THE SOLLBERGER DISTRIBUTION: Analysis and Application of a Tool Reduction Sequence

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On September 4, 1976, J. B. Sollberger gave a demonstration in the art of biface manufacture to the members of the STAA.[1] Recognizing this as a veritable gold mine of lithic information, we Collected the knapping debris from this exhibition for subsequent analysis. The purpose of this experimental study was primarily two-fold: (1) to study the distributional properties of lithic debris from the manufacture of one biface to detect what useful limitations can be placed on field screening, (1. e., what percent of analyzable information is being lost by use of the 1/4" or 1/8" mesh screen, and (2) to devise a standard against which the character of archaeological sites could be judged and the nature and extent of the major technological activity could be established.

For the purposes of this experiment, Mr. Sollberger agreed to divide the biface production process into what he considered to be discrete phases in the tool reduction sequence. He defined three basic stages in this reduction process. Briefly categorized the phases are:

Phase I Decortication and Preforming Phase. Nodule reduction. Hammer percussor (both hard hammer and large billet).
Phase II Shaping and Thinning Phase. Form determination. Soft Hammer percussor (small hard hammer and medium billet.
Phase III Sharpening Phase. Finishing and refining. Antler tine pressure-flaker.

During each production stage a. polyurethane tarp was employed to catch all the chipping debris. Following the completion of each phase the debris was retrieved, bagged and labeled for analysis.

Debris from each stage was passed successively through 1/4", 1/8" and 1/16" mesh screen. The fraCtion which did not pass through the 1/4" screen was then classified by size according to a progression of circles (Figure 1, c), each double the diameter of the preceding one, and in the smaller classes (5 to 7), the diameter of the circles corresponding to the diagonal of the screen apertures. Crystal sized particles and tiny fragments of flakes (from crystal size to 2.25mm) which simultaneously occur when flakes are detached were considered shatter and were not dealt with in this study. Flakes retrieved from the 1/4" screen were then coded by phase, class, platform end condition, material and terminal end condition. (The latter two categories were not directly involved in this analysis). In addition to the above classification procedure, the 1/8" and 1/16" fractions were examined for platform flakes and a count of these flakes was added for each phase. Data was then subjected to computer analysis of the distribution of platform flakes by phase and class. Since the goal was to investigate the amount of useful information lost in screening, only an analysis of the distributional pattern of platform flakes was undertaken due to the fact that they are considered to be most diagnostic of the amount of activity (i. e. , number of blows struck) and at the present state of the art are the most significant in analysis of lithic debris. The number of platform flakes in each class was calculated and plotted on a bar graph (Figure 2, a) and represents what we will call the Sollberger Distribution. Examination of this figure shows that 80% of the useful information as we define it is being lost in excavations which rely on 1/4" screening. With use of 1/8" screens, 40% of the total is lost. This 40% may sound worse than it is in reality. Platform flakes are recovered by 1/16"

mesh screen, but the percentage of platform flakes falls off sharply in the lower part of Class 6. Also, **a** large part of the platform flakes in the 1/8" to 1/16" range are probably simultaneous removals produced by the same blows that detached much larger flakes. So, as long as platforms and not shatter are considered important for analysis, the information lost through 1/8" mesh screens is negligible and there appears to be little utility in the use of the 1/16" sCreen, at least for lithic analysis. Although the degree of resolution desirable must be geared to the research goals of the project at hand, it would appear that an important element in defining site activity, particularly in the sharpening phase, is being ignored by use of the 1/4" screen and an effort should be made to recover these artifacts.

In a much broader aspect, the Sollberger Distribution is but a physical representation of what we will call the Phase Model of lithic tool manufacture (Figure 1, b). In brief, the model may be described as follows. The tool reduction sequence might be visualized as a succession of bell- shaped curves - each curve representing one phase in the sequence. Let the median point of each curve represent the ideal flake desired during that phase of production and the rest of the curve represent the normal distribution of flakes about that ideal. (The curve or phase represents, therefore, the ideal and variations from that ideal). For example, the ideal flake for Phase I - decortication - would be a substantially sized flake which would remove the maximum amount of cortex. Variations from that ideal will no doubt occur (flakes either too large or too small) and they represent the rest of the distribution for that phase. Phases II and ilL likewise are represented by bell-shaped curves, each with ideals for that phase (respectively, "medium-sized" thinning and "small" sharpening flakes) and variations from those ideals. The curve of Phase 11 necessarily overlaps those of Phase I and III because some further decortication and some initial sharpening will also occur in this phase.

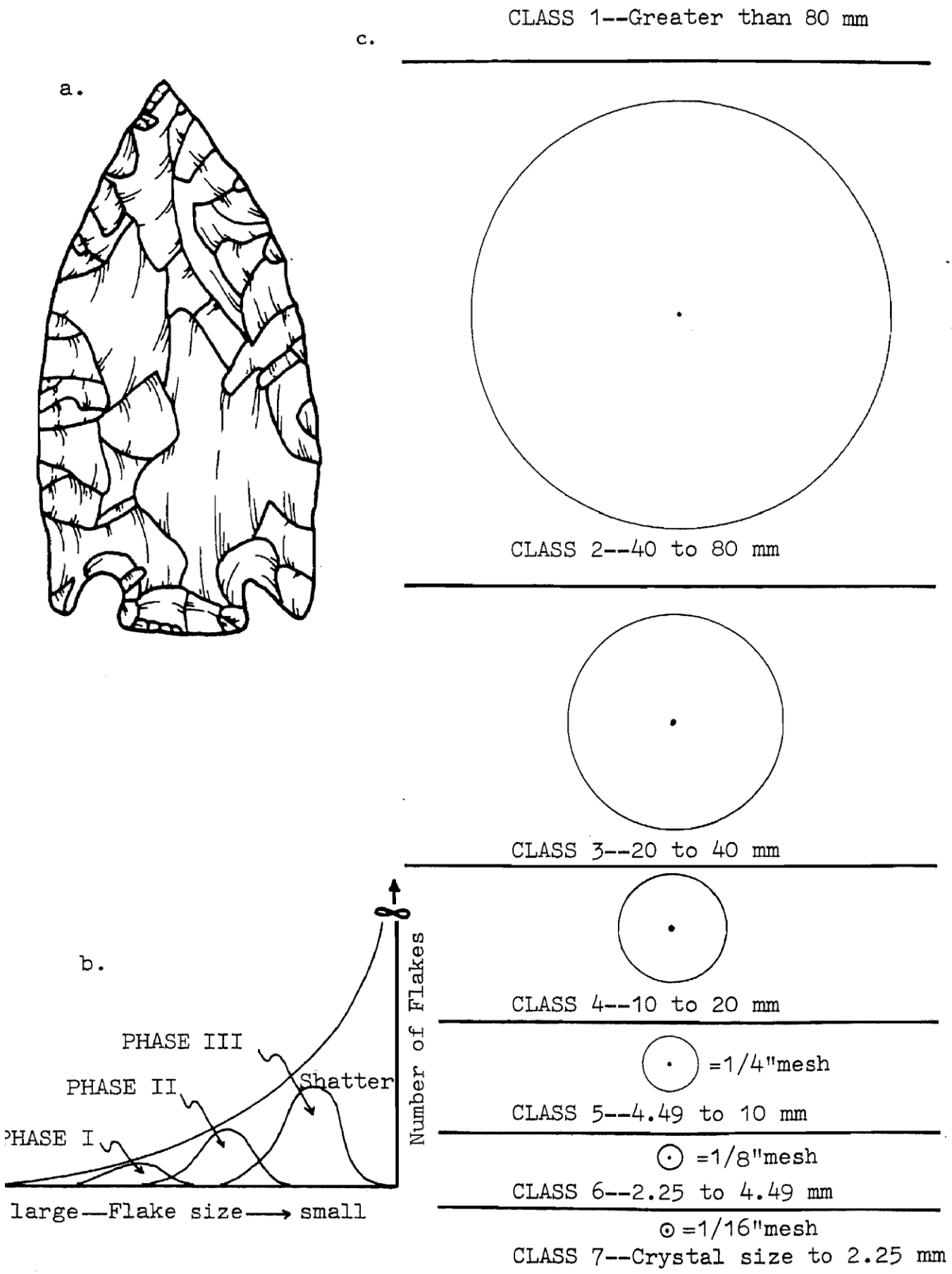

Figure 1. a.Sollberger's finished biface, b.Phase Model, c.Flake Class size measurement device.

In accordance with the model, the number of flakes from each phase would normally be grouped by classes (1. e., decortication in larger Classes 1, 2 and 3, thinning and shaping in middle Classes 3, 4 and 5, and sharpening in smaller Classes 4, 5 and 6) due to the faCt that normal variation from the ideal would be restricted to a certain range of fluctuation between classes. A clustering of flakes by classes may therefore be diagnostic of a phase in lithic production (Katz 1976: 114).

The model as portrayed is basically quantitative - number of flakes by class (this is not, of course, to say that qualitative aspects of flakes do not enter into the picture) - the curve is continuously rising and approaches infinity as the shatter approaches the crystalline grain size of the stone. The graph of the Sollberger Distribution would Conform to that of the total Phase Model in that it is a curve describing the entire range of phases in tool production.
Carrying the Phase Model to its practical application, if, as suggested, the number of flakes in particular classes may be considered indicative of a phase in lithic production, it seems reasonable that the number of flakes by class might also be used to infer the predominant type of lithic activity going on at an archaeological site. If the highest percentage of flakes from a site fall into the classes normally describing Phase I - decortication - for example, this early-rising curve would be characteristic of a quarry or workshop area where the greatest number of flakes fall into the decortication classes. A site whose flakes describe an intermediately rising curve, as in Phase II with the predominant number of flakes falling into the intermediate classes, might be indicative of an occupation area where both shaping and resharpening were occurring. Phase LII could best be described as a hunting camp where resharpening of tools was the dominant activity and would be displayed as a late-rising curve with debris concentrated in the smaller classes. (Incidentally, the amount of information available in this case would be dependent on screen size so that the high resolution of the 1/8" mesh would be desirable.)

Various aspects of the theory of flake propagation proposed above will be tested against the real life faCts of the debris from J. B. Sollberger's stone knapping demonstration in this section of the study.

The shapes of the distributions for the various Phases of Sollberger's knapping are shown in the bar graphs in Figure 2, b, c. d. If these distributions conformed to the model we suggested above, the distributions would be "bell-shaped" in outline and each successive bell-shape or phase would have a high point farther to the right than the previous phase as illustrated in Figure 1, b.

As can be seen, the real distributions start out on the left correctly in all cases. Each begins to rise successively farther to the right. Here the resemblance between theory and reality ceases. Rather than rising and then dropping off, all three curves continue to rise. This would have been expected if we had counted shatter and platforms together, but by counting only platforms we hoped to see a succession of bell-shaped distributions.

Faced with this discrepancy between theory and reality, we must ask ourselves where the problem lies. There are two possibilities. The first is that we are totally wrong about the processes which propagate flakes, and it is necessary to start again from scratch with a new model. The second possibility is that we are at least partly right and only need to add some further explanation to the model we already have.

Since the model fits part of the distribution, and since we have no new ideas at this time, we will attempt to patch up the battered old model and see if it will "fly" in a revised edition.

It is generally understood by flintknappers that when a flake is removed smaller flakes are simultaneously struck, mostly off the platform of the larger flake. It seems reasonable that these simultaneous removals would be much smaller than the main flake, probably measuring in the very small Classes 5 and 6, 2.25-10mm. What the ratio of main flakes to simultaneous flakes would be is conjectural at this point. Perhaps their numbers would be greater with larger flakes since a larger flake has a bigger platform for simultaneous flakes to come from. This additional process added to the existing model would explain the unexpected pile-up of flakes at the right end of the distribution curve.

If we assume the propagation of simultaneous flakes is a constant and exponential process, the effect of simultaneous propagation can be removed by a mathematical formula. We will not discuss the details of this formula here. This will be done in a subsequent publication (Gunn and Mahula 1977). We will, however, attempt to show the effect of its use.

The curved lines in Figure 2, b, c, d, show the Sollberger distributions with the effect of simultaneous propagation removed. These distributions conform in general to the theory. In order to test the simultaneous propagation aspect of the model, the experiment would have to be run again. Instead of collecting flakes after each phase, a collection would have to be made after each blow to determine what the empirical characteristics of simultaneous propagation are.

Finally, we will attempt to apply the Sollberger distribution to archaeological analysis. As was noted earlier, we hoped to refine our ability to define site function by determining exactly what kind of stone knapping was being done at a site. During the 1976 summer field season the UTSA Field School excavated a portion of the Hop Hill site (41 GL 127) in LBJ State Park near Stonewall, Texas. I. David Ing of Texas Parks and Wildlife suggested to us previous to the excavation that the locality was a multifunctional site with village, midden and quarry areas. We excavated

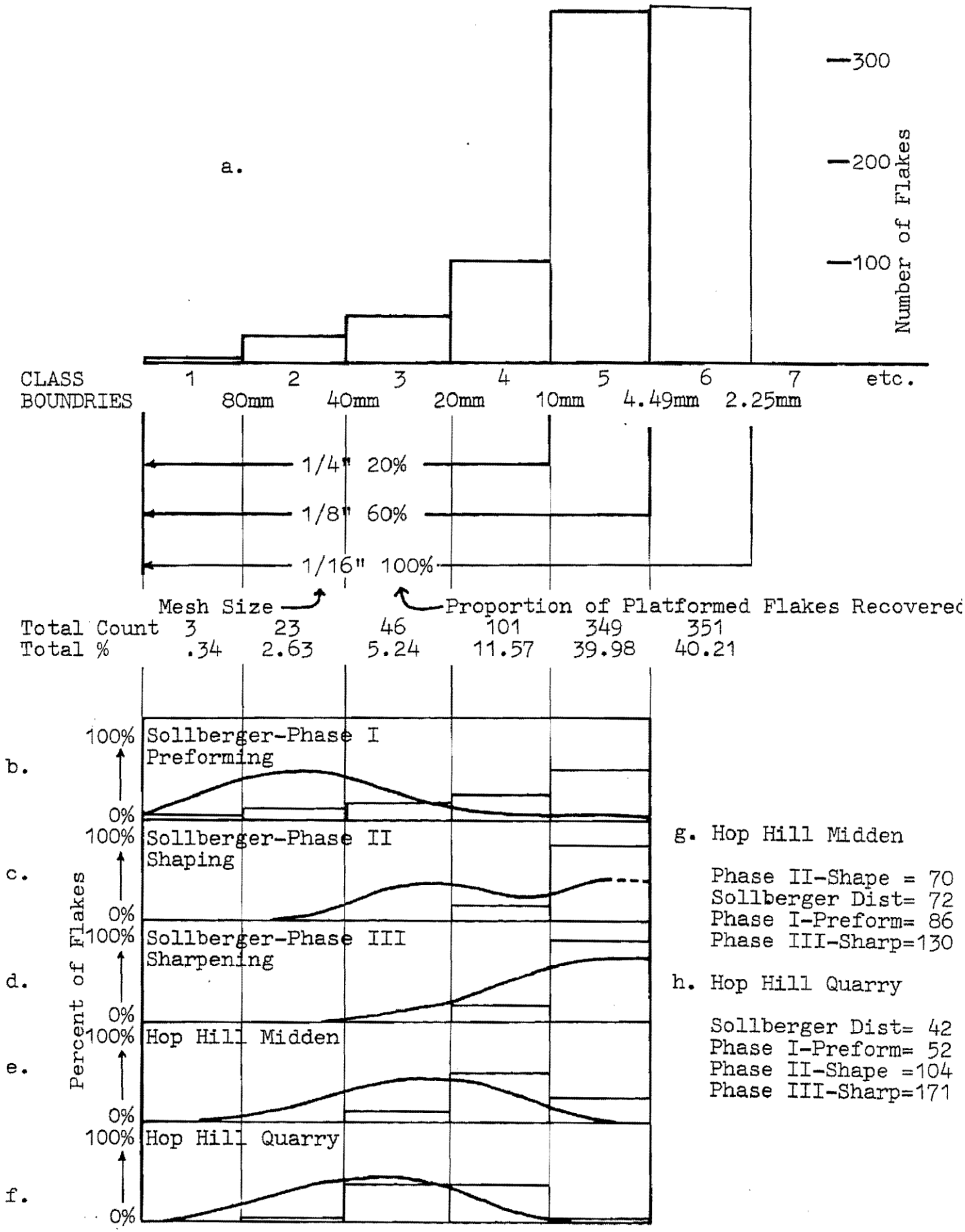

Figure 2. a. Overall Sollberger Distribution and recover by mesh size, b-f. untransformed(bar graph) and transformed(curve) Phase and site Dist. g-h. indexes.

in the proposed midden and quarry areas. The Sollberger Distributions could be used to test Ing 's hypothesis.

This was done by converting the exponentially transformed number of flakes from each size class to percentages and subtracting the midden and quarry distributions from the various phases of the Sollberger Distribution. These differences were then summed to give an index of similarity between phases and areas. The results of these calculations are shown in Figure 2, g, h. The index of similarity is to the right. The smaller it is, the more similar the area is to a phase of the Sollberger Distributions. Inspection of the curved lines will confirm the validity of the figures.

The comparisons show that the midden is most like Sollberger's Phase II - Shaping, while the quarry is most like Sollberger's overall distribution and Phase I - Preforming. Thus, the quarry area was the location of preforming and s ome general, all-around knapping. In the midden, which is located on the hill above the quarry, preforms were apparently shaped into tools as is suggested by the strong relationship to Phase II - Shaping. Thus, the evidence drawn from a replicative experiment supports the hypothesized functions for the two areas of Hop Hill. More could be learned from a more detailed examination of the relationships in Figure g, h, by statistical treatment of the analysis. We hope that the work presented here will serve to demonstrate the basic utility of the Sollberger Distribution.

Bibliography

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1 The biface was knapped from a chert nodule *approximately 7"x 4"x 2"*.