NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION NEWSLETTER

USING A DIGGING STICK TO DIG IN CLAY: AN EXPERIMENT

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Excavation carried out on the site of Hamlin's Hill, N42/137, over several years has revealed many pits and large stone-covered drains (Davidson,1970; Irwin,1975; Pearce,1975, 1977; Walton,1979; Nichol,n.d.). With the idea that the size of these features might say something about the supplies of stored food supporting their construction, we decided to estimate their cost by excavating experimently a small pit and a section of drain using a home made digging stick. Following the recent article by Sutton and Phillips (1980), our results, and some of the problems we encountered, might be of interest.

Procedures and results

The stick used in the experiment (Fig.1A) was made after the style of a stick in the collection of the Auckland Institute and Museum (Fig.1B) and was chopped out of a piece of 10 x 5cm Pinus radiata timber.

The actual digging was carried out on Hamlin's Hill itself, in an area excavated and found to have been scraped clean of archaeological features by a bulldozer. Work commenced by marking out a rectangle 1.2 x 0.65m within a larger area that had been cleared of loose debris. The authors dug alternately in 15 minute spells. The person not digging removed the spoil, taking only a few moments each spell.

Beginning the hole was difficult, as the fixed footrest was too far from the ground for balance to be easily maintained when the digger's weight was transferred from the ground to the stick. At this time we also tried chipping at the ground, raising the stick 20-40cm between blows. This made little impression on the ground, but damaged the cutting edge quite rapidly. Most actions damaged the cutting edge to some extent, and the edge was periodically resharpened using a large knife. Holding the stick at an acute angle to the ground, about 25-35°, and keeping the cutting edge vertical, so that it acted like a plough rather than a spade proved to be the most effective way of starting the hole, and force was more easily applied when the stroke was directed to the side of the digger. Effective poses were a lot like those in Best's (1925: Fig.23) photographs of men digging a garden using ko.

The major drains and many of the pits have been cut down to a layer of consolidated volcanic ash within the hill, so the experimental pit also stopped there, in this area now about 46-51cm below the surface.

This depth was reached over an area of about 50 x 95cm after 75 minutes digging. The excavation was then extended, to produce a pit 1.3 x 1.2m on the surface and 1.1 x 0.95m on the floor. The total time expended was now 110 minutes. Extending the pit once a start had been made could therefore be accomplished at a rate of about 0.65m^3 per hour.

To measure the rate of digging drains, we cut a trench 25cm wide from one corner of the pit, keeping the floor of the trench on the surface of the ash. After two sessions each - 60 minutes of digging - we had produced 1.48m of the trench, with a depth ranging from 46-51cm. This was performed using the same basic 'plough' stroke but directed down the more or less vertical face of the cutting. A further difficulty encountered here was that, toward the bottom of the trench, the walls interfered with the wide footrest.

The largest pit on Hamlin's Hill seems to be about 7 x 4m and about 50cm deep (Davidson,1970: Figs 4 and 5). Ignoring the extra cost of beginning the excavation, we could excavate the volume of 14m^3 in about 22 hours. Including branches, the major drains have been traced for 36.5m so far (Pearce,1977:Plan A). We could dig this length in about 24 hours.

Discussion

There are several ways in which our experiment is inadequate as a test of the efficiency of prehistoric Maori digging techniques. For example, we are unlikely to be as fit as prehistoric workers. We tried to correct for this by taking turns digging, but how far this is appropriate is impossible to say. We had no previous experience with digging sticks, while prehistoric diggers would be experienced and no doubt skilled. Another problem is that the experimental stick is far from being a replica of the stock used as a model: the footrest is fixed, too high for most tasks and much too wide, and the blade itself is also a good deal too wide. The timber used is also rather unsatisfactory, as a prehistoric implement would probably be made in mangeao (Litsea calicaris) (Simmons,pers. comm.), much harder and tougher than pine, but now unobtainable. Also, there is no reason to suppose that the Maori would be restricted to a single implement to carry out the varied tasks involved in digging a pit. A wide range would have been available, and experience would have permitted the choice of the tool most effective for each job. The 'strategy' of the excavation is another area where experience might produce major improvements. There was a clear advantage in digging part of the pit to its full depth then extending, as we approximately doubled the size of the pit with an extra 37% of effort. Unfortunately, the small size of our experimental pit prevented some other likely digging strategies to be tested; one possibility would be

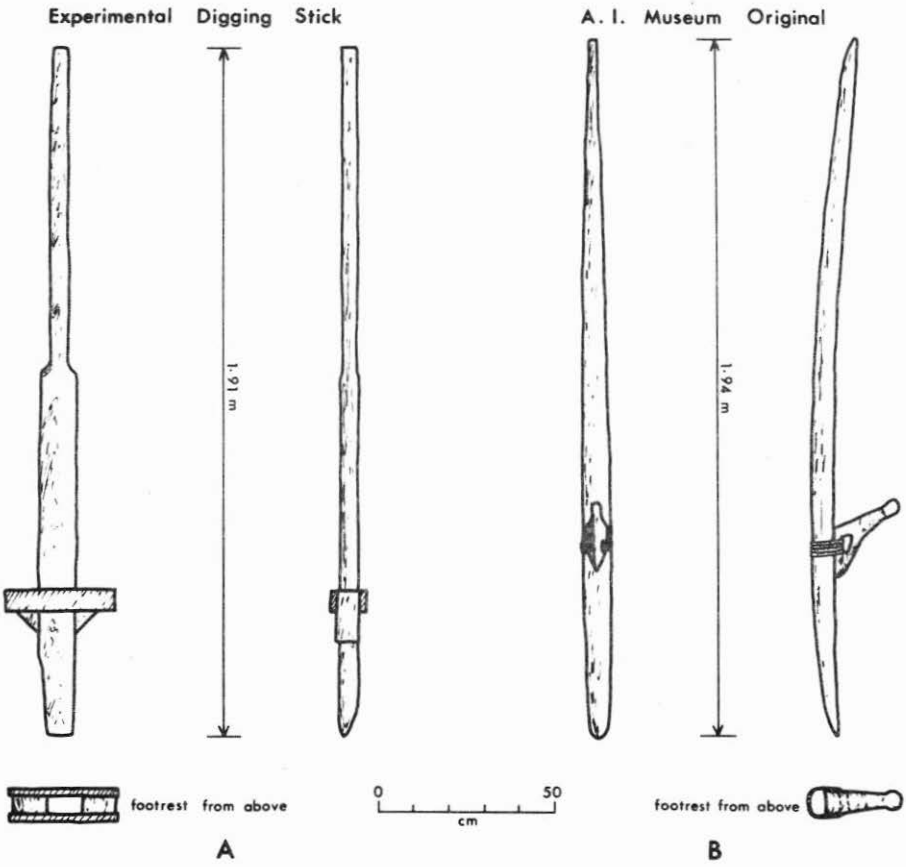

FIGURE 1. Experimental digging stick and museum model.

to pedestal large blocks of clay, which could then be rapidly toppled and removed.

Each of these problems has the effect that our experiment overestimates the effort required to excavate the pits and drains. True values will be substantially less than those calculated above, and even those were quite modest: compared with the cost of digging the large pit on Hamlin's Hill of two or three man days, a pit as large as that would provide storage for perhaps one or two thousands of man days worth of food (Law,ms). Obviously the work involved in digging a pit is much too small to be interesting when assessing the assets of the owners of the pit, and the value of the food that can be expected to have been stored would be much more useful (Law,ms). Our results have a bearing there, however, as the very high relative value of the contents of a pit versus the pit itself means that prehistoric New Zealanders would have been willing to dig replacement pits at the slightest hint of an existing pit becoming unhealthy. With a payoff at a rate of several hundred to one if digging a new pit saves a store of food, it is to be expected that there may be many more pits at a site than will have been in use at any one time, and without evidence of precise contemporaneity in their use, it might be that calculations of the food value represented by volumes of groups of pits will generally produce serious overestimates.

Costs of building pa

Though risky it is tempting to speculate about the costs involved in cutting the ditches of a pa on the basis of our experimental pit digging.

Say the task is to excavate a triangular sectioned ditch 3m wide by 3m deep, dug around a circle with radius 50m. This excavation has a cross-sectional area of $4.5m^2$, and a length of $100\pi m$, so a volume of about $1400m^3$. Digging would be mainly by extending, so a rate of $0.65m^3$ per man hour will be assumed, when the ditch could be dug in about 2200 man hours; say by 22 men in 10 x 10 hour days. This enclosure would have an area of about $2000m^2$, which is considerably larger than most New Zealand pa, though smaller sites have proportionately more edge versus area, and real sites are usually less efficient than the perfect circle assumed here. At a real site, too, the cost of carrying the spoil will be significant, while the cost of moving spoil when digging our pit could be ignored.

Still, the figure of 220 man days for the actual excavation of a ditch 3m wide, 3m deep, and enclosing $2000m^2$, seems quite modest, though on the argument above, it should be an absolute upper limit. Clearly it would be a good idea to test this calculation by an experiment on a much larger scale.

Footnote: To allow comparison to be drawn with the results of other experiments, we measured the strength of the clay we were digging through: a soil test "TORVANE" CL-600 indicated a sheer strength of 1.5kg/cm^2.

Acknowledgements

We would like to thank Agnes Sullivan and Doug Sutton for comments on this experiment. We had a helpful discussion on digging sticks with Dave Simmons, and Don Hansen discussed his own digging stick experiment with us. Mr Grahame Duske of Auckland University School of Engineering provided the instruments to measure soil strength, and helped to interpret the results. Caroline Phillips and Val Bailey produced the Figure. The Auckland Meat Co. kindly allowed permission to carry out the experiment on their property at Hamlin's Hill.

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