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Identifying Fern-root Beaters: Documentary and Statistical Aids to Recognition

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ABSTRACT

Museum collections contain many wooden and stone items that appear to have been used by Maori as beaters and pounders. Some are specifically designated fern-root beaters or *patu aruhe*, yet are morphologically rather variable. Have they been mis-labelled, or did Maori use a wide range of tools to process fern-root? Working from the earliest fern-root beater seen in use, that collected by the Forsters in 1773–4, and from written descriptions of the process and tool, this paper sets up morphological criteria of functional relevance by which to evaluate fern-root beaters in museum collections. In a sample of 541 beaters/pounders studied in 12 institutions, most artefacts labelled as fern-root beaters displayed the appropriate form; however, others may belong to different functional categories, such as flax pounder (*patu muka*), eel club, or ceremonial pestle.

Key Words: MAORI, BEATERS, POUNDERS, FERN-ROOT, EUROPEAN EXPLORERS.

INTRODUCTION

Artefacts described as 'beaters' are relatively common in New Zealand museums which hold collections of Maori material culture. Sometimes they are labelled 'fern-root beaters', 'flax-beaters' or 'barkcloth beaters'; sometimes they are given the corresponding Maori names '*patu aruhe*' '*patu muka*' or '*patu aute*' (cf. Neich 1996: 124). These terms might suggest that in both Maori and English classifications there was a simple breakdown of a functional class (beaters or *patu*, i.e., tools that strike, beat or pound) according to the material the artefacts were considered to beat. However the situation is more complex than this. Some artefacts of similar morphology to beaters have been described as 'pounders' (including the sub-categories 'maize pounder' and 'berry pounder'), 'pestles', 'mallets', and 'clubs' (including 'fish clubs'). But the latter term 'club' has other connotations as well: it is a common translation of the Maori term *patu*, especially when the referent is a weapon used in hand-to-hand combat such as the stone *patu onewa* or bone *patu paraoa*. In storage and display, museums draw a sharp distinction between these high status *patu* used as weapons and the lower status *patu* formerly employed in food and fibre preparation. Thus the category *patu* encompasses more than just beaters. Equally the English words 'beater' and 'pounder' may be used as synonyms, or separated according to the orientation of the tool in use (beaters used with the handle roughly horizontal, pounders used with the handle in a vertical plane).

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Such complexity in terminology has undoubtedly led to some confusion in both the labelling and ascription of function to museum artefacts, which are no longer in daily use and which have out-lasted their makers and context. When we describe them as beaters, pounders or clubs, how can we be certain that they were employed to beat, pound, or club? When we read a label or register entry linking their action to a specific material, how do we know that a 'fern-root beater' or '*patu aruhe*' was made to beat roasted fern-roots, or a '*patu muka*' was designed to beat or pound soaked flax fibres? Unlike many of the artefacts identified as weapons, the provenance details of the tools classified as beaters and pounders in museum collections indicate that most were obtained long after their functional life was over, and that their current labels were not ascribed by people who had actually used them.

Any study of the prehistoric significance of the bracken fern-root (*Pteridium esculentum* [Forst. F] Cockayne) in Aotearoa necessitates examination of the material culture associated with its processing into a foodstuff, in particular the tools used to beat the root after cooking. Given the confusion in terminology outlined above, reliance on museum labels to define the objects to be studied might result in the inclusion of some artefacts that had not been used as fern-root beaters and the omission of others that had. Recognition of fern-root beaters must therefore be based on additional criteria.

Students of material culture regularly employ ethnographic records to identify the tools used by late prehistoric and traditional societies. The ideal is pictorial evidence of the artefact type, or collection and survival of an actual artefact, in both cases accompanied by a description of the tool's function made by one or more reliable eye-witnesses. A written description alone is of less value, though some observers provide detail that is at least as helpful as a hastily made sketch. More problematic still are the casual references made by commentators with no particular interest in the tool or its purpose.

THE FORSTER BEATER

How does the fern-root beater fare in the early artefact collections, images and texts left by the first European visitors to Aotearoa in the eighteenth century? One artefact that is highly likely to have been a fern-root beater exists in a Cook voyage collection: Item 1886.1.1605 in the Pitt Rivers Museum, University of Oxford (Fig. 1). Its background has been thoroughly researched by the curator of the Forster Collection, Jeremy Coote. The artefact was one of many collected by the Forsters (George and his father Johann Reinhold) on Cook's second voyage to the South Pacific, in 1773–74. Formerly in the Ashmolean Museum in Oxford, it was transferred to the Pitt Rivers Museum in 1886. Two or three years before its transfer it was given the number 1605 and described as "a short club, or mallet? of hard heavy brown wood....locality not known....could it have been for beating tapa cloth[?]....given by Reinhold Forster." A handwritten label thought to be contemporary with the Ashmolean catalogue entry referred to item 1605 as an "implement of hard wood: perhaps a mallet for beating cloth, or perhaps a short club. From the South Pacific Islands, but locality uncertain." The entry in the Pitt Rivers Museum's accession book for the material transferred from the Ashmolean Museum (which was compiled from the Ashmolean's catalogue of 1886, but not until the 1940s) goes even further, describing this artefact as from the "South Sea islands. Bark cloth mallet of heavy brown wood...". What happened in the hundred years following the artefact's presentation was that its purpose and origin became confused with the square-sectioned bark cloth beaters collected in greater numbers from tropical South

Sea islands such as Tahiti (Kaeppler 1978: 150). Four facets roughly cut into the body of the tool, to flatten the originally round cross-section, may have contributed to this re-designation of function. When these cuts were made is uncertain, but it is likely to have been before the transfer to the Pitt Rivers Museum.

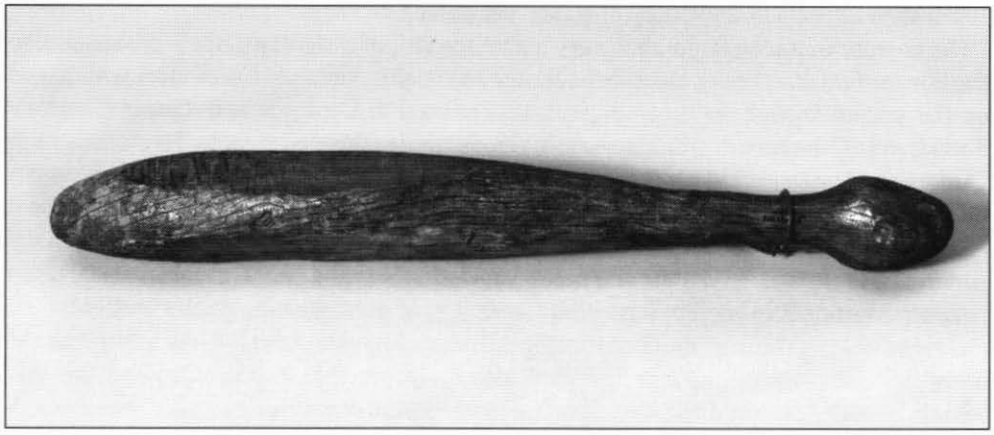

Figure 1: The Forster beater (PRM 1886.1.1605). Courtesy of the Pitt Rivers Museum, University of Oxford (copyright).

While the purpose of the beater was misunderstood for so long, its original documentation as a fern-root beater had in fact existed since 1776. At the time of its cataloguing at the Ashmolean in the mid 1880s, it still had on it an old paper label with the number '173'. While it was generally recognised that this was a 'Forster' number, it was not until 1969, when the manuscript 'Catalogue of Curiosities sent to Oxford' that the Forsters had sent with the collection to Oxford in 1776 was 'rediscovered' by Adriennne Kaeppler, that the Forsters' description of it there as a "piece of wood with which the New Zealanders bruise their fern-roots" was adopted by Museum staff as primary evidence of its provenance and use (Coote *et al.* 2000).

The Forster beater is 435 mm in length, 58 mm in maximum diameter, and has a minimum handle diameter of 25 mm. It is made of a dark-coloured hardwood, and its proximal end is an oval knob. A short length of cord is tied around the handle (Coote 2001: Full record for Forster No. 173; Kaeppler 1978: 198, Fig. 391).

Knowing that the Forsters regarded this artefact as a tool used by the New Zealand Maori in fern-root processing is extremely useful, as is the evidence presented by Jeremy Coote that the pounder was already in Oxford in January 1776, because it places their functional identification very close to the time of collection in 1773 or 1774. But there is no contemporary journal entry by Johann Reinhold or George Forster which describes the circumstances of its collection. George's account of the voyage was written up between July 1776 and February 1777, based on his father's embargoed journal. It included a description of fern-root processing as seen in Queen Charlotte Sound: this "wretched article of New Zeeland [sic] diet, the common fern-root....consists of nothing but insipid sticks,

which after being broiled over the fire for some time, are beaten or bruised on a stone with a piece of wood much resembling the Taheitian [sic] cloth-beater, but round instead of square, and without any grooves" (Forster 2000: 277). Since the elder Forster's journal fails to mention the tool, it is possible that while George was writing this passage he had in mind the artefact so recently donated to the Ashmolean Museum rather than a detailed memory of a tool type last seen in use some two to three years before. His description of the rounded cross-section and lack of grooves suggests close examination of an actual tool rather than a spectator's memory of a food processing event.

The absence of a specific journal entry makes the task of assigning a likely provenance to the Forster fern-root beater more difficult, but not insurmountable. Encounters with Maori on the second voyage were geographically restricted to Dusky Sound, Queen Charlotte Sound, and off the eastern Wairarapa coast. Goods were exchanged at each of these locations. Dusky Sound is the least likely provenance for two reasons: despite being expedition botanists the Forsters did not record the presence of the bracken fern in Dusky Sound, nor comment on its consumption by the Maori groups with whom they made contact. Modern botanical surveys of Fiordland sand dune and beach vegetation reveal a gap in bracken distribution between Martins Bay and Puyseger Point, a section of coast which includes Dusky Sound (Johnson 1992). Of course the absence of the plant at Dusky does not rule out transportation of the dried fern-root to the area by Maori, along with processing tools. However the only ferns that Dusky Sound Maori were seen to consume were tree-ferns (probably the *mamaku*, or black tree fern *Cyathea medullaris*) from which the inner pulp was eaten after cooking. Johann Reinhold Forster tried to prepare some of the latter himself while at Dusky, but it was not sufficiently cooked to be edible (Hoare 1982: 263).

The brief trading encounter off the eastern Wairarapa coast in October 1773 is also an unlikely source for the Forster beater. The Maori who came alongside the *Resolution* traded fish for nails and cloth, and a chief received a substantial gift from Cook of Tongan pigs, fowls, yams and assorted seeds; no mention was made of fern-root or Maori implements (Beaglehole 1961: 279). In contrast, there are several references to Maori fern-root processing and consumption in Queen Charlotte Sound. The *Resolution* anchored there first between 18 May and 7 June 1773. The elder Forster noted that "The hills which have no trees are covered with ferns, whose roots the Natives dress & eat" (Hoare 1982: 297). The second stop-over occurred between 3 November and 25 December, 1773. George Forster's detailed description of the fern-root beater (cited above) is assigned to the date 23 November, 1773 (Forster 2000: 277), though of course it was written three years later. Both Forsters remarked on following a footpath up a hillside "made by the Indians, who commonly go there up, to dig for Fernroots" (Hoare 1982: 421; cf. Forster 2000: 273). On the third and final stop-over at Queen Charlotte Sound on this second voyage, between 16 October and 10 November 1774, the Forsters visited a family whose only remaining food was "several bundles [of] dry Fern-root...which they beat on a Stone & put on the Embers for a few moments" (Hoare 1982: 679; cf. Forster 2000: 611). Any of these three sojourns in Queen Charlotte Sound could have provided an occasion for the Forsters to obtain their fern-root beater.

DESCRIPTIONS OF FERN-ROOT PROCESSING

No eighteenth century illustrations of fern-root beaters have been located and there are no written descriptions as informative as George Forster's. In fact most accounts written in the

period 1769–1900 use rather imprecise language for both the process and the tool. In contrast, the order of operations is usually described as heating in a fire, followed by processing on a flat stone anvil prior to eating. [The reverse order, cited above, in the Forster quotation relating to the third sojourn was later corrected (Forster 2000: 277).] The tool is called by a confusing number of names.

Mallet. "wooden mallet" by Captain Cook in 1769–70 (Beaglehole 1968: 282–83), "wooden mallet" by William Monkhouse at Anaura Bay in 1769 (Beaglehole 1968: 585), "mallet" by John Nicholas in the Bay of Islands 1814–15 (Nicholas 1817: 190), and "wooden mallet" by Sir George Grey in Taranaki 1849–50 (Best 1942: 82). In the eighteenth century, the word 'mallet' was glossed in Samuel Johnson's 1755 dictionary as 'a wooden hammer' (Johnson 1979), so it is reasonable to assume that all who used the word to describe a fern-root beater were looking at a wooden implement, probably used with the same orientation as a hammer.

Hammer. "wooden hammer" by Joseph Banks in 1769–70 (Morrell 1958: 137).

Stick. As used by Joseph Banks at Anaura Bay in 1769 (Morrell 1958: 59), and by William Anderson in Queen Charlotte Sound in February 1777 (Beaglehole 1967: 812). Do we infer from this term that the particular tools they were referring to were little more than unmodified pieces of wood? Though their terminology may simply have been loosely applied or dismissive of the tools' importance, the frequency of fern-root consumption might suggest that on occasions, such as travelling, any suitably shaped object might be enlisted.

Club. As in Thomas Kendall's Bay of Islands vocabulary of 1820, where he translated *morenga* as a "Club made of red wood, with which they beat fern-root", and *paoi* as "A club to beat fern-root with" (Kendall 1820). Roux's French term for the fern-root beaters seen in the Bay of Islands in 1772, *une espèce de massue*, is translated as 'a kind of club' (McNab 1914: 399; Ollivier and Spencer 1985: 166–67). A further Northland example is Wade's reference to the fern-root beater as "a short wooden club called a paoi" (Wade 1842: 15). William Colenso used the phrase "small club" in 1868, and "short hard-wood club, or one made from the bone of a whale" in 1880 (Colenso 1868: 11, 1880: 21–22). The latter is our only reference to a bone fern-root beater.

Pestle. "wooden pestle" by Edward Shortland (1851: 202) on the east coast of the South Island in 1844, and "stone pestle" by Colenso (1880: 21–22). Since Shortland specifically refers to the anvil as "a flat stone similar to a cobler's [sic] lap-stone", and Colenso talks of the anvil as a "large smooth water worn stone", it is tempting to dismiss any implication that these 'pestles' were used as vertical pounders, in the same way as pestles are used in a mortar. Vertical pounding on a flat stone would represent a completely different mode of fern-root processing from that implied by the terms 'hammer' or 'mallet' or as portrayed in Augustus Earle's lithograph of slaves preparing fern-root in the Bay of Islands in 1827 (Fig. 2) (Earle 1838: Plate 3; Murray-Oliver 1968: 116, Plate 48).

Stone. In the Bay of Islands in 1772, Crozet stated that fern-roots were pounded "between two stones" (Ling Roth 1891: 35), while John Savage reported for the same area in 1805–6 the beating of the fern-roots "with a stone" (Savage 1973: 9). From one of his Murihiku

informants Herries Beattie recorded the statement in the 1920s that "The patu-aruhe was a stone beater for fernroot and it was often just a common stone picked up on the beach" (Beattie 1994: 117). Another informant said that "Long shaped stones were used in the old days to beat it but any suitable stone from a river-bed would do for a patu-aruhe (fernroot beater)" (Beattie 1994: 124). Yet another informant considered that stone beaters were too heavy and that the *patu* for household use was a round-bodied tool made from hardwood, often carved (Beattie 1994: 295).

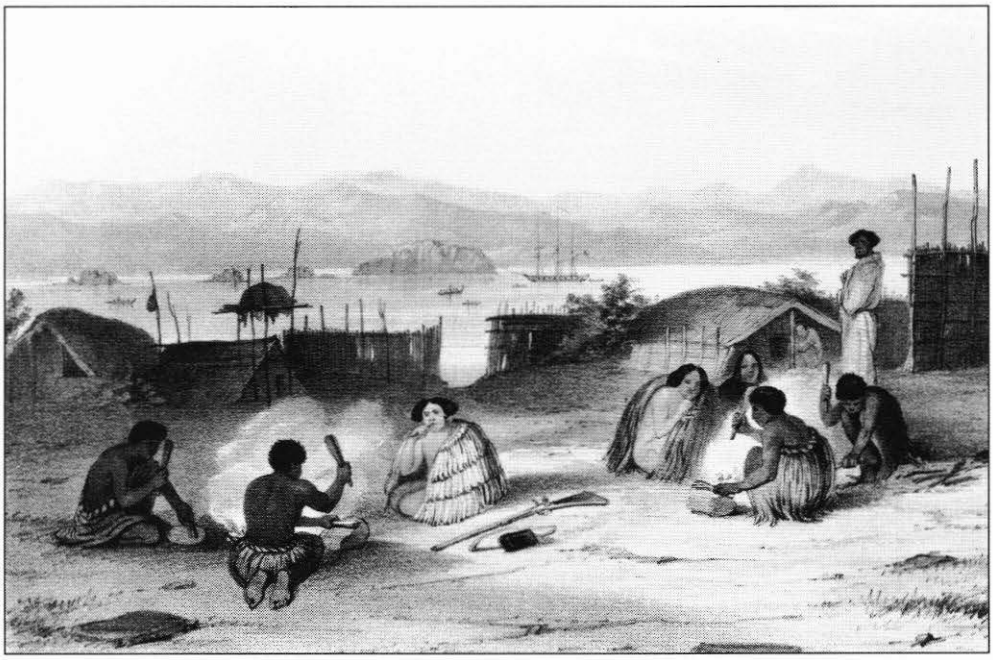

Figure 2: Detail from Augustus Earle's lithograph of slaves preparing fernroot in the Bay of Islands in 1827, Plate 3 in *Sketches Illustrative of the Native Inhabitants of New Zealand* (1838). (By kind permission of The Hocken Library, Uare Taoka o Hakena, Dunedin.)

Just as the implement for fern-root processing was given a range of names and was clearly rendered in more than one material, both formally and informally shaped, the action of the tool has also been described in various ways.

Beating. By far the majority of accounts use this term, from the time of Cook's first voyage through to the reminiscences of Murihiku elders in the 1920s.

Pounding. A word used as synonymous with beating by John Nicholas in 1814–15 (Nicholas 1817: 189–90), and in Ling Roth's (1891: 35) translation of Crozet. It was commonly used by Elsdon Best in his numerous monographs.

Bruising. Shortland's term as used in 1844 (Shortland 1851: 202).

There is no evidence that any of the commentators regarded pounding as a significantly different operation from beating. Certainly Best and Phillipps (1939) used the terms interchangeably, as when Best (1902: 52) spoke of fern-root in Tuhoe land as being "beaten and pounded with a short club".

Despite the confusing terminology in the written descriptions of fern-root beaters, and in the labelling of museum specimens, there are enough detailed accounts of the processing of fern-root to set up some functional criteria for the tool's use. Combined with knowledge of the features of the Forster beater, they allow an evaluation of museum specimens and ultimately definition of the characteristics to be expected in an effective formal fern-root beater. We can build on George Forster's description of the tool presented above, and William Monkhouse's account of the meal preparations for two chiefs at Poverty Bay in 1769:

> They were seated upon the grass—a young man had made a fire a short distance from them—he had a quantity of roots each about nine inches long, a flat large pebble, and a wooden mallet by him—some of these roots were roasting upon the fire he attended and turned them till they were thoroughly heated—he then beat them, one at a time, doubled and beat them again, and when fully softned he threw them to the Chiefs, who now were employed eating a lobster that had been dressed but was now cold. (Beaglehole 1968: 585)

On the basis of these more detailed descriptions we can propose that the functional criteria of a fern-root beater are

- a sufficient length of blade to make contact with the fern-root on the anvil stone;
- a suitable blade cross-section to dislodge the burnt exterior and to flatten the rhizome on the anvil;
- a round handle of sufficient length to accommodate one hand comfortably (while the other manipulates the fern-roots) and maintain clearance between the fingers and the anvil;
- an appropriate tool weight which spreads but does not crush the fibres, and yet can be endured for long periods of beating.

THE MUSEUM SURVEY

Defining what constitutes 'sufficient', 'suitable', and 'appropriate' depends on the identification of a population of fern-root beaters within the general, rather loosely-defined class of beaters/pounders within New Zealand museums. Fortunately, statistical analysis of the metric and non-metric variables of tools can demonstrate whether a broad group of artefacts is likely to contain significantly different sub-groups. It can show the range of variation in the variables for each sub-group, and in combination with the descriptions of artefacts used in fern-root processing, can point to the sub-group of tools most likely to have served as fern-root beaters.

With this potential in mind, a survey of museum collections of beaters/pounders was planned and carried out in 2001. Thirty museums were contacted to determine the size of their holdings of beaters/pounders. On the basis of their responses, 11 museum collections and one university collection were selected for study (for details and data see Purdue 2002: 43–44, Appendix A). The study sample was composed of 541 implements of this broad

class, variously labelled and with varying amounts of provenance information. A recording form was devised and tested on the Otago Museum collection before other institutions were visited. It followed the terminology previously used by Skinner (1974) in his description of hand-held clubs used as weapons. Thus the artefact was divided into butt and blade regions, with the butt termination treated as the proximal end of the tool and the blade end as the distal. A number of measurements of length, thickness, circumference and diameter were specified, along with weight (where this could be obtained). Non-metric variables listed on the form included material, blade and butt cross-sections, proximal butt shape (e.g., presence of a knob), the method of butt formation (by shouldering or tapering), distal blade shape, longitudinal curvature, indications of use wear, and the presence of stylistic features (e.g., incisions, ridges or knobs shaped as human or bird heads).

Some redundancy was built into the selection of metric variables to ensure that all important aspects of morphology were covered. The key measurements proved to be as follows (Fig. 3):

1. total length of the artefact—expected to reflect material and functional constraints.

2. butt length, measured from the proximal butt to the butt/blade intersection. Where the artefact was shouldered, this junction was obvious. In the case of smoothly tapered artefacts, however, the measurement was taken at the point where any change in angle or surface texture was apparent, or failing that, where the tip of the thumb fell when the tool was held comfortably in one hand as though ready for use in a horizontal fashion. Butt length was expected to reflect whether the tool was operated with a one or two-handed grip.

3. butt circumference, measured at the mid-point of the butt's length—should also reflect the type of grip, as well as material constraints affecting handle strength.

4. blade length, measured from the butt/blade intersection to the distal end of the blade. As the working portion of a tool used as a horizontal beater, the blade had to be long enough to make forceful contact with the material placed on the anvil.

5. blade circumference, taken at the mid-point of the blade, along with *maximum and minimum blade diameters*, reflect the sturdiness of the blade and the surface area available for beating or pounding.

6. weight, a measurement relevant to function, tool orientation when in use, and whether the tool could be held comfortably with one hand. In the case of wooden artefacts in museum collections it is likely that they are held under much drier conditions than would have prevailed when they were in use, and therefore may be considerably lighter.

Significant non-metric variables were:

1. blade cross-section (oval, round, ellipsoidal, rectangular, square, plano-convex, faceted)—expected to reflect the raw material and method of manufacture, as well as the function of the tool.

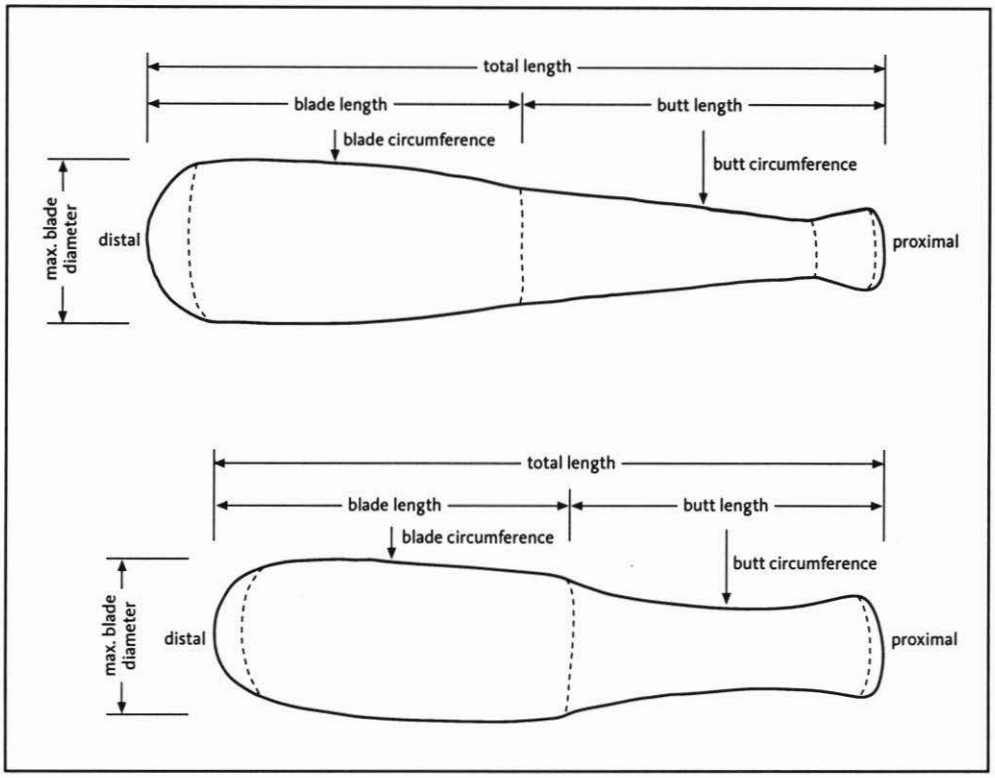

Figure 3: Key measurements taken on beaters/pounders.

2. *butt cross-section* (round, oval, ellipsoidal, rectangular, square)—likely to be subject to manufacturing constraints as well as reflecting criteria of comfort.

3. *proximal butt shape* (knobbed, unmodified)—whether or not the tool was provided with a knob to help prevent the hand sliding back along the handle and losing grip.

4. *butt formation* (shouldered, tapered)—reflecting the method of making the handle, either by shouldering the proximal end of the blade, or more simply by tapering the tool from blade to butt. It was expected that the raw material would influence such shaping decisions, as would perceptions of tool strength.

5. *distal blade shape* (rounded, flat, pointed)—functionally significant in any tool used with a vertical orientation.

6. *longitudinal curvature*—whether the tool was symmetrical or asymmetrical, in the latter case providing further hand clearance in an implement used as a horizontal beater on an anvil stone.

7. stylistic modifications and their location on the tool (e.g., stylised human head or bird's head, ridges, grooves, lobes, 'eel mouth', incised arch).

8. material—primarily wood or stone, each of which could be expected to constrain the shaping of the artefact in significant ways.

9. tool name assigned by the institution register, along with *accession number* and other *provenance* details.

The data were entered on an Excel spreadsheet and then processed by the SPSS 10 statistical computer package which identified the range and frequency of individual variables, as well as whether any relationships and correlations between attributes were significant.

The initial analysis was based on material which preliminary inspection suggested had had a strong impact on tool morphology. Wooden artefacts predominated (n=421), but there were more than enough stone artefacts for statistical comparison (n=115). A small number of whalebone (n = 4) and iron (n = 1) items were also recorded. Although too few for useful statistical description in relation to material, they were included in the cluster analysis of selected morphological variables.

RESULTS

LENGTHS

Wooden implements in the sample ranged in length from 200–520 mm, with a mean length of 329.3 mm (SD 50.88) (Fig. 4a). The stone implements ranged from 160–440 mm with a lower mean of 249.1 mm (SD 50.04). As the box plot graph demonstrates, material was clearly influencing total length. It may have been easier for artisans to obtain longer pieces of wood than of stone from which to form these tools, or they may have wanted to keep tool weights down by reducing stone tool lengths relative to wood. At the same time, the question should be asked: why take the extra trouble to make a stone tool if a more easily shaped wooden one will perform the same function? The possibility that the stone tools were designed for different functions than the wooden must be considered, also the fact that a tool may be used for several functions in its working life.

BUTT LENGTHS

In wooden tools, butts ranged in length from 60–270 mm, with a mean value of 140 mm (SD 28.94) (Fig. 4b). Most fell between 131–140 mm, which is sufficient to accommodate the breadth of one hand comfortably. In the case of the outliers, some had exceptionally long knobs. Stone tools showed a reduced range of butt lengths from 60–180 mm, with a lower mean length of 107.9 mm (SD 21.18), just sufficient for one-handed operation. The longer stone butts would have been suitable for a two handed grasp. Although material distinguishes two groups for this dimension, they both share a minimally acceptable butt length around 60 mm, which provides just enough room for a small adult female hand.

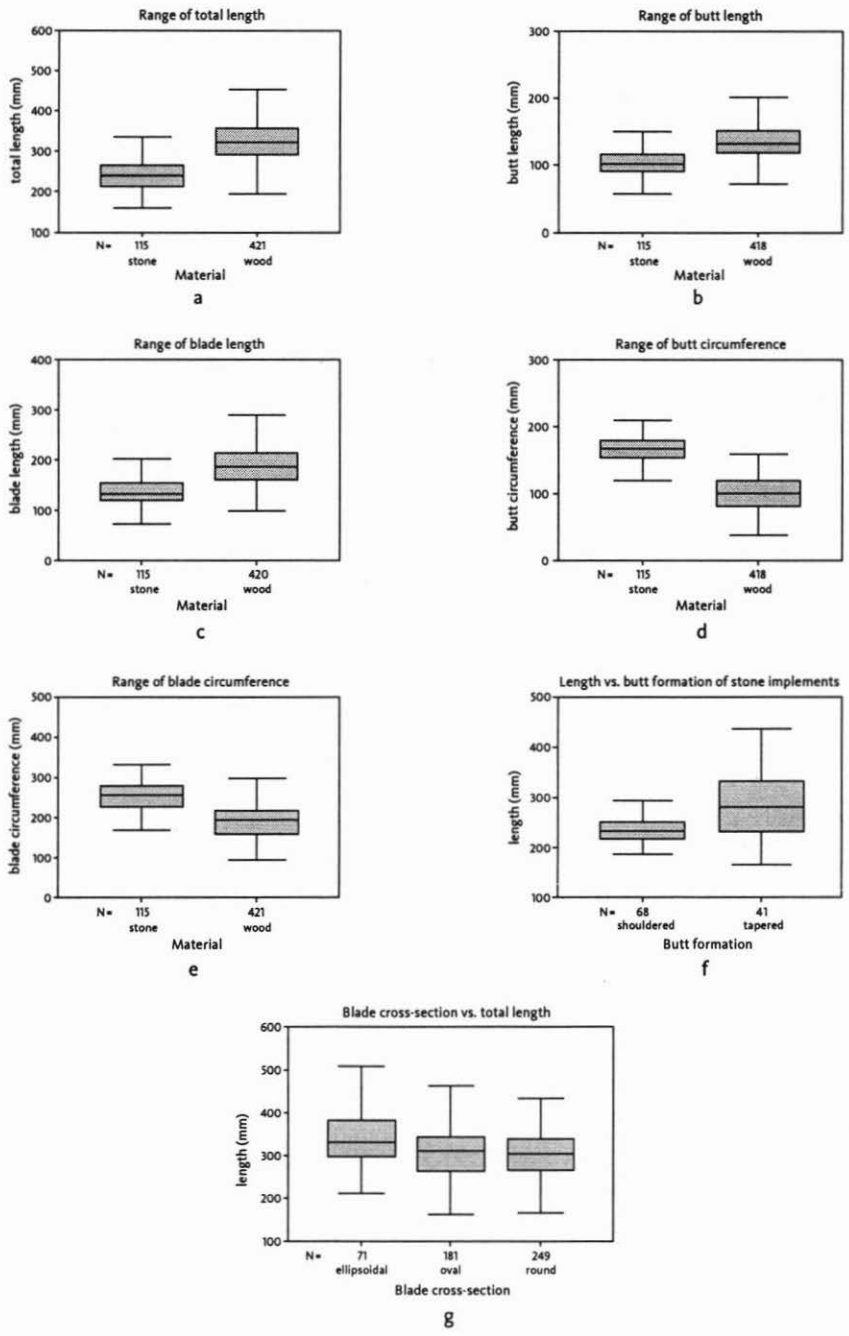

Figure 4: Graphs of selected descriptive statistics (box shows median plus upper and lower quartiles, whiskers show range): a. total length plotted against material; b. butt length plotted against material; c. blade length plotted against material; d. butt circumference plotted against material; e. blade circumference plotted against material; f. length of stone implements plotted against butt formation; g. blade cross-section plotted against total length for both wood and stone.

BLADE LENGTHS

This was very variable, ranging from 100–340 mm in wooden tools and from 70–260 mm in stone (Fig. 4c). Mean blade length in wood was 189.8 mm (SD 39.16) and in stone 141.2 mm (SD 37.38). As with total length, the sample split into two different groups for this dimension, according to material.

BUTT CIRCUMFERENCE

In wooden items this ranged from 40–191 mm with a mean circumference of 101.7 mm (SD 24.45) (Fig. 4d); most examples fell between 111–120 mm, a comfortable size for an adult hand to grasp firmly (using the type of grip applied to a hammer). In stone objects the most slender butt circumference was 120 mm, with a range up to 210 mm. With a mean circumference of 167.3 mm (SD 20.61), most of the stone tools could not have been held comfortably in the grasp of a small female hand for any length of time. It is possible that the much greater effort required to shape a stone handle compared to a wooden one meant that only as much stone was pecked away as was absolutely necessary. The tool-makers may also have been reluctant to make a stone butt as slender as a wooden one in case it was more prone to fracture in use. It is also possible that some of the thicker-circumferenced tools were held in a different type of grip, such as that used to support the weight of a vertical pounder.

BLADE CIRCUMFERENCE

This measurement also showed the greater body size of the stone tools (Fig. 4e). While the range in wooden examples was 100–400 mm, with a mean of 193.8 mm (SD 43.28), the corresponding figures for stone were a range from 150–330 mm, and mean of 252.7 mm (SD 39.91). The other blade dimensions exhibited comparable differences.

WEIGHTS

When available, these revealed that stone tools, though shorter on average than wooden examples, were up to three times heavier. Stone beaters/pounders weighed between 1.05 kg and 3.07 kg (n=27), while wooden ones fell in the range 0.11 to 1.29 kg (n=30). This difference raises the question as to whether the large stone tools included in the survey could have been comfortably used in a one-handed fern-root beating mode similar to that described by Monkhouse.

Overall the wooden tools in the survey were longer, thinner and lighter than stone examples. In non-metric variables, both similarities and differences were apparent.

PROXIMAL BUTT SHAPE

Knobs were present in both wooden (72.9%) and stone (72.2%) artefacts, indicating a general preference for this sort of handle end, regardless of material.

BUTT FORMATION

This was recorded as shouldered, tapered, or indistinguishable. The preference in wooden tools was for a tapered butt (61.8% of cases), like the Forster beater. Shoulders had been made in only 38% of wooden tools. In contrast, the makers of stone specimens preferred shouldered (59.1%) to tapered butts (35.7%). If the weights of stone tools were acting as a constraint on length, then shoulders offered the shortest transition zone between blade and butt. As demonstrated in Figure 4f, shouldered implements were significantly shorter overall than tapered ones (Purdue 2002: 77).

BUTT CROSS-SECTION

As might be predicted for hand comfort in use, round and oval butts predominated (82.4% and 10.9% respectively in wooden items, and 62.6% and 33% in stone).

BLADE CROSS-SECTION

Round and oval cross-sections made up 77.2% of the wooden sample and 89.5% of the stone. The form in which the raw materials were obtained might have been influential here as wood occurs as round branches or roots, and suitable stone as rounded water-rolled billets. However Wallace (1989: 223–226) found that 58 'fern-root beaters' made of kauri were exclusively formed from branch heartwood, and that in general Maori wooden artefacts were made from trunk wood or branch heartwood. Since both required shaping and dressing, a round or oval cross-section should be seen not as a default option but as a deliberate choice. As well,15.7% (n=64) of the wooden artefact blades had been deliberately shaped to an ellipsoidal cross-section. The relatively sharp edges where the front and back surfaces meet on these tools are not consistent with the ethnographic descriptions of fern-root beating. In fact, in cross-section they look more like a weapon (e.g. *patu onewa*, or *mere*), though considerably lighter and often provided with a long butt suited to two-handed use. In overall length, these ellipsoidal-bladed tools are noticeably longer than oval or round-bladed forms (Fig. 4g), and 31% have lengths greater than 1SD beyond the mean for wooden beaters.

DISTAL BLADE SHAPE

Much more variation was noted in the shape of the distal end of wooden blades than of stone. Of wooden blades, 19% terminated in a point, 56.8% were rounded off, and 21.9% were flattened. In contrast, stone specimens were predominantly rounded (86.1%) or flattened (12.2%). Was the incidence of rounded ends in stone tools a reflection of the technology of stone shaping, or was the distal end of some of the stone tools actually part of the working surface (as in a pestle)?

LONGITUDINAL CURVITURE

This occurred in 15.4% of the wooden tools but in only 2.6% of the stone. In wooden specimens natural curvature in some pieces of wood may have eliminated the need to cut shoulders or to taper the handle.

STYLISTIC MODIFICATIONS

These occurred on 28.7% of the stone tools, invariably on the butts of knobbed specimens, but on only 2.6% of the wooden tools (on 7 butts and 4 blades). Pecked ridges were the most common motif on the stone butts (18.3%) followed by a stylised human head (9.6%). Neither of these motifs was rendered on wooden tools, which raises the possibility that a functional and status difference between them proscribed the use of human 'features' on wooden beaters/pounders. If most of the latter were used in food preparation by people of low status, then it might be proposed that the majority of stone tools were either not used on food, or not handled by people of low status.

THE DEFINITION OF BEATER/POUNDER TYPES

On the basis of morphology alone, the analysis suggested that a convenient way of distinguishing beaters/pounders for descriptive purposes was by material (wood or stone), combined with proximal butt shape (knobbed or unmodified) and with butt formation (shouldered or tapered). Eight descriptive types resulted (Fig. 5), accounting for 406 of the wooden items and 109 of the stone—21 items were too incomplete for butt shape and formation to be assessed (Table 1).

TABLE 1
Eight descriptive types of beaters/pounders

		Proximal Butt Shape			
		Knobbed n = 390		Unmodified n = 125	
Butt Formation	Shouldered n = 222	KSS n = 52	KSW n = 116	USS n = 16	USW n = 38
	Tapered n = 293	KTS n = 31	KTW n = 191	UTS n = 10	UTW n = 61
Material		Stone n = 83	Wood n = 307	Stone n = 26	Wood n = 99

In this schema, the Forster beater would be of the KTW type and the flax beater illustrated by Angas (Fig. 7), and discussed below, would be of the KSS type.

When mean dimensions were plotted for each of the wooden types, considerable homogeneity was observed between the four types, suggesting that most had been made for a similar purpose. In the stone types, however, one type (KTS) stood out from the others as being longer in both butt and blade, suggesting that more than one functional category might be present.

Statistical cluster analysis was then performed to see how these intuitive morphological types based on material and butt formation might be grouped when only size dimensions, not material, were taken into consideration. If material was the critical factor in determining

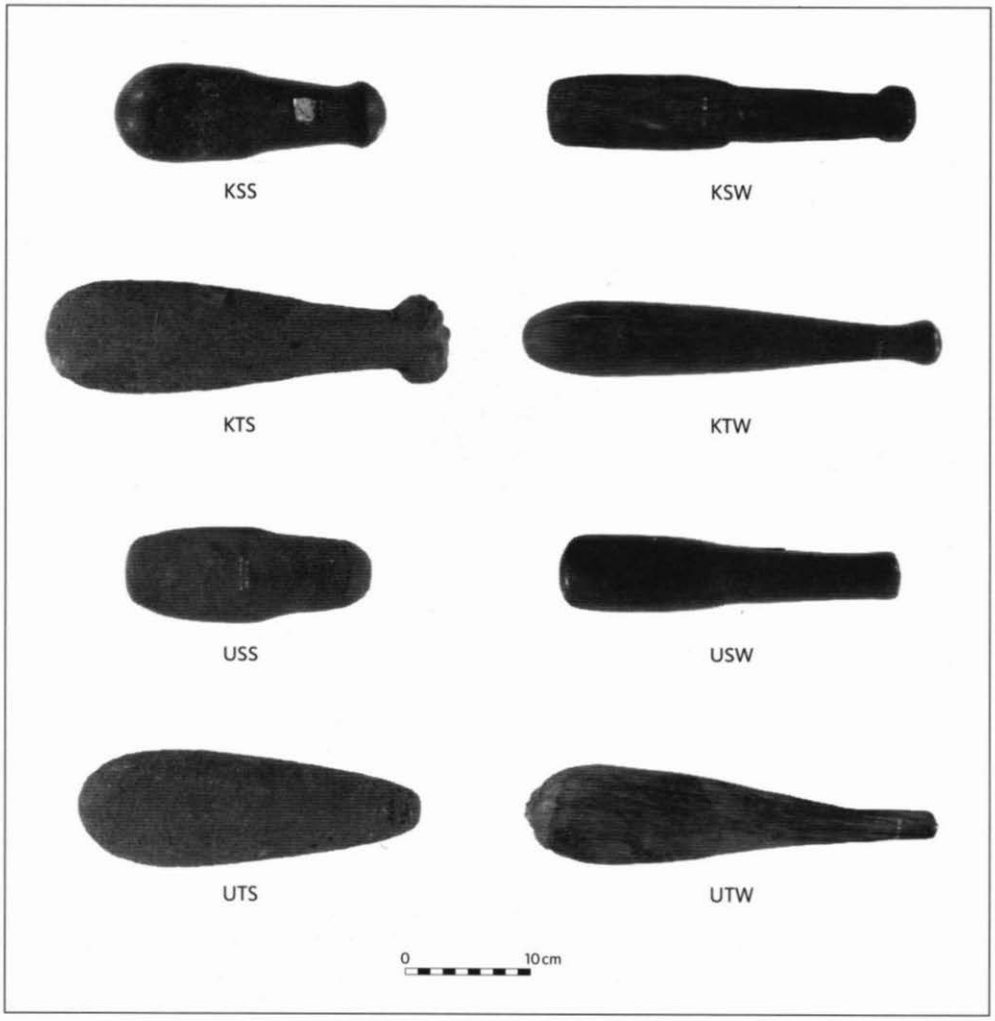

Figure 5: Examples of descriptive types, with possible functions, from the collections of the Otago Museum. KSS: D50.72 Auckland, ?flax beater; KSW: D38.377 Morrinsville, ?fern-root beater; KTS: D33.2012 Taranaki, ?ceremonial pounder; KTW: D29.951 Ohaeawai, fern-root beater; USS: D25.385 Te Awamutu, ?flax pounder; USW: D24.1196 Hamilton, ?fern-root beater; UTS: A37.3 Hornsey Collection, North Island, ?pounder; UTW: D29.954 Ohaeawai, ?fern-root beater. (Photos by Les O'Neill, with kind permission of the Otago Museum)

shape, rather than function, then the objects should cluster according to their material. The variables selected were not strongly correlated: they were total length, butt circumference and blade circumference. The basic aim of cluster analysis is to devise a scheme that finds

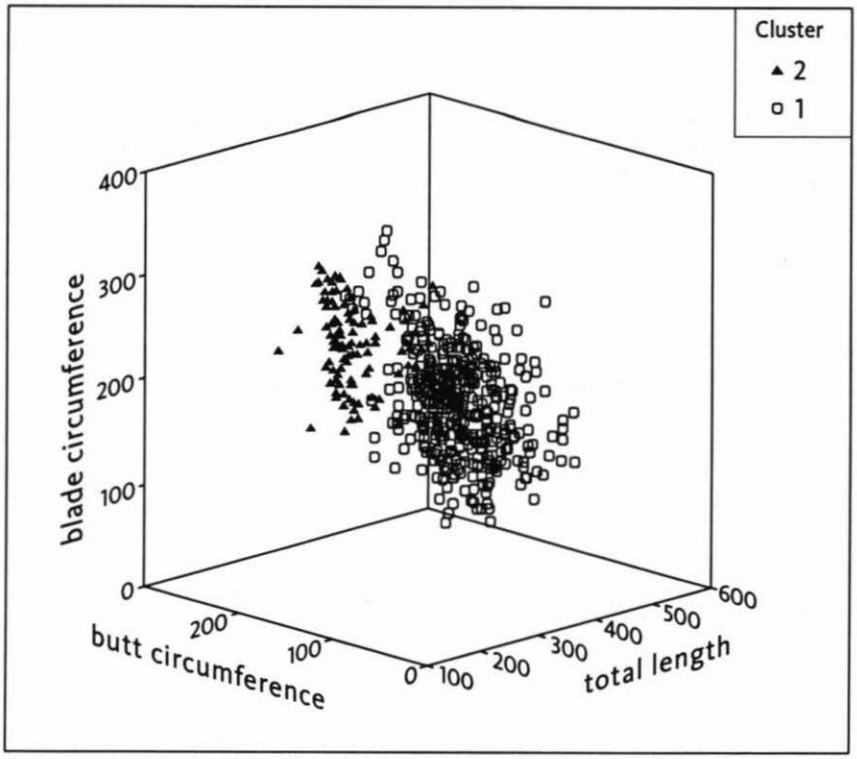

Figure 6: Hierarchical cluster graph, using three dimensions (total length, butt circumference, and blade circumference).

the 'natural groupings', if any, of individuals in a data set. In other words, cluster analysis aims at allocating a set of individuals into a set of mutually exclusive, exhaustive, groups such that individuals within a group are 'similar' to each other while individuals in different groups are 'dissimilar'. Hierarchical cluster analysis was used in this case. The clustering algorithm was average linkage between groups, based on a squared Euclidean distance interval. Initially a four-cluster division was run with five variables (Purdue 2002: 93–94); however, extra weighting to length had been given in the choice of variables so the analysis was re-run with three.

Two strong clusters emerged (Fig. 6), one with 426 members (of which 29 were stone, 4 bone, 1 iron and 392 wood) and the other with 102 members (85 stone and 17 wood). The remaining two clusters contained only 10 items between them and are not shown in the figure. Scatter plots were produced to check the correlations, and the results supported the groupings. The mean metric values for the first cluster matched those of the majority of wooden artefacts in the study; in other words they tended to be longer and thinner than those in the predominantly stone cluster. Nevertheless it was obvious that the clusters cannot be interpreted as reflecting material constraints alone. Variation in function was also indicated.

On examination, the 29 stone items that fell in cluster 1 were found to be longer than most of the stone tools, and 75% were of the less common tapered types (KTS and UTS). Their length and weight suggest that they were not suitable for use as beaters operated in a horizontal orientation, but fit the criteria for a pounder or pestle used in a vertical plane, perhaps to crush objects in a mortar. Of the 20 with provenance details, 12 were from Taranaki and 2 from the Waikato. They appear to be a regionally distinctive artefact type. The 392 wooden members of cluster 1 were long, thin wooden implements with long blades and small butt circumferences. Those with round or oval cross-sections (328) could have been used as fern-root beaters and share the same proportions as the Forster fern-root beater, which would have been assigned to cluster 1 had its dimensions been included. They were more widely distributed, with large numbers recovered from Northland, Auckland, Hauraki, Waikato and Taranaki.

The 85 stone members of the second cluster are predominantly short, thickset tools, with large butt and blade circumferences. They may have been too short and too heavy to have been used comfortably as fern-root beaters, and it is hard to imagine their utilization on a single length of fern-root placed on a stone anvil. Accidental stone-on-stone contact could damage both the beater and its operator. Of the 38 with known provenance, the majority were from Waikato (9), Taranaki (6) and Manawatu (5). The flax-beater illustrated by Angas (Fig. 7) would have belonged in cluster 2. The 17 wooden items in this second cluster may also have been too short for efficient fern-root beating, and perhaps functioned as pounders. These items were from Northland (3), Auckland (3), Hauraki (3) and the Waikato (3) regions.

Figure 7: Details from George French Angas' *The New Zealanders Illustrated* (1847). a. woman pounding flax, detail from Plate 30; b. flax pounder, detail from Plate 55, #7. (By kind permission of The Hocken Library, Uare Taoka o Hakena, Dunedin)

Thus statistical analysis suggests that of the 541 assorted items studied in museum collections, 328 wooden tools of long, thin form, round or oval blade cross-section and relatively light weight, have attributes that are consistent with a beating function on an anvil stone. We are on safe ground to describe them as probable fern-root beaters. Another group of 102 shorter, heavier tools with broad butts, predominantly rendered in stone, but a few in wood, do not appear as suited to use on fern-root. They may be more consistent with the flax beaters described and illustrated in the early nineteenth century. A third group of 29 long stone implements that clustered with the fern-root beaters, but were significantly heavier, each weighing several kilos, may have been designed for use as pestles in a mortar or wooden bowl. Unlike the fern-root beaters they were frequently provided with carved knobs. Their size and weight would have made use in a horizontal orientation extremely fatiguing. A fourth group should tentatively be separated from the wooden tools in cluster 1: the unusually long weapon-like forms with ellipsoidal blade cross-sections. Their prevalence in Murihiku where fern-root is sparsely distributed, and the association of some of their locations with rivers and lakes, may suggest a quite unrelated function, possibly as fish clubs.

MATCHING MUSEUM LABELS AND ARTEFACT CLUSTERS

Of the 392 wooden tools assigned to cluster 1, 334 had been classified as '*patu aruhe*', 37 as 'beaters', 3 as '*patu muka*', and 5 as 'pounders'. In this cluster 64 items possessed ellipsoidal blade cross-sections, and do not closely match the criteria set up on the basis of the ethnohistorical descriptions for an effective fern-root beater. Nevertheless 47 of these had been labelled '*patu aruhe*'. This leaves 287 '*patu aruhe*' which bear an appropriate label, an 86% 'success' rate. Only one of the 29 long, heavy stone tools included in cluster 1 had been labelled 'fern-root beater', probably inappropriately. Among the others, 15 had been called 'pounders' and 7 '*patu muka*'. The less specific term 'pounder' seems a more conservative description for them.

In the second cluster of shorter tools, the 85 stone artefacts had mostly been labelled as 'pounders' (36), '*patu muka*' (36), and '*patu aruhe*' (6). Of the 17 wooden artefacts which fell into this cluster, 15 were also described as '*patu aruhe*'. Associating any of these cluster 2 tools with fern-root beating is problematic for they seem too short to provide adequate hand clearance. Description as a generic 'pounder' is more consistent with their morphology. As for the identification of the 36 stone '*patu muka*', ethnographic evidence reviewed by Purdue (2002: Appendix B) suggests that flax fibre was beaten on a smooth flat stone with a short round-bodied club. In Angas's depiction and description (Angas 1847: Plates XXX, LV No. 7; 1979: 38–39, 48–49), the implement is made of stone, is wielded in one hand, and relies on shouldering to protect the fingers (Fig. 7a & b). The label '*patu muka*' may prove to be correct for these short, thick clubs, though details of the flax-working process need to be documented as intensively as has been done for fern-root before it can be confirmed.

CONCLUSIONS

At this point, the ethnographic and historical records coupled with statistical analysis of a large number of generic beaters/pounders allows closer definition of the *patu aruhe* or fern-root beater than has previously been available. In its commonest form it has the following characteristics (based on means ± 2 SD): it is made of a hard wood and is 230–430 mm in total length. It has a butt or handle (often knobbed at the end) 80–200 mm long and 50–150 mm in circumference, that can accommodate the firm grasp of one hand. The blade is 110–270 mm long, rounded or oval in cross-section, and with a circumference of 110–280 mm. The handle has been formed by progressively reducing the volume of wood (tapering) or cutting more abruptly into the wood (shouldering). The tool is light (*ca.* 0.5 kg), and the rounded sides of its normally symmetrical blade have served as the working surface.

Ideally a fern-root beater should be identified from evidence of fern-root residues. The possibility of extracting plant cells from the pores of wooden beaters and pounders should be recognised and in future, cleaning and chemical preservation of newly found implements may need to be delayed until any residues are extracted. As well, the identification of anvils in occupation sites stands out as a significant omission by archaeologists. Despite the fact that every fern-root beater and probably the majority of flax beaters worked in tandem with an anvil stone, few anvils are represented in museum collections and no attempt has been made to test whether traces of identifiable plant residues remain in their surfaces.

Though recognition of fern-root beaters has been furthered by this combined ethnographic and statistical study, the museum collections deserve much more attention. Within the generic class of beaters/pounders examined in the museum survey, at least three separate categories of tool seem well represented: fern-root beaters, flax beaters, and vertical pounders, with the possibility of a fourth functional category consisting of ellipsoidal-sectioned 'clubs' (Table 2).

TABLE 2
Ascribed functions of beaters/pounders

Ascribed Function	Formal Shape	Material	Dominant Cluster	Notes
Fern-root beater	KT	Wood	1	Widely found
?Fern-root beater	KT, UT, US	Wood	1	Widely found
Flax beater	KS	Stone	2	Widely found
?Flax beater	US	Stone or wood	2	Widely found
?Ceremonial pounder	KT	Stone	1	Taranaki style with knobs often carved
?Fish club	KT, KS	Wood	1	Longer butt; blade cross-section ellipsoidal

Because our objective was to recognise and describe fern-root beaters, our conclusions apply mainly to this group. However the demonstration that two or three other functional categories may be included in the generic class of beaters/pounders signals the importance of documenting other activities in traditional Maori life that involved the processing of foods and fibres with such tools.

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