

A Note on Hawaiian Stone Axes

Jennifer G. Kahn¹ & Thomas S. Dye²

ABSTRACT

As part of a project to describe and classify more than 800 Hawaiian stone adzes held in the ethnographic and archaeological collections at Bishop Museum in Honolulu, 11 finely-finished, double-beveled stone tools, which resemble modern axe or hatchet blades, were identified and described. These 11 axes were surprising finds in the collection because double-beveled stone tools have been reported as absent in Hawai'i and in the Duff typology are restricted to heavy, crudely-finished tools commonly recovered in Mangareva but not found elsewhere in Polynesia. Building on the replication experiments carried out by Turner and her colleagues in New Zealand, it is suggested that stone tools in Hawai'i and elsewhere in Polynesia be classified functionally, rather than grouped according to the type/variety system devised by Duff.

Keywords: Hawai'i, axe, adze, classification

INTRODUCTION

Traditional Polynesian stone wood-working tools, typically denoted in English as 'adzes', 'axes', and 'chisels', have been arranged by archaeologists for more than half a century using a culture historical typology associated with the New Zealand prehistorian Roger Duff (1956). A recent replication experiment using stone tools in the manufacture of an outrigger canoe identified six functional types of stone adzes that correspond generally with the six culture historical types established by Duff (Turner 2000, 2004). The replication experiment concluded that variability in New Zealand stone adzes captured by the Duff types is due to the function performed by the tool, which 'dictated what features and dimensions were required' (Turner 2004: 97), and by raw material and manufacturing techniques. The functional basis of the Duff types casts doubt on their utility for culture history, which requires that artifact types be founded in stylistic variability (Dunnell 1978). In Hawai'i, archaeologists arrange stone wood-working tools by cross-section shape using a typology derived from Duff's (Emory 1968), yet the adze types this yields fail to satisfy the historical significance criterion (Krieger 1944; Dunnell 1978: 196; Lyman & O'Brien 2002: 78). Problematically, each cross-section shape is found throughout the traditional Hawaiian period (Cleghorn 1992). Together, the results of the replication experiment (Turner 2000,

2004) and the distribution study (Cleghorn 1992) indicate that the Duff types are unsuitable for culture history and thus fail to function as intended.

Despite this failure, archaeologists are understandably reluctant to abandon the Duff typology. Several generations of archaeologists in the Pacific have learned to arrange Polynesian adzes according to the Duff types and many stone tool collections have been described in its terms. Turner was eager to dispel the notion that the Duff types needed to be abandoned and wrote of the 'good news . . . that for ease of description . . . Duff's basic terminology can be retained with the bonus of now being able to explain the distinctions between the different types' (Turner 2004: 63). However, this assessment fails to take into account that the Duff types, along with the functional types derived from them (Turner 2004: 63–90), are defined as *groups* rather than *classes* (Dunnell 1971, 1986). The groups are defined by enumerating attributes shared by the members of each group rather than the attributes that distinguish one class from another. This characteristic binds the types to particular sets of objects and locations, when what is required are distinguishing criteria that can be applied irrespective of time and place.

This brief note begins the project of building a functional classification of Hawaiian stone wood-working tools by considering the case of the axe. As part of a project to describe and classify more than 800 Hawaiian stone adzes held in the ethnographic and archaeological collections at Bishop Museum in Honolulu, 11 double-beveled stone tools, which resemble modern axe or hatchet blades, were identified and described. These 11 tools can be distinguished from adzes by the presence of a double bevel, which represents the necessary and sufficient condition for membership in the axe class. They were surprising finds in the collection because double-beveled stone tools

1 Anthropology Department, College of William & Mary, Washington Hall, Room 103, 241 Jamestown Rd., Williamsburg, VA 23185

2 T. S. Dye & Colleagues, Archaeologists, 735 Bishop St., Suite 315, Honolulu, HI 96813

Corresponding author: tsd@tsdye.com

Submitted 9/6/14, accepted 28/10/14

have been reported by some as absent in Hawai'i (Duff 1959:141; Hiroa 1950:194; Weisler & Green 2001), and in the Duff typology are restricted to heavy, crudely-finished tools commonly recovered in Mangareva but not found elsewhere in Polynesia (Buck 1938:277; Weisler & Green 2001; Weisler, Conte & Kirch 2004; Figueroa & Sanchez 1961:199). However, stone axes from Hawai'i were noted more than a century ago in a descriptive work that figures two double-bevel tools: an unusual, thick wedge-like tool, catalog 4603 (Brigham 1902:75), that does not look as if it could be readily hafted, and which was not re-identified in the Bishop Museum collection during the project; and catalog 3141 (Brigham 1902:74), a finely-made tool whose double-beveled longitudinal section was also illustrated (Brigham 1902:76). For many years, investigations of Hawaiian stone tools have focused exclusively on adzes (e.g., Emory 1968; McCoy 1977; Cleghorn 1982, 1984; Bayman & Nakamura 2001; Weisler 2011), and this has had the effect of reinforcing the mistaken notion that stone axes are absent.

AXES IN POLYNESIA

The study of stone tools in Polynesia has, for the last 70 years, been carried out largely within the framework of a descriptive arrangement developed initially for adzes from southern South Island in New Zealand (Skinner 1943a, b) and later rearranged and revised to accommodate tools from the rest of Polynesia (Duff 1956, 1959). The culture-historical and diffusionist rationale for grouping (Dunnell 1971) stone tools in this way was questioned by Marianne Turner and her colleagues, whose replication experiments demonstrated beyond a reasonable doubt the functional basis for the stone tool groups established by the diffusionists (Turner 2000, 2004). In many ways, Turner's work harkens back to an interest in function that underlay earlier published descriptions of Polynesian stone tools in Hawai'i (Brigham 1902) and New Zealand (Best 1912; Hiroa 1950).

In the introductory remarks to *The Stone Implements of the Maori*, written more than a century ago, Best found it necessary to clarify the English-language terminology used to describe Maori stone implements. He was concerned to counter the indiscriminate use by other writers of the terms 'celt', 'axe', 'adze', 'hatchet', 'chisel', and 'gouge'. He distinguished chisels, which were 'lashed on in a line with the handle' (Best 1912:10), from adzes and axes, which were lashed at an angle to the line of the handle (see Leroi-Gourhan 1945). He also presented several Maori accounts that describe stone axes and their use (Best 1912:137–155) and a photograph of 'a genuine axe-form, hafted with the cutting edge in line with the handle' (Best 1912:142) from the Buller Collection in the Dominion Museum (Best 1912:389). He gave the Maori name of the axe as *toki titaha*. Hiroa (1950:191–192) noted that the specimen in the Buller Collection was hafted in the post-Contact period, and that

its cutting edge was not in the direct axis of the handle but parallel to it due to the method of hafting. Nevertheless, he agreed with Best that Maori made and used axes, and that they called them *toki titaha*.

The terminological clarity achieved by Best (1912) and Hiroa (1938) was later muddied by a grouping of greywacke and nephrite adzes from Murihiku, New Zealand into 'types' and 'varieties' that failed to distinguish between single- and double-beveled tools (Skinner 1943a, b). Skinner was concerned to problematize 'whether in pre-European times the Maori used an axe' (Skinner 1943b:159). His argument that such a use 'must have been uncommon' (Skinner 1943b:159) was based on the polysemy of the Maori term *toki titaha*, which was used for steel axes, side-hafted adzes, and stone axes, and by the curious argument that the double-beveled stone tools of the Maori weren't true axes because the cutting edge wasn't 'strongly curved convexly [such that it] fades into the sides of the implement' (Skinner 1943b:159).

Skinner's approach was followed by Duff (1977:190), who accepted all of Skinner's varieties, but grouped them into five types instead of ten. Duff grouped axes as Variety B of the laterally hafted adze, Type 5. Working in an essentialist tradition that fails to distinguish empirical entities from tools of measurement (Dunnell 1986:154), Duff referred to Type 5 Variety B as a local phenomenon of Mangareva, where stone axes were once common (Buck 1938:277; Weisler & Green 2001; Weisler, Conte & Kirch 2004; Figueroa & Sanchez 1961:199). The Mangarevan axes are different from the finely-finished axes illustrated by Best (1912:389) and by Brigham (1902: Plate LVII). They are mostly large tools 'made from coarse-grained rock (probably all local) and . . . ground mostly at the bevel leaving the rest of the tool unfinished, thus exhibiting the original weathered rock surface' (Weisler, Conte & Kirch 2004:142). Duff does not mention the double-beveled tools discussed at length by Best (1912), nor the descriptions of axes in Hawai'i (Brigham 1902:73–76). Recent work on New Zealand stone tools (Turner 2004) fails to distinguish among the varieties of Type 5, effectively lumping axes with adzes.

Outside of Hawai'i, New Zealand, and Mangareva, the Eastern Polynesian ethnographic and archaeological literature yields scant evidence of axes in other Eastern Polynesian island groups. A tool with a 'rough axe-like form' is described from Tubuai in the Austral Islands (Aitken 1930:145). Subsequently, another possible example from Tubuai was noted in an unpublished manuscript (Miller n.d.). Specimen 452–351–2Ec-1f is described as having an 'axe-like nature . . . [where t]he front has been deliberately flattened.' The artifact illustration demonstrates that the specimen is broken around the mid-section.

At the current stage of research, it is difficult or impossible to distinguish possible explanations for the observed distribution of axes. Are so few axes reported because they are not distinguished in the Duff typology? Were there historical forces at work in New Zealand (Hiroa 1950:193),

Hawai'i and Mangareva that were not felt elsewhere? Or, is the apparent absence of axes outside New Zealand, Hawai'i, and Mangareva due to the rarity of axes and their likely absence from small collections? These explanations are not mutually exclusive and one or more of them might be operating at the same time.

DESCRIPTION OF THE HAWAIIAN STONE AXES

Ten of the 11 Hawaiian axes reported here were identified in the ethnological collection at Bishop Museum. These range from short, irregular tools to long, finely polished, and neatly symmetrical double-beveled tools. Here, we generally describe tool form, shape, raw material, and size for each axe. Forthcoming publications on the Bishop Museum axe and adze collections will include data on tool location and site function, whether the find site has been dated, and details of source geochemistry.

B.01397

This is an unusual tool with a nearly constant thickness along most of its length (fig. 1, *a*). Most of the edge is missing, but one corner is intact. Too little remains of the edge to describe its shape, but the obtuse angle of the surviving corner suggests the edge was convex in plan view. The opposite end at the poll is also incomplete, so a complete longitudinal section is absent. The tool is made from a dark grey basaltic rock that has a pitted texture and feels light for its size. It is 18.4 cm long, 4.8 × 1.3 cm at mid-section, and weighs 223 g. The cutting edge measures 5.1 cm.

10454

The smallest axe among the ethnographic specimens is from the Ka'iulani Collection (fig. 1, *b*). It is made from a dark grey basalt. One face and one side are well polished, but the other side and face exhibit flake scars and are not as well polished. The edge is convex in plan, with rounded corners. The poll is intact and is not polished. The tool is 4.6 cm long, 1.9 × 1.3 cm at mid-section, and weighs 23 g. The cutting edge measures 1.7 cm.

B.01700

This short axe is well polished on both faces and sides (fig. 1, *d*). The edge is straight and meets the side at a sharp angle. The butt is the only portion of the artifact that is not polished and that has an unfinished look. The butt may have been pecked as a way of shaping it to fit the lashing, or alternatively it may have some use-wear resulting from its having been hafted. There are a few flakes removed from the sides, probably from use but possibly during reworking. The tool is made from basaltic rock that has turned reddish-brown in color, presumably due to the original surrounding soil matrix. The tool is 8.7 cm long, 3.2 × 2.1 cm at mid-section, and weighs 125 g. The cutting edge measures 3.2 cm.

11021

This axe has a pitted surface similar to catalog B.01397 but is better polished than that tool (fig. 1, *e*). The edge is straight and meets the sides at a sharp angle. Both faces and sides are well polished, with the exception of one face near the poll that has flake scars, perhaps to facilitate hafting. The poll itself is polished and intact. There are several small flake scars on the edges of one face. The tool is fashioned from a dark black basaltic rock. The artifact is 16.4 cm long, 5 × 1.9 cm at mid-section, and weighs 332 g. The cutting edge measures 5.6 cm.

3127

This specimen from the George H. Dole Collection is one of the longer axes in the collection (fig. 1, *f*). The color is typically light grey but is discolored a light brown in places. The tool is well polished on both faces and sides close to the cutting edge, but surfaces farther away from the cutting edge exhibit flake scars with some polish on the high points. The edge is straight and meets the sides at a sharp angle. The edge is quite a bit wider than the poll. Approximately two-thirds of the way toward the poll the cross-section becomes triangular and remains so until the poll. Near the poll, one face that has been minimally worked looks to be the ventral surface of a larger flake. The tool is made from a light grey basaltic rock that has discolored to a light brown in places. The tool is 20 cm long, 3.7 × 2.7 cm at mid-section, and weighs 1,434 g. The cutting edge measures 5.5 cm.

D.04030

This tool is partially polished, with areas near the edge being the most highly polished (fig. 1, *g*). The edge is very slightly convex in plan and the corners where it meets the sides are both rounded. It is wider than the poll. The butt portion has been reduced and the flake scars have not been polished. The axe is fashioned from a basaltic rock that has discolored to a dark brown. The tool is 8.5 cm long, 3 × 1.8 cm at mid-section, and weighs 71 g. The cutting edge measures 4.3 cm.

4561

This relatively short tool from the George H. Dole Collection appears to have been fashioned from a flake (fig. 1, *h*). It is well polished at the cutting edge, but the rest of the surfaces exhibit flake scars. The edge is very slightly convex in plan and meets the sides at rounded corners. The axe is fashioned from a light grey basaltic rock with some brown patination. The tool is 8.4 cm long, 4.7 × 1.4 cm at mid-section, and weighs 90 g. The cutting edge measures 4.6 cm.

B.02518

This tool is well polished from butt to cutting edge on both faces and sides (fig. 1, *i*). The edge is slightly convex in plan with somewhat rounded corners. The butt was either left

unfinished and unpolished or it has been broken and slightly reworked. The axe is made from a dark grey basaltic rock. The tool is 17.1 cm long, 5 × 1.8 cm at mid-section, and weighs 349 g. The cutting edge measures 5.8 cm.

3141

This tool is well polished on both faces and sides, although the sides exhibit remnant flake scars that have been moderately polished down (fig. 1, j). The edge is slightly convex

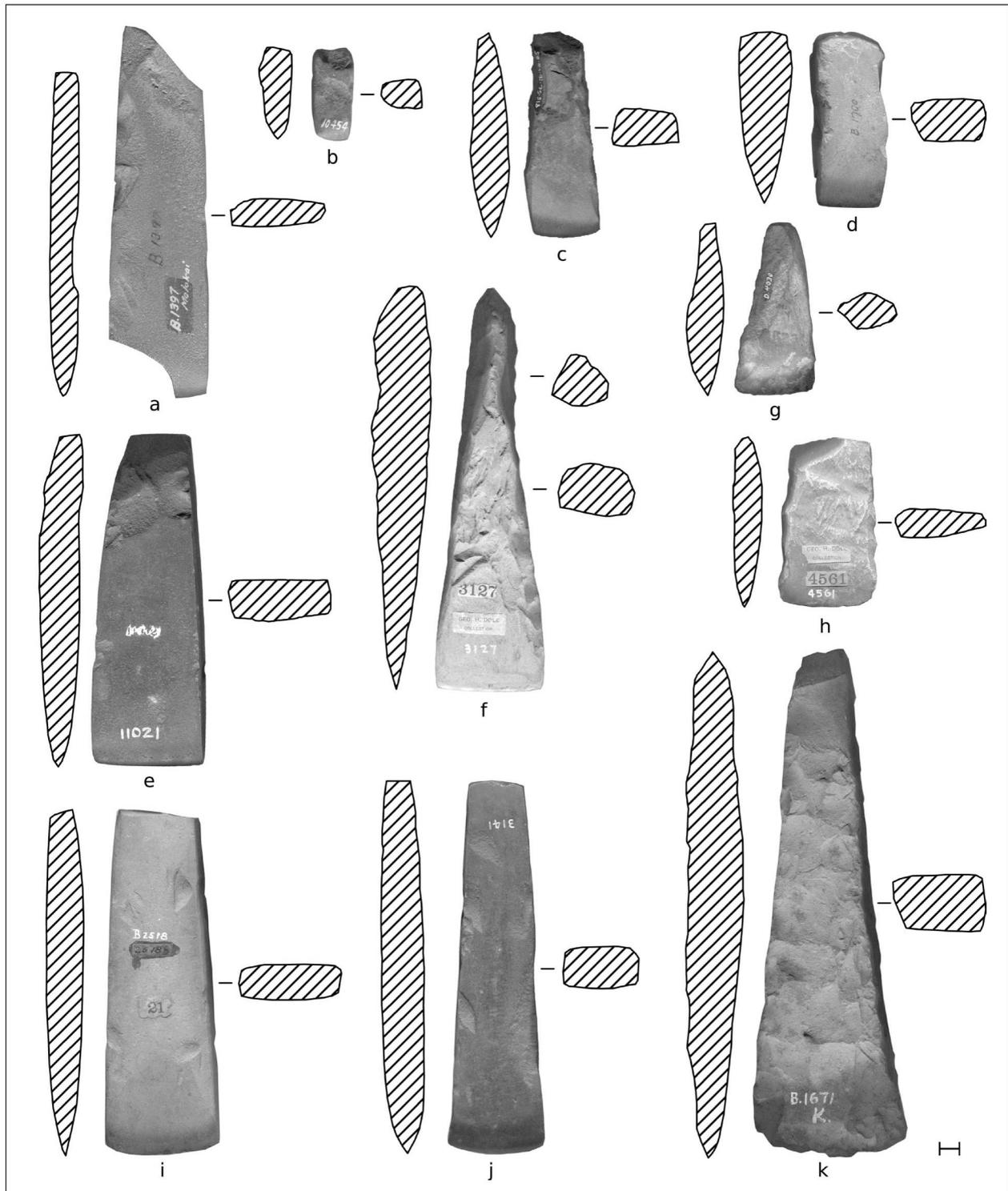


Figure 1. Axes in the ethnographic and archaeological collections: a, catalog B.01397; b, catalog 10454; c, 50-Oa-B1-75-518; d, catalog B.01700; e, catalog 11021; f, catalog 3127; g, catalog D.04030; h, catalog 4561; i, catalog B.02518; j, catalog 3141 (see Brigham 1902: Plate LVII); k, catalog B.01671. The scale bar is 1 cm.

in plan with somewhat rounded corners. The poll is intact and is slightly polished. This tool was described previously (Brigham 1902). This tool is made from fine-grained dark grey/black basaltic rock. It is 18.5 cm long, 3.9 × 2 cm at mid-section, and weighs 332 g. The cutting edge measures 5 cm.

B.01671

This is an unfinished tool with a small bit of polished surface, or perhaps cortex, near the edge (fig. 1, *k*). It is made of fine-grained, medium-grey rock with small phenocrysts. One face of the tool appears to be a ventral flake surface. The cutting edge is extensively flaked along one surface and is not ground. It appears that the intent was to have a cutting edge convex in plan with rounded corners, and wider than the poll. One face and both sides have fine flaking originating from each surface. The tool is made of fine-grained, medium grey basaltic rock with small phenocrysts. The tool is 25.1 cm long, 4.7 × 2.6 cm at mid-section, and weighs 568 g. The cutting edge measures 7.8 cm.

Five smaller tools with double bevels were identified in the Bishop Museum archaeological collections deriving from the Hawaiian archipelago. Most of them are either broken, crudely fashioned, or incomplete and are not described here. However, one complete double-beveled tool from the archaeological collection can be confidently identified as an axe.

50-Oa-B1-75-518

This tool is fully polished near the cutting edge (fig. 1, *c*). The edge is slightly convex in plan and meets the sides in sharp angles. The poll end has been reworked and left unpolished, and the sides have been diminished over more than half the length of the tool. The axe is fashioned from a basaltic rock. This tool is 10.6 cm long, 3.7 × 2 cm at mid-section, and weighs 147 g. The cutting edge measures 3.6 cm.

FUNCTIONAL CONSIDERATIONS

Elsewhere in Polynesia, axes are considered a variety of Type 5 (Duff 1977), which includes side-hafted adzes. Turner considers Type 5 among a small group of ‘specialized forms’ (Turner 2000: 107) that were designed for specific tasks – unlike other forms that were used under a wider variety of conditions – and attributes their rarity to this functional specificity. One function of Type 5 tools was to remove material from the interior surface of a piece of work, such as a canoe hull, a bowl, or a trough. In this application, the tool would typically be hafted with the edge in line with the handle and the tool would enter the work at a low angle to shave off long, thin chips.

Side-hafted adzes have not been reported from Hawai‘i. Duff believed they were functionally replaced in Hawai‘i by a ‘normal adze in a rotating sleeve’ (Duff 1959: 141), which

Brigham referred to as an ‘adjustable adze of the Kupaai-kee pattern’ (Brigham 1902: Plate LX), presumably for its use in production of canoes, Kūpā‘aīke‘e being a god of canoe makers. The term ‘rotating sleeve’ describes a hafting method in which the blade is not lashed directly to the handle, but instead to a short rounded staff that was lashed to a handle that was grooved to fit the shaft (Hiroa 1950: 190). The staff could be rotated in the groove to adjust the alignment of the cutting edge. Duff’s reference to a ‘normal adze’ suggests that there is no way to distinguish an adze used side-hafted once it has been separated from its haft. Thus, it is not possible to compare the axes with a subset of the adze collection either known or inferred to have been used with a side haft.

In the laboratory, the formal qualities of the axes that stand out most strongly in a comparison with adzes are their length and low shoulder index (Buck 1944; Garanger 1972). Figure 2 compares the length and shoulder index of the 11 axes with 871 complete adzes from the Bishop Museum collection. Axes typically have a lower shoulder index than an adze of similar length, as can be seen by their position mostly beneath the regression line for the adzes. The inference that some New Zealand axes ‘are so thin that they could not possibly have been used as anything but cutting or chipping tools’ (Best 1912: 236) applies equally to Hawai‘i. Also, unlike the adzes, where shoulder index increases with length, longer axes tend to have a lower shoulder index than shorter axes. Whereas increasing the length of an adze is one way to increase the mass of the tool so that it might deliver more force to the work (Cotterell & Kamminga 1990), this was not the case with Hawaiian axes, which tend to thin out as they get longer.

Several of the axe specimens had evidence for flaking or wear on the butt, suggestive of lashing to the haft. In a few cases flakes were removed from the sides of the butt. We interpret this as shaping the butt for hafting and note that such flaking around the butt is found in Eastern Polynesian adze assemblages widely. An alternative argument, that such flakes around the butt might have been removed when using the axes like chisels, by tapping the poll with a hammer, is unlikely. Such use would not result in axes with flakes removed at the sides of the butt; one would expect flakes or bashing to be found around the entire butt or concentrated along its center line rather than its extremities.

DISCUSSION

Identification of 11 stone axes in the Bishop Museum collection was unexpected because axes are rarely identified elsewhere in Polynesia and have often been reported as absent in Hawai‘i. One of the axes described here was first reported more than a century ago, but the other ten are identified and described here for the first time. Although the number of axes seems large from this perspective, the 11 axes represent just over 0.1 percent of the more than 800 complete adzes and axes in the Bishop Museum collection.

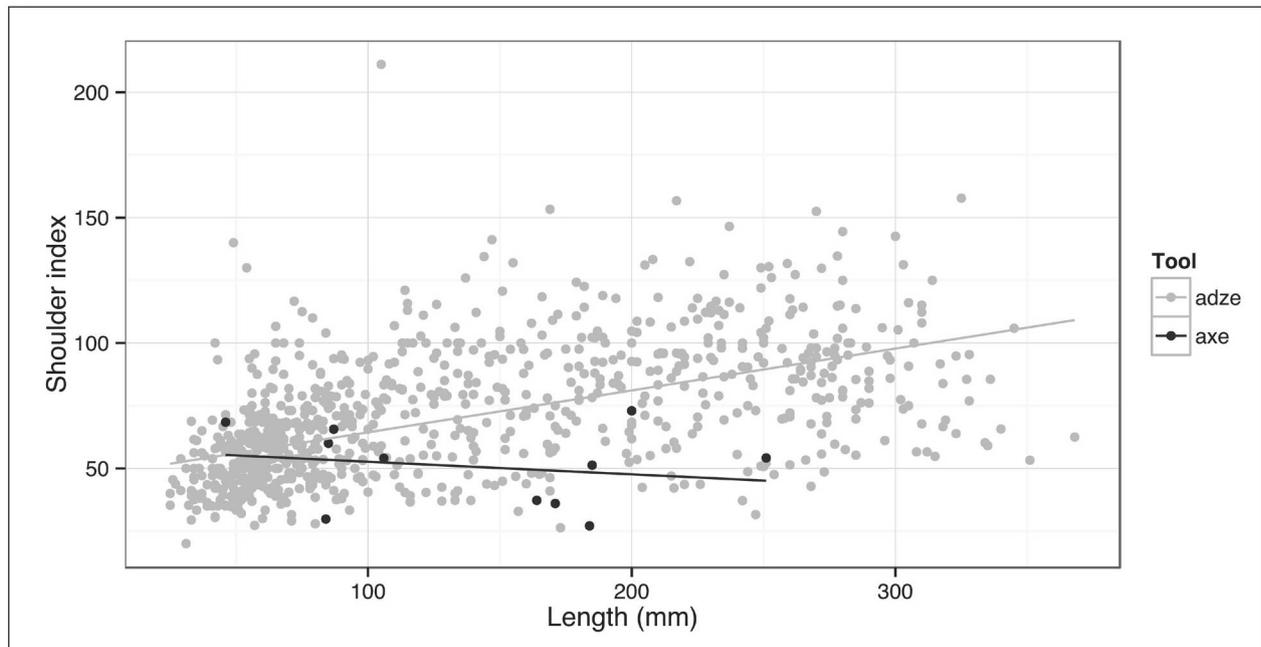


Figure 2. Comparison of the shapes of axes and adzes. Shoulder index is defined by Buck (1944) as $R7 \times 100/R9$, where $R7$ = thickness of the standard cross-section and $R9$ = width of the standard cross-section (see Garanger 1972). The robust regression lines were calculated using the *rlm* method of Venables & Ripley (1994: 216).

They are rare in Hawai'i, as they are elsewhere in Eastern Polynesia.

The longer Hawaiian axes are notable for their low shoulder index. In formal comparison with axes from other Polynesian island groups, the Hawaiian axes appear to be most closely related to the thin New Zealand axes (Best 1912: 234). The thinness and fine finish of Hawaiian axes differ sharply from the thick New Zealand axes and from the large, roughly finished axes common in Mangareva (Buck 1938; Weisler, Conte & Kirch 2004).

These long tools were not designed to transmit a large force, as was typically the case for long adzes. This leaves open the question of what purpose was served by axe length. One possibility is that length was needed to achieve a secure attachment to the haft. Although the antiquity of a hafted Polynesian axe described by Buck (1938: 274) is suspect, he believed that the lashing reflected traditional practice. The lashing of this particular axe was unusual in extending well onto the blade, presumably to secure the attachment. The length of the thin Hawaiian axes thus might be linked functionally to details of the haft, rather than the cutting performance of the tool.

The longer axes are unusual tools that are likely to be functionally specific (Turner 2000: 107). They were presumably designed for light chipping and cutting tasks. It is difficult to know whether or not they were suited for use on the inside of canoes or other pieces of work. The straight edges might not curve enough toward the body to protect the corners from taking excessive force (Turner 2004: 87). Replication experiments such as those carried

out in New Zealand (Turner 2000, 2004) might, if extended to include the various axe forms, indicate functions to which the axes are most suited.

Hiroa (1950: 193–194) noted that axes are distinguished from adzes in two ways – according to the relationship of the cutting edge to the line of the handle when the tool is hafted, and by the presence of a single or double bevel. Although he personally believed that hafting was most distinctive, he noted that most of the specimens left to us today are not hafted, which makes the bevel important. In New Zealand, Best found that tools with an 'axe-like form' gradually merge into the 'adze-form' (Best 1912: 234), apparently because adzes with a curved front might have the cutting edge near the axial center of the tool, much like an axe. In practice, it was relatively easy to distinguish single-beveled and double-beveled tools in the Bishop Museum collection, perhaps due to the limited range of adze forms produced in Hawai'i. In the Hawaiian case, a nominal scale attribute that distinguishes single-bevel and double-bevel tools seems sufficient to distinguish adzes from axes.

The lack of axes from dated contexts in Hawai'i makes it impossible to address the question debated in New Zealand whether axes were used traditionally or were an historic-era innovation. This is unfortunate because the issue of material culture change brought on by Western contact is an important one for archaeologists interested in historic process (Bayman 2003; Bayman & Dye 2013: 101–104). In order to study historic process, it is necessary to move beyond grouping schemes, such as Skinner and Duff's adze types and varieties, and to establish artifact classes that

exist independently of space and time. Our work follows other Polynesian scholarship, such as Allen's (1996) analysis of Cook Island fishhooks, that distinguishes style from function and classes from groups in an effort to elucidate cultural patterns. Differentiating the class of double-beveled axes from the class of single-beveled adzes is the first step toward unlocking the history of the rare and unusual Polynesian stone axe.

Acknowledgments

We would like to thank Betty Kam and her assistants in the Bishop Museum Cultural Resources Division for providing access to the ethnographic collections. Several Archaeology Collection Managers at Bishop Museum likewise facilitated our research by providing access to the Hawaiian archaeological collections. Two anonymous reviewers and Ethan Cochrane provided perceptive comments on a draft of the paper. Any errors of fact or interpretation are the authors'.

References

- Aitken, R.T. 1930. *Ethnology of Tubuai*. Honolulu: Bernice P. Bishop Museum Bulletin 70.
- Allen, M.S. 1996. Style and function in East Polynesian fish-hooks. *Antiquity* 70: 97–116.
- Bayman, J.M. 2003. Stone adze economies in post-contact Hawai'i. In: Cobb, C. R. (ed.), *Stone Tool Traditions in the Contact Era*. Tuscaloosa, AL: The University of Alabama Press, pp. 94–108.
- Bayman, J.M. & Dye, T.S. 2013. *Hawaii's Past in a World of Pacific Islands*. Washington, DC: SAA Press.
- Bayman, J.M. & Nakamura, J.J.M. 2001. Craft specialization and adze production on Hawai'i Island. *Journal of Field Archaeology*, 28(3–4): 239–252.
- Best, E. 1912. *The Stone Implements of the Maori*. Wellington, NZ: Dominion Museum Bulletin 4.
- Brigham, W.T. 1902. *Stone Implements and Stone Work of the Ancient Hawaiians*. Honolulu: Vol. 1, Memoirs of the B. P. Bishop Museum 4.
- Buck, P.H. 1938. *Ethnology of Mangareva*. Honolulu: Bernice P. Bishop Museum Bulletin 157.
- Buck, P.H. 1944. *Arts and Crafts of the Cook Islands*. Honolulu: Bernice P. Bishop Museum Bulletin 179.
- Cleghorn, P.L. 1982. The Mauna Kea Adze Quarry: Technological analyses and experimental tests. PhD thesis, Anthropology, University of Hawai'i at Mānoa, Honolulu.
- Cleghorn, P.L. 1984. An historical review of Polynesian stone adze studies. *Journal of the Polynesian Society*, 93: 399–421.
- Cleghorn, P.L. 1992. A Hawaiian adze sequence or just different kinds of adzes?, *New Zealand Journal of Archaeology*, 14: 129–149.
- Cotterell, B. & Kamminga, J. 1990. *Mechanics of Pre-Industrial Technology*. Cambridge: Cambridge University Press.
- Duff, R. 1956. *The Moa-Hunter Period of Maori Culture*. Wellington, NZ: Canterbury Museum Bulletin 1.
- Duff, R. 1959. Neolithic adzes of Eastern Polynesia. In: Freeman, J. D. & Geddes, W.R. (eds.), *Anthropology in the South Seas: Essays Presented to H. D. Skinner*. New Plymouth, NZ: Thomas Avery & Sons, pp. 121–147.
- Duff, R. 1977. *The Moa-Hunter Period of Maori Culture*, 3rd ed. Wellington, NZ: Canterbury Museum Bulletin 1.
- Dunnell, R.C. 1971. *Systematics in Prehistory*. New York: Free Press.
- Dunnell, R.C. 1978. Style and function: A fundamental dichotomy. *American Antiquity*, 43: 192–202.
- Dunnell, R. C. 1986. Methodological issues in Americanist artifact classification. In: Schiffer, M.B. (ed.), *Advances in Archaeological Method and Theory*. Vol. 9, New York: Academic Press, pp. 149–207.
- Emory, K.P. 1968. East Polynesian relationships as revealed through adzes. In: Yawata, I. & Sinoto, Y.H. (eds.), *Prehistoric Culture in Oceania: A Symposium*. Honolulu: Bishop Museum Press, pp. 151–169.
- Figueroa, G. & Sanchez, E. 1961. Adzes of certain kinds from Eastern Polynesia. In: Heyerdahl, T. & Ferdon, E. N. (eds.), *Reports. Norwegian Archaeological Expedition to Easter Island and the East Pacific*. Vol. 2, Stockholm: Forum, pp. 169–254.
- Garanger, J. 1972. Herminettes lithiques Océaniennes: Éléments de typologie. *Journal de la Société des Océanistes*, 28(36): 254–274.
- Hiroa, T.R. 1938. *Ethnology of Mangareva*. Honolulu: Bernice P. Bishop Museum Bulletin 157.
- Hiroa, T.R. 1950. *The Coming of the Maori*. Wellington, NZ: Maori Purposes Fund Board.
- Krieger, A.D. 1944. The typological concept. *American Antiquity*, 9: 271–288.
- Leroi-Gourhan, A. 1945. *Évolution et Techniques: Milieu et Techniques*. Paris: Albin Michel.
- Lyman, R.L. & O'Brien, M.J. 2002. Classification. In: Hart, J.P. & Terrell, J.E. (eds.), *Darwin and Archaeology: A Handbook of Key Concepts*. Westport, CT: Bergin & Garvey, pp. 69–88.
- McCoy, P. C. 1977. The Mauna Kea Adze Quarry Project: A summary of the 1975 field investigations. *Journal of the Polynesian Society*, 86(2): 223–244.
- Miller, L.A. n.d. Tubuai: Archaeological exploration and inventory. Typescript in possession of J. Kahn.
- Skinner, H.D. 1943a. The classification of greywacke and nephrite adzes from Murihiku, N. Z. *Journal of the Polynesian Society*, 52(1): 65–85.
- Skinner, H.D. 1943b. The classification of greywacke and nephrite adzes from Murihiku, N. Z. *Journal of the Polynesian Society*, 52(4): 157–190.
- Turner, M. 2000. The Function, Design and Distribution of New Zealand Adzes. PhD thesis, Anthropology, University of Auckland, Auckland, NZ.
- Turner, M. 2004. Functional and technological explanations for the variation among early New Zealand adzes. *New Zealand Journal of Archaeology*, 26: 57–101.
- Venables, W. N. & Ripley, B. D. 1994. *Modern Applied Statistics with S-Plus*. Statistics and Computing, New York: Springer-Verlag.
- Weisler, M.I., Conte, E. & Kirch, P.V. 2004. Sourcing of basalt ar-

- tifacts. In: Conte, E. & Kirch, P.V. (eds.), *Archaeological Investigations in the Mangareva Islands (Gambier Archipelago), French Polynesia*. Contribution 62, Berkeley, CA: Archaeological Research Facility, pp.128–148.
- Weisler, M.I. & Green, R.C. 2001. Holistic approaches to interaction studies: A Polynesian example. In: Jones, M. & Shepard, P. (eds.), *Australasian Connections and New Directions: Proceedings of the 7th Australasian Archaeometry Conference*. Auckland, NZ: Research Papers in Anthropology and Linguistics 5, pp.413–447.
- Weisler, M. 2011. A quarried landscape in the Hawaiian Islands. *World Archaeology*, 43(2): 298–317.