cross-sectioned fragments with parallel sides and straight edges. No measurements were taken.

One of the adzes from post A.D. 1500 contexts is rectangular in cross-section and three are reverse trapezoidal. One is parallel sided and one has expanding sides. Two have straight cutting edges. The size ranges are: length, 51.5–60.0 mm (mean 55.8 mm); width 24.5–25.5 mm (mean 25.0 mm).

Site 50-Oa-G7-23 (O-18)

One adze was recovered from the surface and six from Layers II and III at this site. A graphical analysis of the radiocarbon ranges suggests that Layers II and III may be inverted and Layer II may be older. However, the pooled Layer II dates overlap the pooled Layer III dates at *c.* A.D. 800–850. The prehistoric occupation of this site and the subsurface adze assemblage can be placed in this period.

One of the subsurface adzes is reverse triangular in cross-section, two are reverse trapezoidal, and three have circular cross-sections (these are commonly referred to as chisels); one adze is tanged. One adze has expanding sides and two have tapering sides. One has a straight cutting edge and one has a curved edge. Size ranges of the three subsurface adzes are: length, 69.5–80.0 mm (mean 74.8 mm); width, 23.5–27.5 mm (mean 25.5 mm);

thickness, 14.5–21.5 mm (mean 17.8 mm). Size ranges of the three subsurface chisels are: length, 7.5–10.1 mm (mean 8.8 mm); thickness, 7.0–10.1 mm (mean 8.6 mm)

The single surface adze is tanged and reverse trapezoidal in cross-section. It has expanding sides and a straight cutting edge. It measures 112.0 by 28.0 by 15.5 mm.

MOLOKA'I

Only one site on Moloka'i contained adzes from dated contexts which could be used in this study.

Site 50-Mo-A1-3

Four adzes were recovered from Layer IV, which dates to *c.* A.D. 500–1100. Two of the adzes have rectangular cross-sections and two are reverse trapezoidal; one is tanged. One has parallel sides and one has expanding sides. Two have straight cutting edges. Only two adzes were complete enough to measure. Their size ranges are: length, 79.5 mm; width 27.0–30.5 mm (mean 28.8 mm); thickness 9.0–16.0 mm (mean 12.5 mm).

MAUI

Only one site on Maui contained adzes from dated contexts which could be used in this study.

Site 50-Ma-C9-37

One adze was recovered from a context dated by two radiocarbon dates to A.D. 1430–1760. It is a reverse trapezoidal fragment. No other information could be obtained from this specimen.

HAWAI'I

Four archaeological sites from the island of Hawai'i contained adzes from dated contexts.

Site 50-Ha-B20-1

Eight adzes were recovered from Layer II of this site. Dye (this volume) has reinterpreted the occupancy of this site to the period of A.D.1400–1500.

One adze is rectangular in cross-section, five are reverse trapezoidal, and two are reverse triangular; six are tanged. Two have parallel sides and four have expanding sides; five have straight cutting edges and one has a curved cutting edge. Size ranges are: length, 61.5–82.0 mm (mean 71.1 mm); width, 18.0–30.5 mm (mean 25.7 mm); thickness 15.0–28.0 mm (mean 19.6 mm).

Site 50-Ha-B20-2

Three adze fragments were recovered from a level slightly above a radiocarbon date of A.D. 1501–1641, and so are more recent than A.D. 1500.

Cross-sections are represented by single occurrences of rectangular, reverse trapezoidal, and reverse triangular; two of the adzes are tanged. One has expanding sides. The fragmentary condition of the adzes make measurements meaningless.

Site 50-Ha-B21-6

This site produced 18 adzes from dated contexts. Dye's re-evaluation (this volume) of the dates from this site indicates that Layer I dates to A.D. 1650–1850 and Layer II dates from A.D. 700-1650. Sixteen of the adzes are from Layer I and two are from Layer II.

Eleven of the Layer I adzes are rectangular in cross-section and five are reverse trapezoidal; three of these are tanged. Seven of the Layer I adzes have parallel sides, four have expanding sides, and one has tapering sides. Eight have straight cutting edges. Most of the adzes are fragmentary, so measurements are not presented here.

The two adzes from layer II are tanged rectangular fragments. No other data are pertinent.

Site 50-Ha-C19-2

Two adzes were found on the surface in this lava tube site. A single radiocarbon date of A.D. 1600–1900 dates the traditional use of this lava tube. The adzes probably post-date A.D. 1600.

The adzes are both untanged rectangular cross-sectioned specimens with parallel sides and straight cutting edges. They measure 55.5 by 22.0 by 11.3 mm and 80.0 by 35.0 by 28.5 mm.

ADZE ANALYSES

The first analyses plot cross-section, tang, plan shape, and the form of the bevel against time. Then the frequencies of these various forms are plotted for the different time periods. The following histograms show the frequencies of the different variables through time. In these analyses, all dates are rounded to the nearest 100 years, and the first appearance of a particular variable is plotted at the earliest end of the radiocarbon range.

CROSS-SECTION (Fig. 2)

Three major forms of cross-section are present in the sample: rectangular, reverse trapezoidal and reverse triangular. Rectangular and reverse trapezoidal forms are present in the earliest assemblages, at approximately A.D. 500. Reverse triangular adzes appear at about A.D. 800. All of these forms persist throughout the pre-Contact sequence, until the

A.D. 1800s. The circular, or possibly plano-convex chisels were only found at one site (Oa-G7-23) and date from *c.* A.D. 800–900.

It is clear that the rectangular cross-section is the dominant form in this sample, followed closely by the reverse trapezoidal form. Rectangular cross-sectioned adzes are present in the sample from the earliest assemblage (N=2, 50%). The reverse triangular form persists in very small numbers (1 to 2 adzes, 2–25%) from A.D. 700 to the end of the sequence.

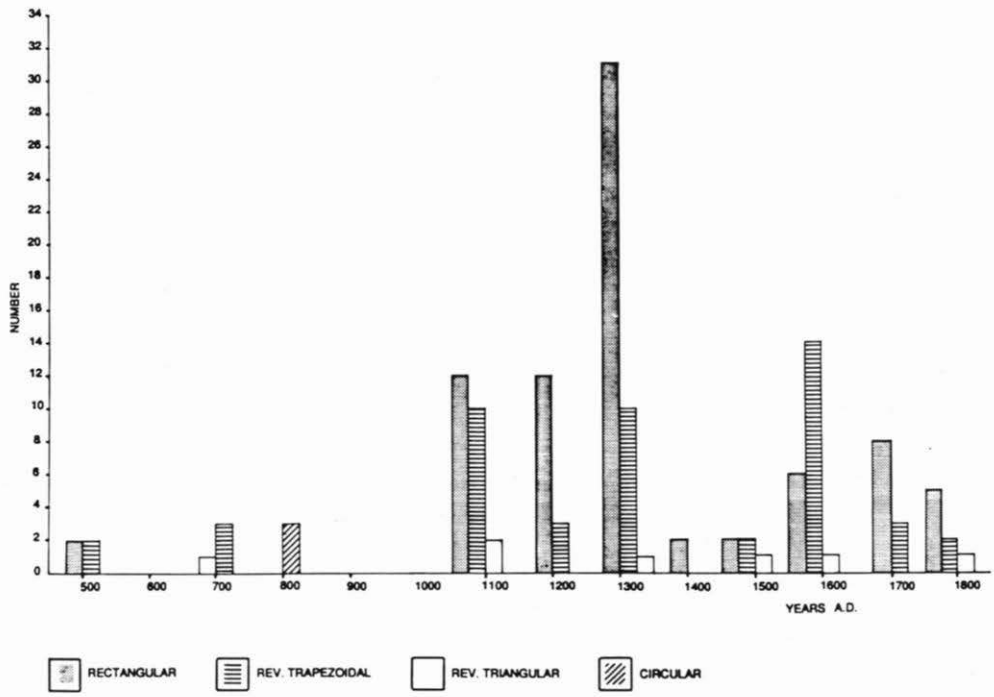

Figure 2: Frequency of cross-section forms (rounded to the nearest 100 years, at the earliest end of the radiocarbon range).

TANGS (Fig. 3)

Tanged adzes are present in the earliest assemblages and continue throughout the pre-Contact sequence. Tanged reverse trapezoidal cross-section adzes are present in the earliest assemblages, rectangular tanged adzes appear *c.* A.D. 700, and reverse triangular tanged adzes appear about a century later. It is interesting to note that all of the reverse triangular adzes in the sample exhibit tangs.

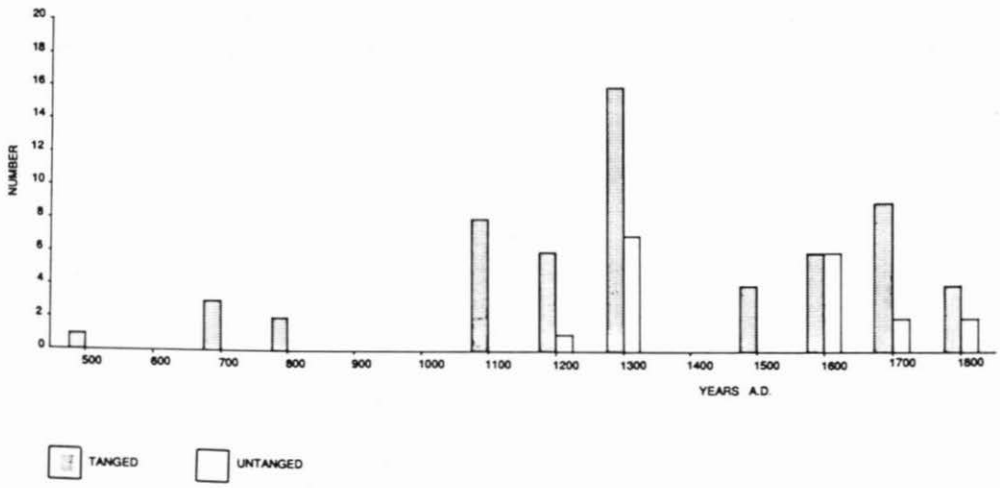

Figure 3: Frequency of tangs (rounded to the nearest 100 years, at the earliest end of the radiocarbon range).

Tanged adzes are the dominant form in Hawaiian assemblages. They appear in the earliest dated assemblages and continue throughout the sequence. Untanged adzes appear considerably later at around A.D. 1200, and are present in small numbers (1 to 7 adzes, 14–50%).

PLAN SHAPE (Fig. 4)

The parallel and expanding plan shapes are present in the earliest assemblages (A.D. 500), while the tapering form appears at about A.D. 800. All three shapes persist throughout the pre-Contact sequence.

Parallel-sided adzes, the dominant adze shape in Hawai'i, are present in the earliest assemblages and continue throughout the sequence. They are followed closely by the expanding shaped adzes, which are also present in the earliest assemblages and continue throughout the sequence. Tapering adzes are only present as single occurrences at A.D. 800, 1100 and 1300.

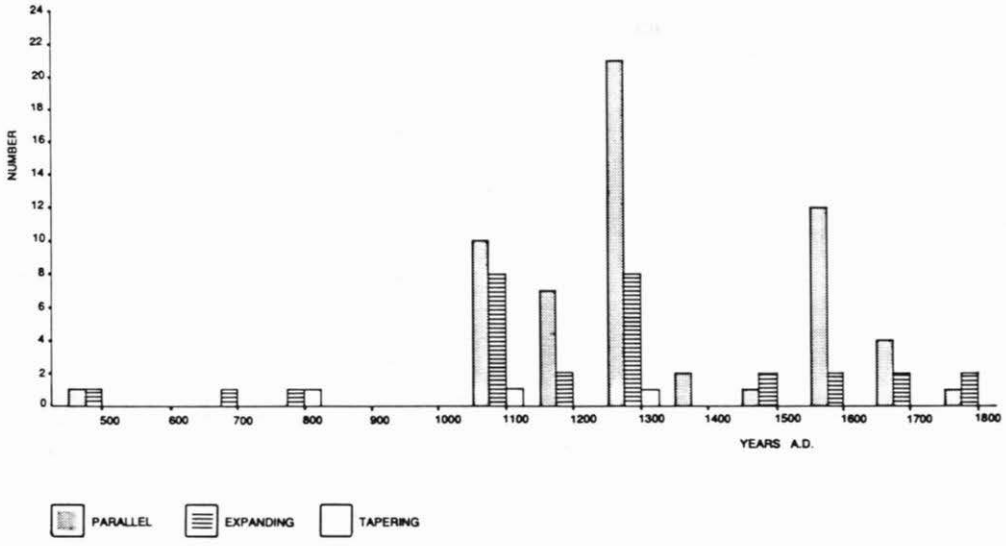

Figure 4: Frequency of plan shapes (rounded to the nearest 100 years, at the earliest end of the radiocarbon range).

BEVEL FORM (Fig. 5)

Straight bevels are present in the earliest assemblages (A.D. 500) and curved bevels are present from *c.* A.D. 700. The straight bevel is the dominant form and is found throughout the sequence. The curved bevel is present in very small numbers (1–3, 7–100%) between A.D. 700 and 1300.

METRICAL ATTRIBUTES (Figs 6–8)

The ranges and means of the three recorded metrical attributes (length, width, and thickness) have been plotted by 100 year interval, like the frequency data. Of these three metrical variables, length varies the most, with a total range of 6.0 to 212.0 mm. The mean length is 68.2 mm, with a standard deviation of 30.4 mm.

Width and thickness are much less variable. Width has a total range of 8.0 to 71.0 mm. The mean width is 30.1 mm, with a standard deviation of 10.5 mm. Thickness has a total range of 5.0 to 47.0 mm. The mean thickness is 17.8 mm, with a standard deviation of 9.0.

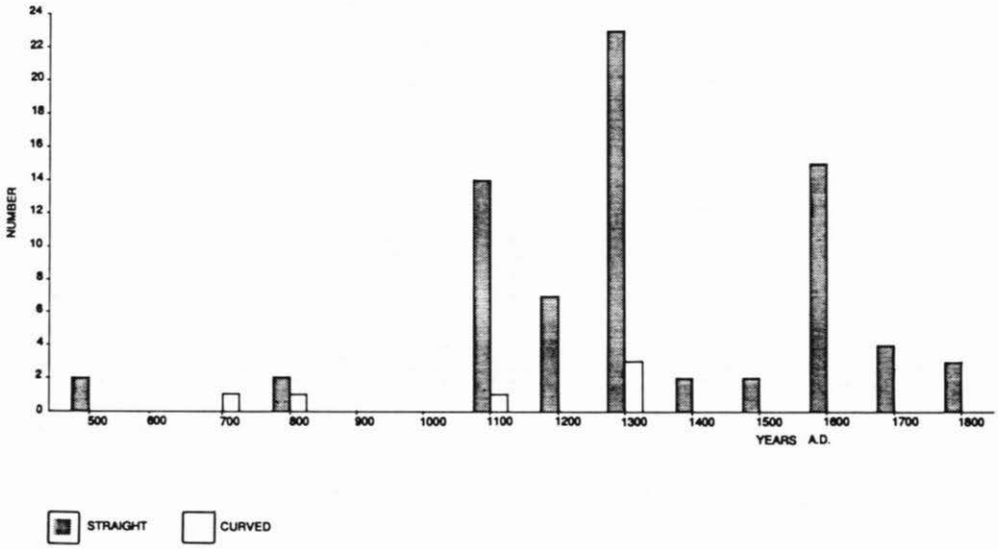

Figure 5: Frequency of bevel forms (rounded to the nearest 100 years, at the earliest end of the radiocarbon range).

All of the adzes in the sample are quite small, with only one adze exceeding 200.0 mm in length. The overall mean length is less than 70.0 mm, the overall mean width is less than 35.0 mm, and the overall mean thickness is less than 20.0 mm.

CONCLUSION AND DISCUSSION

A single, straightforward conclusion can be drawn from these analyses: there is insufficient evidence to establish an adze sequence in Hawai'i. It appears that Hawaiians had a varied tool kit with the same forms of adzes persisting throughout the entire pre-Contact sequence; in other words, adze variability is present throughout Hawaiian prehistory. All of the cross-section forms (rectangular, reverse trapezoidal, and reverse triangular) are present in the earliest assemblages as well as in the latest, though rectangular cross-sectioned forms appear to predominate throughout the sequence. This may mean that Hawaiians increasingly preferred to make rectangular cross-sectioned adzes without ever abandoning the other cross-section forms. These various forms may be associated with specific functional tasks. The only form that appears to be restricted to the early part of the sequence is the circular,

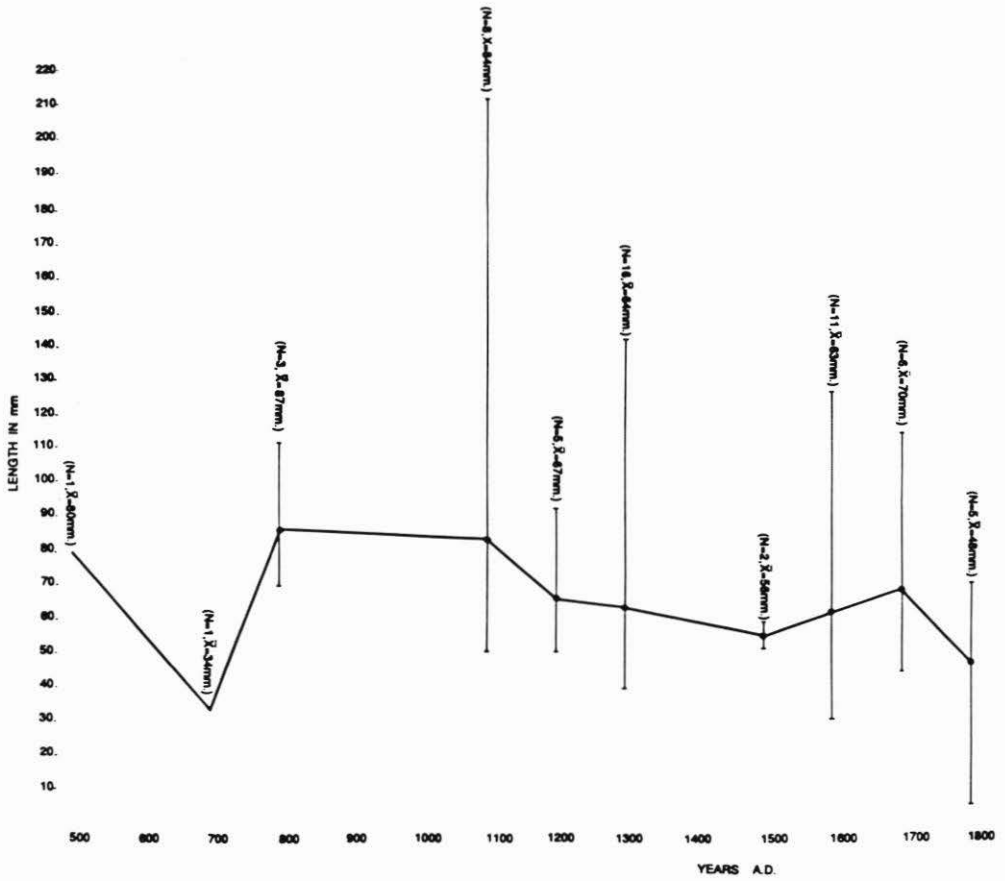

Figure 6: Length variability through time.

or plano-convex, cross-sectioned chisel, but this form is restricted to only one site on O'ahu.

The results presented in this paper have clearly shown that archaeologists working in Hawai'i can no longer assume that when they find a reverse triangular cross-sectioned adze in a site, they have found an early site. Likewise, a rectangular adze cannot be assumed to come from a late archaeological site.

The technique of creating a tang or angled shoulder between the blade and butt portions of the adze is present in the earliest assemblages and continues throughout the sequence. The results have also shown that there is variability in the plan shape and bevel form, with no form being restricted to any single portion of the Hawaiian sequence.

It was shown that tanged adzes are present in the earliest assemblages containing adzes (six tanged adzes have been recovered from sites dating to before A.D. 800). Although some of these adzes may be described as 'incipiently tanged' others have pronounced shoulders. Three questions immediately arise regarding the meaning of 'incipiently tanged' adzes: (1) are 'incipiently tanged' adzes stylistic manifestations of culture historical connections with

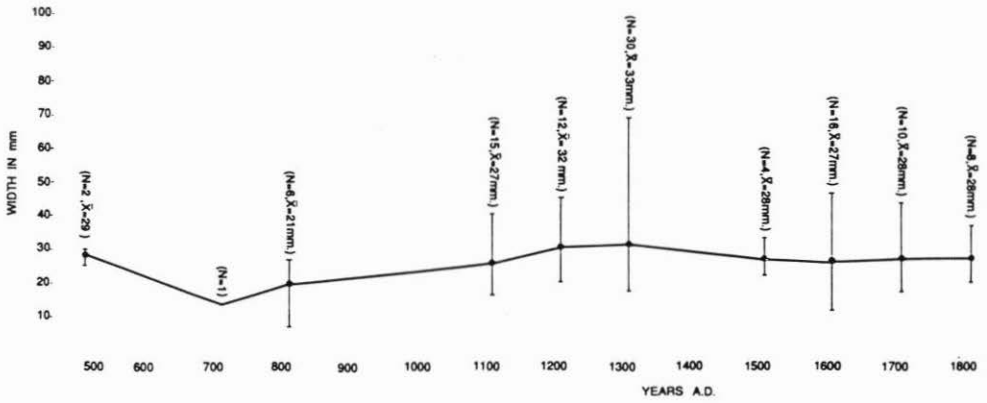

Figure 7: Width variability through time.

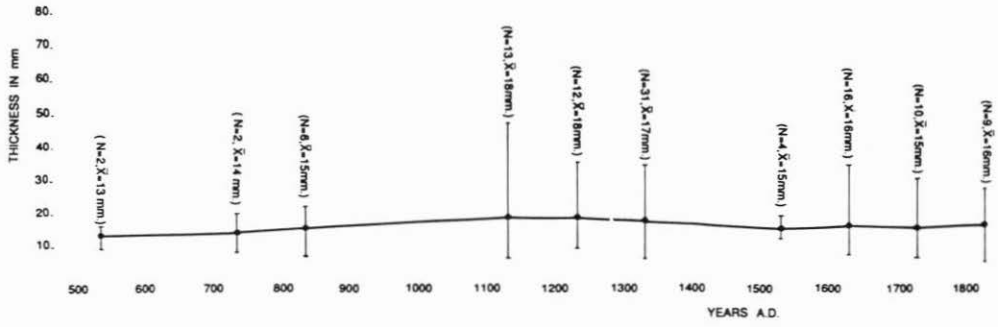

Figure 8: Thickness variability through time.

other Polynesian groups? or (2) are 'incipiently tanged' adzes stylistic variations based on personal choices on the part of the adze makers and users? or (3) are 'incipiently tanged' adzes related to specific functions that were only required in the early part of the Hawaiian sequence and not in later times? Further work, including a combined programme of multivariate analyses and experimentation, is required to address questions relating to 'incipiently tanged' adzes.

One of the major limitations of the current study is that all of the adzes from the different islands have been combined into a single sample, thereby masking any inter-island variability. There very well may be variability in adze forms between the different islands but the sample sizes, both in terms of total number of adzes and the number of dated sites with adzes, are too small for island specific analyses.

One of the interesting findings of the above analyses is the small size of the adzes that have been recovered archaeologically (mean length less than 70.0 mm; mean width less than 35.0 mm, and mean thickness less than 20.0 mm). Brigham, in his monograph on stone implements of the ancient Hawaiians, measured the lengths and widths of a sample of 76 finished adzes in the Bishop Museum ethnology collection (Brigham 1902: 82–83). The lengths ranged from 36.0 to 551.0 mm (mean 177.0 mm), and the widths ranged from 15.0 to 53.0 mm (mean 52.0 mm). Although it is not clear how representative this sample is of the entire ethnology collection, it supports personal observations that the adzes in the ethnology collection are considerably larger that those recovered from archaeological contexts. Another informal observation of ethnology collection adzes is that they are more completely and highly polished than those found archaeologically. A possible explanation for these differences is that smaller adzes were more easily lost or laid aside by ancient Hawaiians, while the larger adzes were more highly valued and may have been handed down from generation to generation. The extensive polish found on the larger specimens may be the result of different generations of owners continuing to grind and polish their heirlooms, and thus adding their own *mana* to these tools. More study of adzes in the ethnology collection is necessary to document the variability of these adzes.

The considerable variability that has been documented for archaeologically recovered adzes requires explanation. The various adze forms may be the result of at least two different, though possibly interrelated, factors. The observed variability may be the result of personal choice and preference, where an adze maker and user would fabricate an adze to meet his own particular specifications. Alternatively, the different forms may have been used for different functions. The latter provides an obvious explanation for size variability: very small adzes would not be used for the felling of large trees, but would be highly suitable for fine carving; likewise, large thick adzes would be better suited for tree felling rather than fine carving. The other variables studied may also have functional correlates.

The fact that we have found considerable variability in the forms of pre-Contact Hawaiian adzes should not be surprising, and actually should be expected. Adzes as functional tools would have been fabricated to meet certain requirements that varied with the type of work the particular tool was going to be used for. It would not be surprising if similar analyses of archaeological adzes from other parts of Polynesia revealed similar patterns of variability. It is interesting to note, however, that the adzes in the ethnology collections at the Bishop Museum do appear to be quite standardised, with relatively large tanged quadrangular adzes being the dominant form.

This type of variability in Hawaiian material culture is not restricted to stone adzes. It has also been documented for feather cloaks by Kaeppler (1985), who showed in her analysis that earlier (i.e., late prehistoric and early historic) cloaks exhibited considerable variability,

while later cloaks were standardised in form. While Kaeppler offers some functional explanations for these changes, she argues that the study of material objects can reveal a great deal about the society that produced the objects. The variability that we have seen in pre-Contact Hawaiian adzes as well as that which Kaeppler found in her analysis of feather cloaks indicates the existence of a varied and dynamic pre-Contact Hawaiian culture, which may have become much more standardised and uniform after western societal influence became pronounced.

ACKNOWLEDGEMENTS

The Bishop Museum, where I was employed when these analyses were undertaken, is acknowledged for supporting this research. Several people were instrumental in making this paper a reality. Kathy Rogers first researched the provenance of dated adzes, and Lisa Armstrong, with the assistance and guidance in the archaeology collections of Muffet Jourdane, found all the adzes and recorded primary data. Hemanta Jaytellake ably drafted the illustrations and Gavin Archer assisted with the statistics. Tom Dye is thanked for pressing me to research and write this paper, and for comments on an earlier draft. Tom and Eric Komori produced the computerised printout of the adjusted radiocarbon dates for my use in this study. Several of the participants at the XVII Pacific Science Congress are thanked for useful comments on the version of this paper that was presented there. Finally, my wife June is thanked for her encouragement and support during the hard times.

REFERENCES

Ayres, W. S. 1970. *Archaeological Survey and Excavations, Kamana-nui Valley, Moanalua Ahupua'a, South Halawa Valley, Halawa Ahupua'a.* Department of Anthropology Report Series 70-8. Bishop Museum, Honolulu.

Best, S. 1977. The Maori adze: an explanation for change. *Journal of the Polynesian Society* 86: 307–37.

Brigham, W. 1902. *Stone implements and stone work of the ancient Hawaiians.* Bishop Museum Memoir I(4). Bishop Museum Press, Honolulu.

Buck P. H., Emory, K. P., Skinner, H. D. and Stokes, J. F. G. 1930. Terminology for ground stone cutting implements in Polynesia. *Journal of the Polynesian Society* 39 (2): 174–180.

Cleghorn, P. L. 1984. An historical review of Polynesian stone adze studies. *Journal of the Polynesian Society* 93: 399–420.

Dye, T., Weisler, M. and Riford, M. 1985. Adz Quarries on Moloka'i and O'ahu, Hawaiian Islands. Manuscript in Bishop Museum Library, Honolulu.

Emory, K. P. 1968. East Polynesian relationships as revealed through adzes. *In* I. Yawata and Y. Sinoto (eds), *Prehistoric Culture in Oceania.* Bishop Museum Press, Honolulu.

Emory, K. P. 1970. *Inventory of Archaeological and Historical Sites in the Districts of Kona and Ka'u and in Anaehoomalu, South Kohala, Island of Hawaii*. Department of Anthropology Report Series 70-12. Bishop Museum, Honolulu.

Emory, K. P., Bonk, W. and Sinoto, Y. H. 1969. *Waiahukini Shelter, Site H-8, Ka'u, Hawaii*. Pacific Anthropological Records 7. Bishop Museum, Honolulu.

Emory K. P. and Sinoto, Y. H. 1969. *Age of Sites in the South Point Area, Ka'u, Hawaii*. Pacific Anthropological Records 8. Bishop Museum, Honolulu.

Green, R. C. (Ed.) 1969. *Makaha Valley Historical Project: Interim Report No. 1*. Pacific Anthropological Records 10. Bishop Museum, Honolulu.

Hommon, R. J. and Barrera, W. 1971. *Archaeological Survey of Kahana Valley, Koolauloa District, Island of O'ahu*. Department of Anthropology Report Series 71-3. Bishop Museum, Honolulu.

Kaeppler, A. 1985. Hawaiian art and society: traditions and transformations. *In* A. Hooper and J. Huntsman (Eds), *Transformations of Polynesian Culture*. The Polynesian Society, Auckland.

Kirch P. V. 1972. Five triangular adzes from Haiku, Maui, Hawaiian Islands. *New Zealand Archaeological Association Newsletter* 15 (4): 140–3.

Kirch, P. V. 1985 *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. University of Hawaii Press, Honolulu.

Kirch, P. V. and Kelly, M. (Eds) 1975. *Prehistory and Ecology in a Windward Hawaiian Valley, Molokai*. Pacific Anthropological Records 24. Bishop Museum, Honolulu.

Struiver, M. and Reimer,P. J. 1986. A computer program of radiocarbon age calibration. *Radiocarbon* 28: 1022–30.

Received 20 November 1991
Accepted 17 December 1992

APPENDIX 1
AGES OF HAWAIIAN ADZE ASSEMBLAGES

Site number[1]	Estimated Age	Reference
Kaua'i		
50-Ka-C10-2	More recent than A.D. 1300	Appendix 2
O'ahu		
50-Oa-A1-54	A.D. 1600–1800	Appendix 2
50-Oa-A2-1	More recent than A.D. 1580–1880	Appendix 2
50-OA-B1-30	A.D. 1200–1500	Ayres 1970: 40
50-Oa-B1-74	More recent than A.D. 1700	Appendix 2
50-Oa-B1-84	A.D. 1600–1800	Appendix 2
50-Oa-B1-85	More recent than A.D. 1680–1800	Appendix 2
50-Oa-B1-91	A.D. 1600–1800	Appendix 2
50-Oa-B1-95	More recent than A.D. 1670–1750	Appendix 2
50-Oa-B1-104	A.D. 1750–1870	Appendix 2
50-OA-C4-18	More recent than A.D. 1125–1335	Green 1969: 63–68
50-Oa-D6-52	More recent than A.D. 1700–1850	Appendix 2
50-OA-F9-61	Earlier than A.D. 675–845	Hommon and Barrera 1971: 18
50-Oa-G7-23	A.D. 800–950	Appendix 2
50-Oa-G5-119	More recent than A.D. 1500	
Moloka'i		
50-Mo-A1-3	A.D. 500–1100	Kirch and Kelly 1975
Maui		
50-Ma-C9-37	A.D. 1580–1760	Appendix 2
Hawai'i		
50-HA-B20-1	A.D. 1400–1500	Dye, this volume
50-Ha-B20-2	More recent than A.D. 1501-1641	Emory 1970: 27
50-HA-B21-6	A.D. 1650–1850 (Layer I)	Dye, this volume
50-HA-B21-6	A.D. 700–1650 (Layer II)	Dye, this volume
50-HA-C19-2	More recent than A.D. 1600	Emory 1970: 27

[1] Bishop Museum site numbers.

APPENDIX 2
UNPUBLISHED RADIOCARBON SAMPLE DATA

Site number	Sample no[1]	Lab no	$\delta^{13}C$	CRA	Material
50-HA-B20-0002	HRC-0016	GRN 2061	-25.0‡	modern	Charcoal
50-HA-B20-0002	HRC-0017	M-478	-25.0‡	200 ± 200	Charcoal
50-HA-B20-0002	HRC-0063	GAK-1347	-25.0‡	379 ± 70	Charcoal
50-KA-C10-0002	HRC-0029	M-906	-25.0‡	570 ± 150	Charcoal
50-KA-C10-0002	HRC-0030	GAK-1343	-25.0‡	840 ± 70	Charcoal
50-KA-C10-0002	HRC-0098	GAK-1350	-25.0‡	440 ± 90	Charcoal
50-KA-C10-0002	HRC-0121	GAK-1351	-25.0‡	520 ± 80	Charcoal
50-KA-C10-0002	HRC-0123	GRO-2293	-25.0‡	580 ± 50	Charcoal
50-MA-C09-0037	HRC-0715	BETA-12414	-25.0†	420 ± 100	Charcoal

50-MA-C09-0037	HRC-0716	BETA-12415	-25.0†	280	±	90	Charcoal
50-OA-A01-0054	HRC-0035A	GAK-302	-25.0‡	620	±	150	Charcoal
50-OA-A01-0054	HRC-0036	GAK-354	-25.0‡	250	±	100	Charcoal
50-OA-A02-0001	HRC-0033	C-540	-25.0‡	946	±	180	Charcoal
50-OA-A02-0001	HRC-0034	M-564	-25.0‡	220	±	150	Charcoal
50-OA-BO1-0074	HRC-1194	BETA-34085	-20.5	300	±	60	Charcoal
50-OA-BO1-0074	HRC-1195	BETA-34086	-24.2	200	±	50	Charcoal
50-OA-B01-0084	HRC-0987	BETA-25193	-12.7	350	±	50	Charcoal
50-OA-B01-0084	HRC-0988	BETA-25194	-12.0	170	±	40	Charcoal
50-OA-B01-0084	HRC-1038	BETA-29277	-13.9	360	±	70	Charcoal
50-OA-B01-0084	HRC-1039	BETA-29278	-23.0	100	±	70	Charcoal
50-OA-B01-0084	HRC-1040	BETA-29279	-10.0	140	±	60	Charcoal
50-OA-B01-0085	HRC-0985	BETA-25191	-20.8	210	±	60	Charcoal
50-OA-B01-0085	HRC-1035	BETA-29274	-27.4	580	±	100	Charcoal
50-OA-B01-0091	HRC-1014	BETA-27819	-28.4	220	±	50	Charcoal
50-OA-B01-0091	HRC-1015	BETA-27820	-29.4	110	±	50	Charcoal
50-OA-B01-0091	HRC-1036	BETA-29275	-26.7	300	±	60	Charcoal
50-OA-B01-0091	HRC-1037	BETA-29276	-26.8	150	±	50	Charcoal
50-OA-B01-0091	HRC-1060	BETA-29561	-25.0	380	±	70	Charcoal
50-OA-B01-0091	HRC-1061	BETA-29562	-27.1	620	±	60	Charcoal
50-OA-B01-0091	HRC-1062	BETA-29563	-28.1	170	±	50	Charcoal
50-OA-B01-0095	HRC-1020	BETA-27825	-28.6	210	±	70	Charcoal
50-OA-BO1-0104	HRC-1205	BETA-34096	-21.9	140	±	60	Charcoal
50-OA-D06-0052	HRC-0251	I-8400	-25.0‡	185	±	80	Charcoal
50-OA-D06-0052	HRC-0252	I-8401	-25.0‡	325	±	80	Charcoal
50-OA-GO5-0119	HRC-1133	BETA-32305	-27.7	550	±	70	Charcoal
50-OA-GO5-0119	HRC-1134	BETA-32306	-27.3	210	±	50	Charcoal
50-OA-G07-0023	SPRIGGS-1	BETA-20852	-24.90	720	±	130	Charcoal
50-OA-G07-0023	SPRIGGS-2	BETA-20852	-26.40	1330	±	230	Charcoal
50-OA-G07-0023	SPRIGGS-3	BETA-20853	-25.00	1070	±	370	?
50-OA-G07-0023	SPRIGGS-4	BETA-20854	-29.20	320	±	50	Charcoal
50-OA-G07-0023	UH-01[2]	GAK-1820	-25.0‡		modern		Charcoal
50-OA-G07-0023	UH-02[2]	GAK-1817	-25.0‡	1030	±	110	Charcoal
50-OA-G07-0023	UH-03[2]	GAK-1816	-25.0‡	700	±	125	Charcoal
50-OA-G07-0023	UH-04[2]	GAK-1819	-25.0‡	1600	±	90	Charcoal
50-OA-G07-0023	UH-05[2]	GAK-1818	-25.0‡	1110	±	120	Charcoal

[1]HRC = Bishop Museum sample numbers; UH = University of Hawaii sample numbers; Spriggs = samples submitted by Matthew Spriggs.

[2]The five UH samples from site 50-OA-G07-0023 have been published previously (Pearson *et al.* 1971), but are included here for comparison with the other samples from this site.

† = $\delta^{13}C$ known to have been assumed as -25.00‰

‡ = $\delta^{13}C$ status not verified