NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION NEWSLETTER

QUANTIFYING SHELL MIDDEN: WEIGHTS OR NUMBERS?

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The question of whether to use weights or numbers when quantifying shell is one of the most fundamental issues in midden analysis, but it does not seem to have been resolved to date. Shell weight has been the choice of most American archaeologists dealing with midden, from Nelson (1909, 1910) and Gifford (1916) to Kolosieke (1969). Shell weight has also been used by some archaeologists in New Zealand (Davidson 1964, Shawcross 1967), while others have used shell numbers (Smart and Green, 1962; Ambrose, 1963; Anderson, 1979; Sutton, 1980). Rowland (1977) uses both, and he also points out that the apparent importance of species might not be much affected by the choice.

The results of the two methods can appear to be more or less comparable, in relative terms. However, there are major differences in the significance that can be attached to the two styles of data, and we also believe that the choice between the two can be looked at very usefully in terms of their costs. This paper describes an experiment that leaves no doubt about which of the two is to be preferred.

Procedure

Using a triple beam balance, model Ohaus 2610, sets of 100 valves of Chione stutchburyi and 100 shells of Amphibola crenata were found to weigh 184.3 g and 105.4 g, respectively. The sets were then mixed, and the following sequence of operations then carried out six times: the shells were dumped in the middle of a wooden tray about 1 m^2. They were walked on, sedately, wearing flat rubber-soled shoes which were then cleaned of shell fragments. The mixture of whole and broken shells was sieved using 6.3 and 2.0 mm screens.

Taking the 6.3 mm screen first: material in the screen was searched for whorls of Amphibola and hinges of Chione (here called "diagnostic elements"). The counts were recorded, as was the time taken to find these elements. The rest of the material in the screen was then sorted between the two species. The total weights of the material of the two species, diagnostic plus undiagnostic, were measured and the additional time taken was recorded. The same set of procedures was then applied to the material retained in the 2 mm screen. Lastly the residue, collected in another large tray, was weighed and all the material, including the residue, was remixed ready for another cycle.

Results

The sorting times in each of the runs are set out in Table 1, the recovery rates in Table 2.

Screen Size (mm)	Material Sorted	Run Number (Time in Minutes) 1	2	3	4	5	6
6.3	Diagnostic Elements	5	9	8	6	5	5
6.3	Rest of Shell	7	10	18	9	8	6
2.00	Diagnostic Elements	7	11	15	14	21	20
2.0	Rest of Shell	14	33	52	43	55	54

TABLE 1. Sorting times.

It is apparent, first, that sorting all the undiagnostic pieces into species consistently takes about twice as long as simply sorting and counting the diagnostic elements, and of course sorting for species weights would take even longer if the diagnostic elements had not been removed beforehand.

Second, the counts represent a higher proportion of the original quantities than do weights, with the ratio

$$\frac{\text{fraction of weight not recovered}}{\text{fraction of number not recovered}}$$

ranging from a little more than 1 to as much as 7, and averaging over 2 for both species.

Discussion

The situation examined in this experiment is very simple, but the results should generally hold true. One important change is that real middens will usually have more than two species, but we cannot think of a situation where an additional species will make it easier to sort the

Species	Run	Weight of shell recovered: In 6.3mm screen (g)	In 2mm screen (g)	Total (g)	Total (%)	Number of shells recovered: In 6.3mm	In 2mm	Total
Chione	1	174.5	7.7	182.2	98.9	97	3	100
	2	151.9	23.8	175.7	95.4	73	26	99
	3	147.4	31.3	178.6	96.9	65	33	98
	4	130.3	46.5	176.8	96.0	55	42.5	97.5
	5	118.0	57.0	175.0	95.0	47	51.5	98.5
	6	105.5	67.4	172.9	93.8	39	58	97
Amphibola	1	73.1	25.5	98.6	93.4	76	24	100
	2	41.6	49.6	91.2	86.5	52	46	98
	3	29.5	54.5	84	79.7	26	60	86
	4	13.0	64.3	77.3	73.3	15	70	85
	5	8.7	62.9	71.6	67.9	9	68	77
	6	4.7	59.3	64.0	60.7	2	66	68

TABLE 2. Recovery rates for weights and numbers.

material, because the third species almost has to be more like either the gastropod or the bivalve than the two are like each other. Increasing the number of species will therefore increase the time required for sorting, either by weights or counts. However, the pieces of shell 'diagnostic' of the presence of individual shells are also most 'diagnostic' of the animals' species. It is easier to speciate shells from whorls or hinges than from almost any other portions of shell, but when weights are the objective the most anonymous pieces of shell need to be sorted too. It follows that increasing the number of species will make the weight method even more time-consuming, and even less accurate.

Other problems with the use of shell weights could be mentioned. For example, the question asked in the experiment, i.e. how completely the original weight of shell can be recovered after it is crushed leaves out of the reckoning that fact that prehistoric shell will have been soaking in a dilute solution of carbonic acid ever since its deposition. Shawcross (1967:122) found that <u>intact pipi</u> from Galatea Bay (N43/33) had apparently lost around 20% of their original weight, compared with similar-sized local live specimens. Of course broken shell, with higher surface/volume ratios, will be subject to even greater losses. By contrast, decay will have to proceed very far indeed before entire individuals are lost, so, again, numbers will be less inaccurate.

A further complication with shell weight is that the significance of a particular weight of shell depend on the size of the shells present. If, say, the intention is to establish the relative contributions of different species to meat weight consumption, it will be necessary to make allowance for the variation in meat weight/shell weight ratios within each species. This variation is illustrated strikingly by Terrell (1967:Fig. 18), who showed that the ratio for <u>pipi</u> changes from 0.5-0.6 in the 1-2 cm range to 0.2-0.3 in the 5-6 cm range. Shawcross (1967:109, 120) used this data and a size frequency distribution for <u>pipi</u> from N43/33 (Terrell 1967:Fig. 15), to produce an overall meat weight shell weight ratio, but this seems needlessly complicated. If a size frequency distribution is available what could be simpler than using this and an experimentally derived relationship between shell length and meat weight to produce the estimate of meat weight directly, rather than via shell weight and meat weight/shell weight ratios?

All these factors point to the same conclusion: that 'weight of shell' should be abandoned as a method of quantifying shell midden.

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