

OVATE AND POINTED HANDAXE ASSEMBLAGES : TWO POINTS MAKE A LINE

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INTRODUCTION

While variation in western European handaxe morphology has been well documented for over a century, the behavioral significance of this variation is still unclear. In Great Britain, Roe's (1964, 1968) study of 38 handaxe assemblages has structured the debate for the last three decades. In his study, Roe found two basic assemblage types : one characterized by ovate forms and the other by pointed handaxes. This finding has been independently confirmed with various statistical techniques (DORAN and HODSON 1975; CALLOW 1976). An explanation of this variability, however, is still lacking. Roe (1968) originally posited that it might have chronological significance. At the time this suggestion could hardly be confirmed or denied given the lack of well dated assemblages or sites with stratigraphic sequences incorporating assemblages of both handaxe types. Recent work, however, has made the chronological position untenable (cf. ASHTON *et al.* 1992). Thus, Roe (1981) has also suggested that function or cultural traditions may account for the differences, but this too remains to be substantiated.

New studies of these British handaxes have explicitly de-emphasized the importance of traditional stylistic and functional modes of explanation and instead focused on the role of raw materials (ASHTON and MCNABB 1994; WHITE 1995) and intensity of bifacial reduction (McPHERRON 1994, 1995) in structuring these assemblages. Ashton and McNabb (1994) argue that the shape of the nodule or flake blank has an important and previously understated role in determining handaxe shape. Thick, long and narrow nodules, for instance, lend themselves more easily to pointed forms than rounded forms. On the

other hand, in instances where the raw material is judged to be more neutral, lending itself equally to an ovate or pointed form, ovates seem to have been manufactured. As a result, both Ashton and McNabb (1994) and White (1995) argue that ovate was the preferred handaxe shape, presumably because it maximized the functional utility of the piece. To the contrary, Jones (1994) argues that pointed, elongated forms are preferable since they maximize the ratio of the length of the edge to the weight of the handaxe.

The concept of a preferred shape, however, needs to be reexamined. In particular, the idea that handaxes recovered from the archaeological record represent preferred shapes goes against three decades of research that demonstrates that stone tools often enter the record exactly because they are no longer preferred. Jelinek (1976, 1977) calls this the "Frison effect" after Frison's (1968) demonstration of these principles at a Paleoindian bison butchering site in Wyoming. Similarly, Davidson and Noble (1993; DAVIDSON 1991) call this the "finished artefact fallacy" wherein the final form a tool takes is thought to be the only form it may have had. It is quite likely that an artifact may have gone through a succession of forms before entering the archaeological record. Moreover, it is even possible that the form was secondary to the process. Davidson and Noble (1993), for instance, suggest that handaxes were cores and not shaped tools. Similarly, Hayden (1987, 1989) focuses on the creation of a bifacial edge rather than a handaxe of a particular shape.

While there are a number of ways to operationalize this approach, one of the more productive is based on the lithic reduction process beginning with the selection of suitable raw materials and continuing through to the production of tool blanks and

retouched tools which are used and eventually discarded into the archaeological record. This approach differs most fundamentally from the traditional normative one in the extent to which it de-emphasizes an artifact's final form. Instead, the focus is shifted to the process of lithic reduction and to the lithic reduction strategies employed in the past.

One aspect of the reduction process which has received considerable attention is tool resharpening, rejuvenation and reuse. These studies, which focus on process, are particularly interesting in that their results often directly impinge on traditional typologies, which focus solely on artifact form. A number of studies on various types of stone tools from the New and Old World have shown that tool morphology is often the product of a very complex reduction strategy involving numerous stages of resharpening and rejuvenation. At different stages in the reduction process the tool may have very different forms, some of which may be recognized by archaeologists as completely different tool types (BAUMLER 1988; CAHEN *et al.* 1979; DIBBLE 1984, 1987a, 1987b, 1995; FLENNIKEN and RAYMOND 1986; FRISON 1968; GALLAGHER 1977; GOODYEAR 1974; GOULD *et al.* 1971; HAYDEN 1977, 1979; HOFFMAN 1985; HOLDAWAY 1991; HOLDAWAY *et al.* 1996; JONES 1994; VERJUX 1988).

Elsewhere, I (McPHERRON 1995) argue that a model of bifacial reduction can account for a large part of the assemblage level variability in handaxe shape as documented by Roe. I use his published data to show that the morphological variability in all of his 38 handaxe assemblages, Ovate and Pointed, can be neatly organized along a single variable, namely tip length, which is interpreted as measuring changes in raw material size and reduction intensity. Because this article relied on Roe's published data, it was limited to assemblage averages and inter-assemblage variability. The present article uses new data from two sites in northern France to demonstrate how the model works both within and between assemblages. It will be shown that with the reduction model, the handaxes of two very different assemblages, one composed almost exclusively of ovates and the other of more pointed forms, represent stages in a single

reduction path from large pointed handaxes to small ovate ones.

A REDUCTION MODEL FOR ACHEULIAN HANDAXES

The three principle axes of morphological variability a reduction model must address are elongation, refinement and edge shape since they are the foundation of both Bordes' (1961) and Roe's (1964, 1968) typologies. Elongation is the ratio of the length to the width (Figure 1) such that high values indicate more elongated handaxes. Refinement is the ratio of the width to the thickness such that relatively thin handaxes have high values. Edge shape has been quantified in a number of ways (cf. WYNN and TIERSON 1990), but Roe and Bordes take essentially the same approach. Bordes mathematically combines two ratios to produce edge shape types : 1) the width at the midpoint relative to the maximum width and 2) the location of the maximum width relative to the length of the handaxe. Similarly, Roe uses a graphical approach that combines elongation with two ratios : 1) the width near the tip relative to the width near the base and 2) the location of the maximum width relative to the length of the handaxe. The second ratio in each case is the same, and the first ratio differs only in where the widths are recorded. Thus, in the discussion that follows, Bordes' edge shape ratio refers to the formula shown in Figure 1. Since Roe did not mathematically combine his ratios, they will be considered separately, but Roe's edge shape ratio is used here to refer to Roe's first ratio.

In order to model the effect of the bifacial reduction process on these aspects of shape, a measure of reduction intensity is required. The best measure would relate original nodule or blank size to the actual handaxe size. Dibble, for instance, approaches this issue for flake scrapers by correlating platform measurements to original blank size (DIBBLE 1984, 1987a, 1987b; DIBBLE and WHITTAKER 1981). This particular approach, of course, is not possible with most handaxes since there is no remaining part of the nodule that can be used to estimate its original size. Dibble also looks at scraper retouch intensity, and Hoffman (1985) uses blade edge angles which have

been shown to decrease with resharpening. While these types of observations could be applied to Acheulian handaxes on occasion, most times they could not.

Within an assemblage, the issue of how to measure reduction intensity is addressed with a simplifying assumption, namely that if raw material size and shape are constant, then handaxe size alone reflects the degree to which it has been reduced. This assumption is often made for cores. Clearly it will be violated to varying degrees in actual assemblages (PETRAGLIA *et al.* 1999), thereby introducing a certain level of noise or unexplained variability into the results. In assemblages with partially cortical handaxes, this assumption can be tested with another measure of reduction intensity. If raw material size is roughly constant, then the percentage of cortex remaining on the handaxe should also correlate with the intensity of reduction and, therefore, with the size of the handaxe. Two handaxes with 50 percent cortex, for instance, should be roughly the same size if they were manufactured from nodules of the same size.

There are relatively few instances where absolute size has been incorporated into a model to explain handaxe shape. The traditional, typological approach attributes variability in size to some combination of raw material constraints, the level of bifacial reduction and the number of resharpening or rejuvenation episodes; whereas, variability in shape is attributed to culturally defined differences in shape preferences or perhaps tolerable variability within a single culturally defined shape preference or mental template. Importantly, the traditional, typological approach assumes that the factors that affect size are independent of shape. Increased bifacial reduction or small nodules, for instance, are assumed to have little effect on elongation, refinement or edge shape since these latter aspects are thought to be culturally determined and can be arbitrarily imposed on nodules of virtually any size or shape.

To the contrary, there are now several studies that show a relationship between size and shape in Paleolithic handaxes (CROMPTON and GOWLETT 1993; GOWLETT and CROMPTON 1994; McPHERSON 1994, 1995). By explicitly linking these two attributes, a reduction

model emphasizing the process of producing a bifacial edge (HAYDEN 1987, 1989) rather than achieving a handaxe of a particular shape can offer an explanation of why this might be the case. This model assumes that a handaxe edge, once made, would then be reused and reworked repeatedly before the handaxe was eventually abandoned. Repeatedly resharpening or reworking a handaxe edge will obviously diminish its size. However, depending on the goals of the reduction strategy, measures of size such as length, width and thickness may be affected differentially as overall size decreases. For instance, if maintaining a consistent shape is important, then care must be given to reducing length, width, thickness and the relative size of the tip and base at a constant rate. On the other hand, if factors such as the length of the bifacial edge and the edge angle are important (JONES 1994), then these measures may decrease at very different rates. As a result, shape, as measured by elongation, refinement and edge shape, will change as a function of reduction intensity.

How exactly shape might vary with the reduction intensity obviously depends on the reduction strategy. Handaxes made from flake blanks, for instance, may follow a different pattern than those made from nodules, and certainly the two technologies should be considered separately where possible. Nevertheless, given the striking similarity of handaxes across the Middle Pleistocene, there are undoubtedly general principles structuring the reduction process. Jones (1994), for instance, argues that, given the need to minimize weight while maximizing useable edge, elongated, pointed shapes are optimal. Thus in the early stages of reduction, handaxes will be elongated and pointed (Figure 2a). At this point refinement will be largely influenced by the shape of the flake blank or nodule from which the handaxe is made. In the case of a handaxe made from a nodule, where the base of the handaxe is still partially cortical, refinement will be quite low.

Regardless of whether they are made from flake blanks or nodules, as the handaxe tip is formed and then reworked, tip length, length and width will decrease. Almost certainly, these variables will decrease at different rates, thereby changing the elongation of the handaxe. In the model presented here, length variables decrease

more quickly than width and thus the handaxe becomes less elongated (cf. BRADLEY 1974). As Jones (1994) notes, there are good technological reasons why elongation should decrease or at least remain constant since highly elongated pieces are subject to end-shock breaks. Of the length variables, tip length in particular will have to decrease if there is a constraint on retaining some sort of base (CROMPTON and GOWLETT 1993 : 196), possibly for prehension. But as tip length decreases, the length of the workable edge decreases quickly unless the base is incorporated into the edge (Figure 2b). At this point traces of the original nodule or blank are nearly completely gone and the refinement is reflective of the bifacial thinning technology. After further reduction, the tip and the base are almost indistinguishable (Figure 2c), thus the tip length will equal the base length and the overall length will approach the width. At this point, the handaxe is clearly neither elongated or pointed. Refinement will generally stay constant, though at some point it becomes difficult to continue thinning the handaxe and the refinement ratio will begin to decrease (HOFFMAN 1985; JONES 1994).

TESTING THE REDUCTION MODEL

A number of testable implications regarding shape and intensity of reduction are easily derived for both the traditional typological approach and the alternative reduction model just outlined. Though intensity of reduction can be generally quantified with size measures and the percentage of remaining cortex, the reduction model outlined here focuses primarily on the changes in shape that occur when the tip is reworked. Thus tip length will be the primary measure of reduction intensity. In the traditional model, elongation, refinement and edge shape will vary independently of tip length. On the other hand, the reduction model predicts that elongation and edge shape will vary directly with reduction intensity as measured by tip length. In these instances, a simple regression analysis between tip length and shape should yield a significant result if the reduction model is accurate and a non-significant result if the traditional model is accurate. In the case of refinement, however, the test is more

difficult since the reduction model predicts that refinement will at first rise, then follow a period of relative stability, and begin to decrease only in the final stages. From the perspective of regression analysis, an assemblage representing all stages of reduction or only the middle stage will look exactly like a traditional assemblage where there is no relationship between reduction intensity and shape. It is expected, therefore, that the reduction model of refinement will only work with very lightly or heavily reduced assemblages and that these two types of assemblages will differ in the direction of the relationship.

To test the reduction model and to demonstrate its implication for Roe's assemblage types, two very different handaxe assemblages from northern France are considered : Gouzeaucourt and Cagny-la-Garenne (Figure 3).

The classic Acheulian site of Cagny-la-Garenne is located in the Somme Valley of northern France. The site, located in a quarry exploited between the years 1916 and 1959, yielded a substantial number of handaxes and flake tools. The industries are best known from two large, intact collections : the Kelly collection and the Bordes-Fitte collection. The latter, which at the time of this study was stored at the Institut du Quaternaire in Bordeaux, is considered here. The principal problem with the Bordes-Fitte collection is that the exact stratigraphic provenience of the artifacts is unknown. Most of the Cagny-la-Garenne artifacts, however, seem to have come from the fluvial levels near the base of the terrace. While reliable absolute dates are not yet available for these layers, the relative stratigraphic position of the Cagny-la-Garenne levels vis-à-vis the Somme valley terraces has been well studied over the course of this century. The fluvial levels are now dated to the Middle Terrace II. In the current view of terrace formation, the Middle Terrace II is more than four glacial cycles before the present (ANTOINE 1990; TUFFREAU *et al.* 1982; TUFFREAU 1987 : 455), which would mean that it dates to at least oxygen isotope stages 11 and 12 (HAESAERTS and DUPUIS 1986).

Gouzeaucourt (TUFFREAU and BOUCHET 1985; TUFFREAU 1987) is also located in northern France about 50 kilometers northeast of Cagny-la-Garenne. Recent

excavations have revealed an extremely rich site with a series of stratified archaeological levels. The assemblage considered here is from Level H which comes from a loessic deposit approximately one meter thick. Radiometric dates for this deposit are not available, nor is the geological date for its formation certain. Based on geological analysis, however, Tuffreau (1987 : 324-327) suggests that Level H could not date to later than Stage 8 and could be earlier.

The Gouzeaucourt and Cagny-la-Garenne handaxes are quite dissimilar. First, in terms of typology, the Cagny-la-Garenne assemblage is characterized by thicker, more elongated and more pointed types than Gouzeaucourt (Table 1). There are also more types represented in the Cagny-la-Garenne assemblage. While there are hundreds of handaxes from Gouzeaucourt, the forms, technologies and sizes are repetitive and narrowly defined. Second, another way to show the differences in form is with the shape ratios (Table 2). The two assemblages are statistically distinct in terms of elongation, refinement and edge shape (as defined by Bordes and Roe). The Cagny-la-Garenne handaxes are more elongated, less refined and more pointed than the Gouzeaucourt handaxes. Third, the handaxes of Cagny-la-Garenne are significantly larger than the handaxes of Gouzeaucourt in terms of length, width at the midpoint, maximum width, maximum thickness, base length and tip length (Table 3). Fourth, based on cortex, the Cagny-la-Garenne handaxes are less reduced than the Gouzeaucourt handaxes. Most of the Cagny-la-Garenne handaxes retain some cortex (Table 4), and quite often a nearly fully cortical, globular base is retained. The Cagny-la-Garenne handaxes are seldom retouched around the entire edge. As a result, in most instances it could be positively affirmed that the handaxes were made from large nodules. In addition, when the Cagny-la-Garenne handaxes are arranged by the percentage of cortex, decreasing size (as measured by length) and increased reduction intensity (as measured by decreasing tip lengths) clearly parallel the removal of cortex from the nodules (Table 5). This suggests that handaxe production began with similar size nodules. The Gouzeaucourt handaxes, on the other hand, typically have no remaining cortex. The handaxes often have the appearance of being made on flakes, but in the vast majority of cases, bifacial flaking

across the entire surface and around the entire edge has removed any unmistakable sign of a flake blank.

Following Roe's classification scheme the two assemblages are also quite different (Table 6). Gouzeaucourt is easy to classify as part of the Ovate Tradition, given that fully 90% of its handaxes are classified as ovate based on the relative location of the maximum width. In fact, this percentage exceeds all of Roe's 38 British handaxe assemblages. The Cagny-la-Garenne assemblage, on the other hand, is more intermediate or "generalized" (in Roe's terminology) since it has a roughly equal percentage of ovate and pointed forms. In contrast to Gouzeaucourt, Cagny-la-Garenne's handaxes appear pointed, but slightly more of the handaxes are ovate than pointed, and the assemblage average (see Table 3) for Roe's key index is just slightly above the 0.35 cut-off for the Ovate Tradition. Thus while the two assemblages can be classified as Ovate, they are at opposite ends of the range encompassed by this term.

Despite all of these differences, when the two assemblages are considered with respect to reduction intensity they show very similar patterns. In both assemblages, there is a statistically significant relationship between tip length and three measures of shape : elongation, refinement and edge shape (Table 7). With elongation and edge shape, there is a positive correlation meaning that as tip length decreases, the handaxes become less elongated and less pointed. In the case of refinement, the relationship moves in different directions. With the Cagny-la-Garenne handaxes, the correlation is negative meaning that as tip length decreases, refinement increases. To the contrary, at Gouzeaucourt the refinement decreases with the tip length. According to the reduction model, the Gouzeaucourt pattern for refinement is indicative of a highly reduced assemblage where it is no longer possible to continue thinning the handaxes, and, where in fact, the handaxes become progressively thicker as the edges are reworked. The Cagny-la-Garenne handaxes are indicative of the early to middle stages of reduction where refinement increases as more of the nodule is worked and less of the nodule's original shape is retained.

The similarity between these two assemblages from the reduction perspective is even more striking when the individual handaxes are plotted against the shape ratios (Figures 4, 5, 6, 7 and 8). In each instance, the handaxes of Cagny-la-Garenne grade directly into the handaxes of Gouzeaucourt. In other words, Gouzeaucourt handaxes look like heavily reduced Cagny-la-Garenne handaxes.

DISCUSSION

There are other lines of evidence that support the reduction model interpretation of the differences between Gouzeaucourt and Cagny-la-Garenne. If we accept Rolland and Dibble's (1990; DIBBLE and ROLLAND 1992) model of assemblage variability, then the flake tool components at these sites also support the model. According to Rolland and Dibble, assemblages characterized by relatively few retouched tools and few scrapers in particular represent lightly utilized assemblages with low reduction intensities. On the other hand, assemblages with many retouched tools and high percentages of scrapers represent heavily utilized assemblages. At Cagny-la-Garenne there are very few retouched tools in general and, of the retouched component, notches and denticulates are by far the most common (TUFFREAU 1987). There are very few scrapers and fewer still of what Dibble (1984, 1987a, 1987b) calls "reduced forms" (such as convergent and transverse scrapers or multiply-retouched tools). This is despite the fact that these artifacts were collected under conditions that undoubtedly would have favored scrapers over notched tools given the excavator biases that were common at that time. More recent excavation at Cagny-la-Garenne and at the nearby site of Cagny-l'EpINETTE (TUFFREAU *et al.* 1995; DIBBLE *et al.* 1997) confirm this pattern. In contrast, Gouzeaucourt is notable in the region for a relatively high number of retouched tools associated with a handaxe industry. In addition to notches and denticulates, there are a fair number of scrapers including some reduced types and bifacially retouched scrapers (TUFFREAU and BOUCHET 1985; MARCY 1989). At Gouzeaucourt there are also a large number of pieces that straddle the typological lines between scrapers, cores and handaxes (TUFFREAU and BOUCHET 1985).

Particularly interesting in this regard are a number of handaxes with large flake removals suggestive of the Levallois technique (LAMOTTE 1992 : 38); these pieces indicate a willingness to reuse artifacts and therefore may reflect a certain level of flexibility in the reduction process that may derive from raw material stress.

In this regard it is important to note that there are no obvious sources of raw material in the loess deposits of Gouzeaucourt, whereas large nodules of flint are found in abundance in the terrace gravels of Cagny-la-Garenne. Similarly White's (1995) data show a correlation between the distance to raw material sources and shape. Sites located on gravel terraces seem to be dominated by pointed forms, while sites without an apparent, immediately available raw material source tend to be dominated by more ovate forms. Furthermore, his analysis indicates that often where ovate handaxes are found in association with pointed handaxes made from terrace gravels, the ovates have been transported into the site. This would seem to suggest that ovates were simply the more reduced forms and not necessarily the preferred forms.

If the reduction model is correct, then two very different handaxe assemblages, one that Roe would classify as part of the Ovate Tradition and another that straddles the line between Ovate and Pointed, can be shown to be part of a single bifacial reduction strategy. In other words, the handaxe shapes found in each of these assemblages cannot be viewed as preferred forms. Rather, there was a preferred bifacial reduction strategy that resulted in a range of forms depending on the intensity of reduction and the size of the original nodules. This is particularly apparent where the handaxes of the two assemblages overlap (see Figures 4, 5, 6, 7 and 8). The more reduced handaxes from Cagny-la-Garenne are identical to the less reduced handaxes of Gouzeaucourt, and the reduction trajectory followed at Cagny-la-Garenne leads directly to Gouzeaucourt handaxes. It is worth noting that this trajectory has at times been interpreted as representing chronological stages in the advancement of handaxe manufacturing techniques (BORDES 1984; BAR-YOSEF 1994). In this regard, Cagny-la-Garenne is considered a classic Acheulian site, but Gouzeaucourt, with its small, ovate handaxes and developed flake tool industry,

has been classified as a variant of the Mousterian (AMELOOT-VAN DER HEIJDEN 1991). Thus we move from early crude, pointed handaxes with cortical bases and few flake removals to well made ovates and cordiforms that lack cortex entirely.

Jones (1994), working with Bed IV Olduvai materials, found a similar pattern. He found that some of the differences between Developed Oldowan and Acheulian handaxes could be explained by resharpening reduction. Experiments on typical Acheulian handaxes showed that after three or four resharpening episodes the artifact could be classified as a typical Developed Oldowan handaxe. Thus the Acheulian and Developed Oldowan handaxes likewise represent two stages in the use-life of a single tool.

It is important to note that the reduction model works at Cagny-la-Garenne despite the potentially poor integrity of the assemblage. Mixed assemblages from secondary or derived context should bias the results in favor of the traditional model over the reduction model since the latter assumes that factors such as variability in raw materials are held constant within an assemblage. Clearly, when two or more discrete assemblages are brought together, this assumption will likely be violated to a larger degree. The fact that the reduction model nevertheless works with Cagny-la-Garenne, that it works with the 38 assemblages published by Roe (McPHERRON 1995), many of which have collection and curation histories similar to Cagny-la-Garenne's, and that it works with assemblage averages collected from throughout the Old World (McPHERRON 2000) speaks to the robustness of the model.

CONCLUSION

It is well known that handaxe forms grade into one another. This is essentially the reason why handaxe typologies are based on *arbitrary* cut-offs of various shape ratios. It is also fairly well-known that despite a simple characterization of Pointed and Ovate Traditions, assemblages as a whole also grade into one another. Using the 38 British assemblages as a sample, for instance, plot any of the standard shape ratios, including Roe's critical relative location of the

maximum width, with means and standard error bars, and it is impossible to draw a line separating one group from another. Ovate assemblages typically include some pointed forms and Pointed assemblages generally include ovate forms. Likewise, this paper shows how the handaxes of Cagny-la-Garenne and Gouzeaucourt grade into one another. However, here and elsewhere (McPHERRON 1994, 1995, 2000) it has been shown that handaxes grade into one another along a single axis that can best be interpreted as reflecting the intensity of bifacial reduction. Thus it seems likely that Roe's assemblage types represent two points on a single line. In this context it becomes nonsensical to speak of the ideal shape or preferred form. Rather, there was a preferred method that resulted in a range of forms. In this light, the suggestion that ovates were preferred over pointed handaxes is a bit like suggesting that a pencil sharpened all the way down to within an inch of its eraser is preferable to a fresh one. The fact that Ovate assemblages outnumber Pointed ones in Roe's original sample by nearly 2 to 1 is not indicative of a preference but of the simple rule that artifacts tend to enter the archaeological record towards the end of their use lives.

If the reduction model is correct, Acheulian variability cannot be addressed by simply comparing average handaxe morphology between sites. If shape is a function of the raw materials and the intensity of reduction, it is more important to compare reduction strategies instead. In other words, to answer the larger questions about the meaning of Acheulian variability, we must look for similarities and dissimilarities in process and not in final form.

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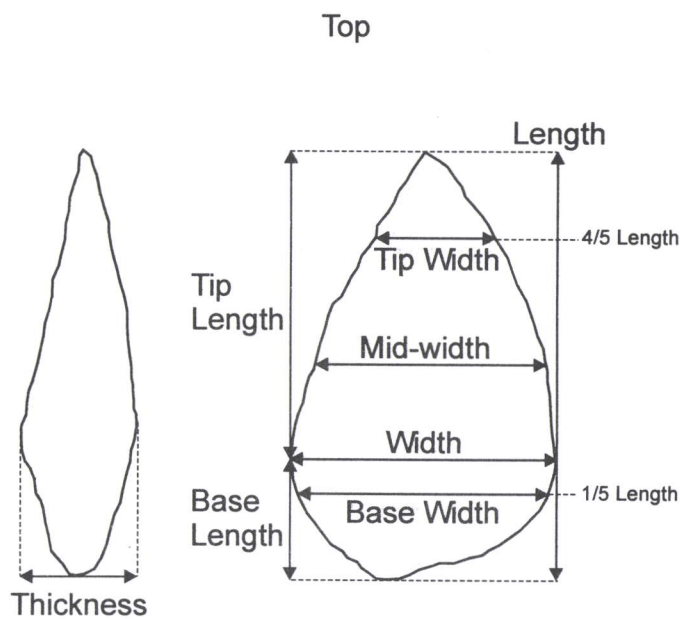
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Bordes

Elongation = Length / Width

Refinement = Width / Thickness

Edge Shape = (Length / Base Length) - (4.575 * (Midwidth / Width))

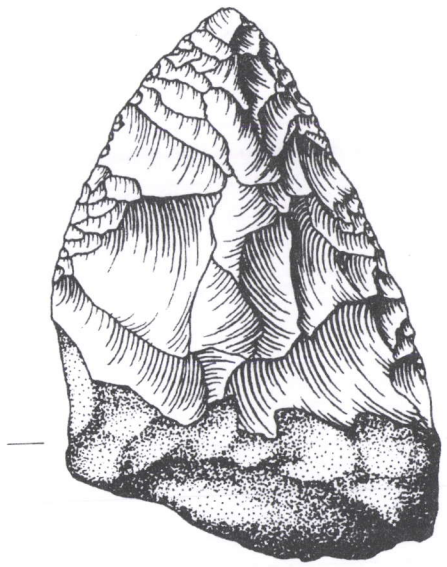
Roe

Elongation = Width / Length

Refinement = Thickness / Width

Edge Shape = Tip Width / Base Width and
Base Length / Length

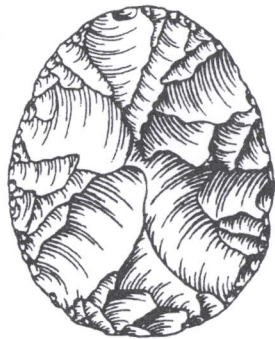
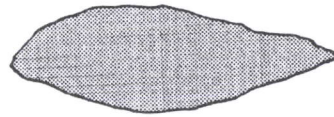
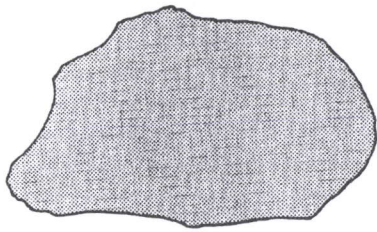
Figure 1
Shannon Patrick McPherron



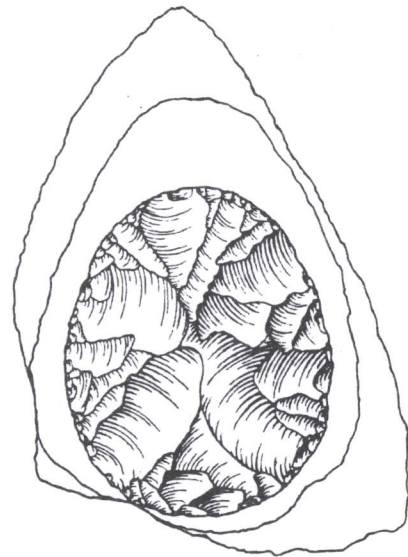
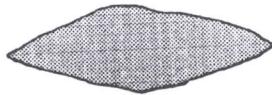
a)



b)



c)



d)

Figure 2
Shannon Patrick McPherron

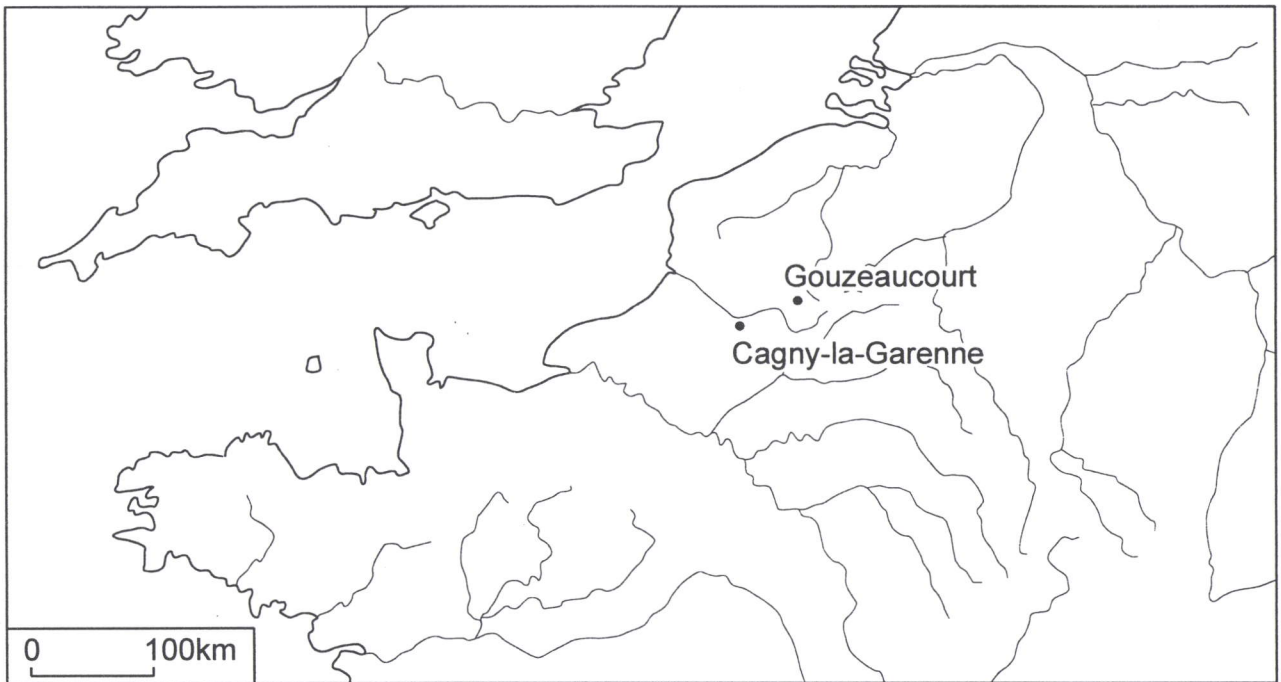


Figure 3
Shannon Patrick McPherron

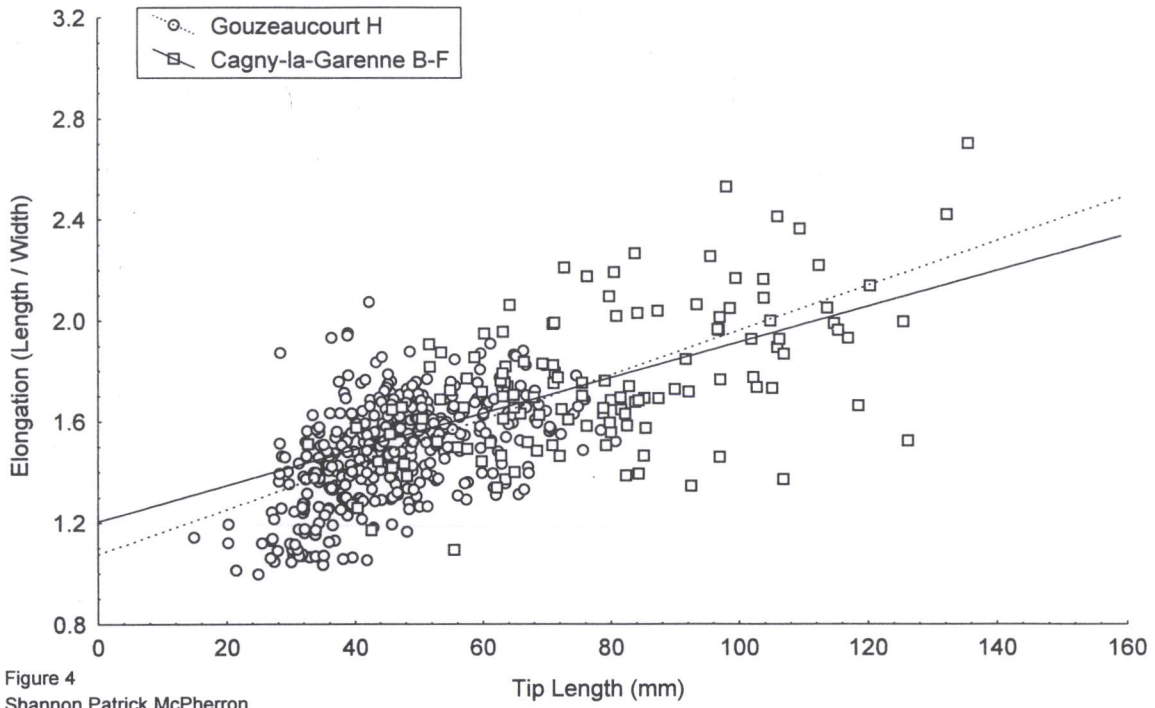


Figure 4
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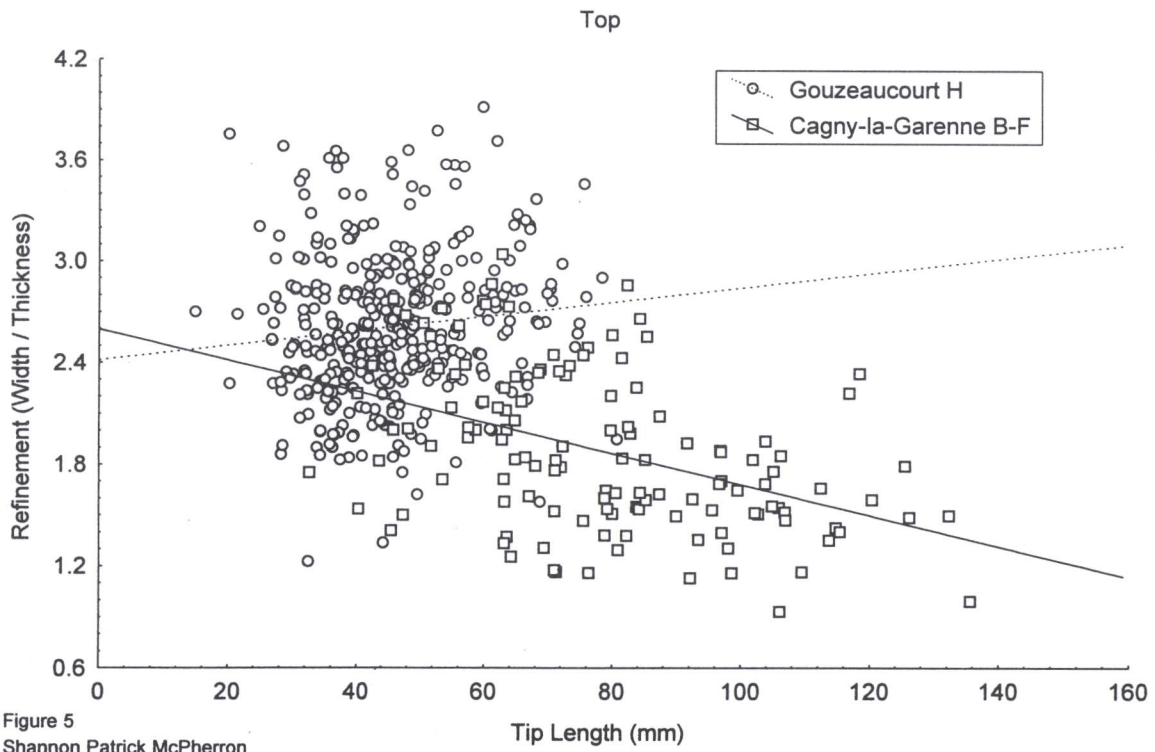


Figure 5
Shannon Patrick McPherron

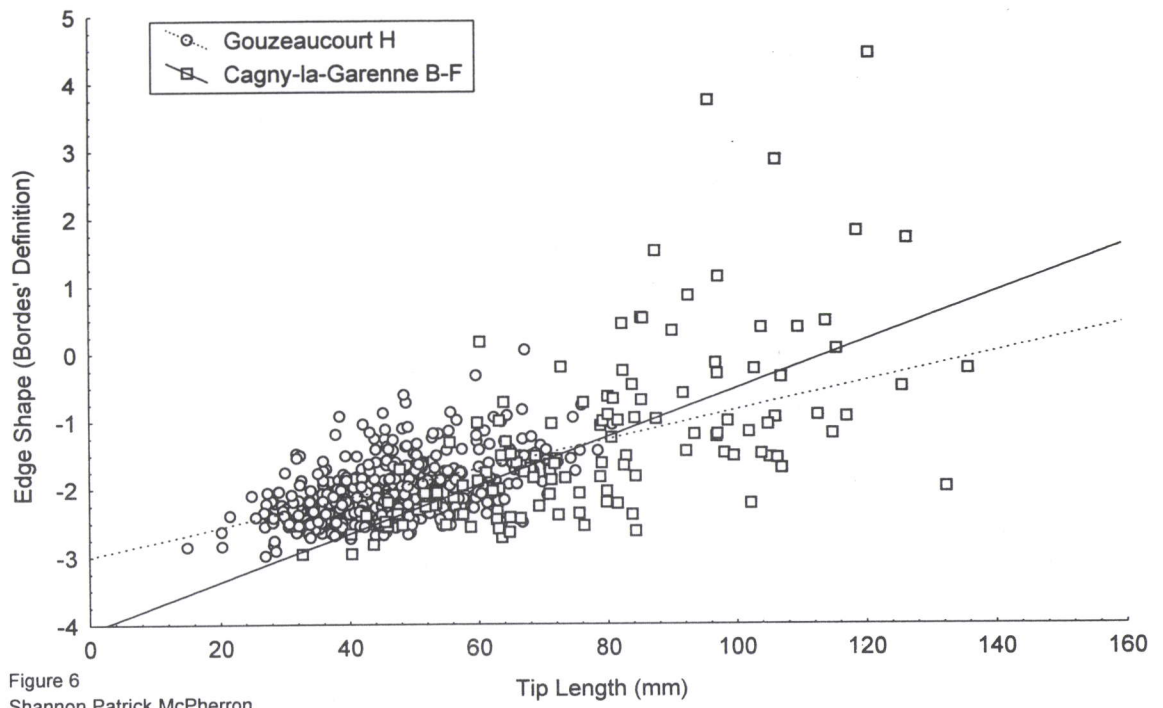


Figure 6
Shannon Patrick McPherron

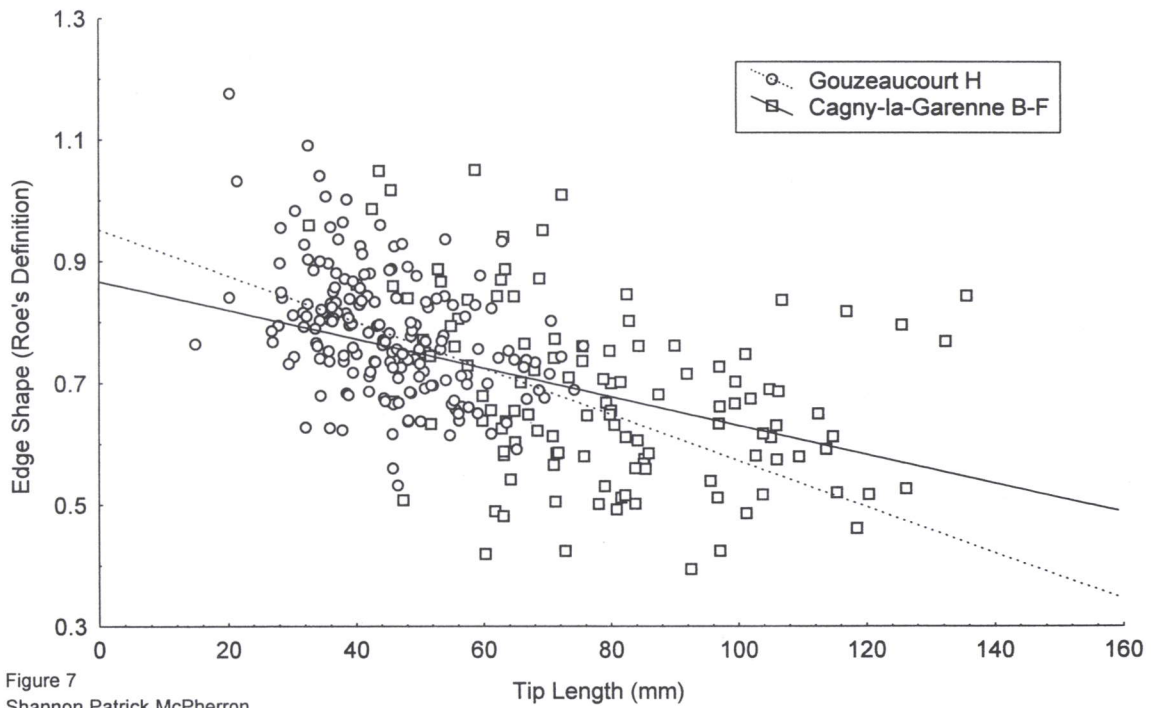


Figure 7
Shannon Patrick McPherron

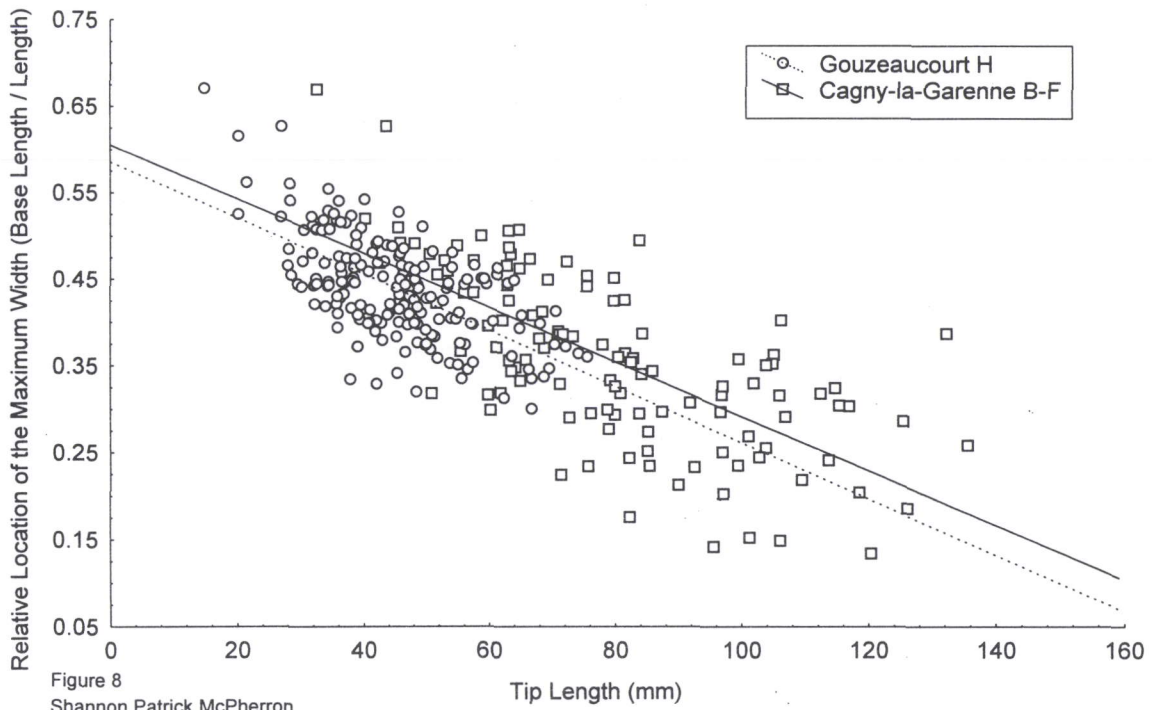


Figure 8
Shannon Patrick McPherron

Tables : Table 1. Comparison of handaxe types between Gouzeaucourt Level H and Cagny-la-Garenne. The types listed here follow Callow's (1976) system for classifying shapes which is based on Bordes (1961). Table 2. Comparison of handaxe size between Gouzeaucourt Level H and Cagny-la-Garenne. See Figure 1 for an explanation of how these measurements are recorded. Table 3. Comparison of handaxe shape between Gouzeaucourt Level H and Cagny-la-Garenne. See the text for an explanation of how these aspects of shape are quantified. 1Relative location of the maximum width or base length / length. This is Roe's index for determining whether a handaxe is classified as pointed, ovate or a cleaver. Table 4. Percentage of cortex on handaxes from Gouzeaucourt Level H and Cagny-la-Garenne. Table 5. Mean length and tip length by percentage of cortex categories for the Cagny-la-Garenne handaxe assemblage. Table 6. Gouzeaucourt Level H and Cagny-la-Garenne classified according to Roe's index for determining Ovate and Pointed assemblages. Roe's index, abbreviated here as RLMW, quantifies the relative location of the maximum width as the base length / length. Handaxes with values not exceeding 0.35 are classified as pointed. Values greater than 0.35 but not exceeding 0.55 represent ovate handaxes. The rest, where the maximum width is closer to the tip than the base, are classified as cleavers. Table 7. Relationship between tip length and handaxe shape. See the text for an explanation of how these aspects of shape are quantified. 1Relative location of the maximum width or base length / length. This is Roe's index for determining whether a handaxe is classified as pointed, ovate or a cleaver. Figures Figure 1. The handaxe measurements used by Bordes and Roe to calculate elongation, refinement and edge shape. Figure 2. A single handaxe in various stages of reduction from a) just roughed out, to b) a classic pointed handaxe and to c) a classic ovate handaxe. d) shows the outlines of each stage superimposed on one-another. Figure 3. The location of Cagny-la-Garenne and Gouzeaucourt. Figure 4. Elongation to tip length for Cagny-la-Garenne and Gouzeaucourt with regression lines for each. Figure 5. Refinement to tip length for Cagny-la-Garenne and Gouzeaucourt with regression lines for each. Figure 6. Edge shape (Bordes) to tip length for Cagny-la-Garenne and Gouzeaucourt with regression lines for each. Figure 7. Edge shape (Roe) to tip length for Cagny-la-Garenne and Gouzeaucourt with regression lines for each. Figure 8. The relative location of the maximum width to tip length for Cagny-la-Garenne and Gouzeaucourt with regression lines for each.

	Gouzeaucourt Level H		Cagny-la-Garenne	
	N	Percent	N	Percent
Elongated Amygdaloids	2	1.1	32	26.7
Amygdaloids	0	0.0	3	2.5
Elongated Cordiforms	0	0.0	3	2.5
Cordiforms	2	1.1	2	1.7
Discs	27	15.0	1	0.8

Lanceolates	0	0.0	3	2.5
Elongated Lanceolates	0	0.0	20	16.7
Limandes	40	22.2	7	5.8
Ovates	57	31.6	6	5.0
Elongated Subtriangulars	0	0.0	2	1.7
Subtriangulars	0	0.0	1	0.8
Thick Discs	9	5.0	1	0.8
Thick Limandes	12	6.6	26	21.7
Thick Ovates	31	17.2	12	10.0
Elongated Triangle	0	0.0	1	0.8
Totals	180	100.0	120	100.0

Table 2. Comparison of handaxe size between Gouzeaucourt Level H and Cagny-la-Garenne.

See Figure 1 for an explanation of how these measurements are recorded.

	Length	Midwidth	Width	Thickness	Base Length	Tip Length
Gouzeaucourt (N=180)	79.99 (16.61)	51.37 (8.95)	53.72 (9.42)	21.35 (4.35)	34.88 (7.48)	45.11 (11.52)
Cagny-la-Garenne (N=120)	122.09 (25.14)	63.67 (12.47)	69.90 (12.44)	38.80 (11.32)	43.24 (13.50)	78.85 (21.97)
<i>t</i> statistic	17.47	9.94	12.80	18.72	6.88	17.34
Probability	0.000	0.000	0.000	0.000	0.000	0.000

Table 3. Comparison of handaxe shape between Gouzeaucourt Level H and Cagny-la-Garenne.

See the text for an explanation of how these aspects of shape are quantified.

	Elongation	Refinement <i>t</i>	Edge Shape (Bordes)	Edge Shape (Roe)	RLMW ¹
Gouzeaucourt (N=180)	1.49 (0.21)	2.57 (0.43)	-2.06 (0.45)	0.78 (0.10)	0.44 (0.06)
Cagny-la-Garenne (N=120)	1.76 (0.27)	1.91 (0.45)	-1.10 (1.38)	0.68 (0.14)	0.36 (0.10)
<i>t</i> statistic	9.52	-12.83	8.67	-7.05	-8.77
Probability	0.000	0.000	0.000	0.000	0.000

¹Relative location of the maximum width or base length / length. This is Roe's index for determining whether a handaxe is classified as pointed, ovate or a cleaver.

Table 4. Percentage of cortex on handaxes from Gouzeaucourt Level H and Cagny-la-Garenne.

	Gouzeaucourt Level H		Cagny-la-Garenne	
	N	Percent	N	Percent
0%	144	80.0	16	13.3
0-10%	27	15.0	36	30.0
10-40%	9	5.0	50	41.7
40-60%	0	0.0	12	10.0
60-90%	0	0.0	6	5.0
Totals	180	100.0	120	100.0

Table 5. Mean length and tip length by percentage of cortex categories for the Cagny-la-Garenne handaxe assemblage.

Percentage Cortex	N	Length	Tip Length
0%	16	109.67 (19.09)	70.82 (19.85)
0-10%	36	115.81 (24.56)	74.67 (21.04)
10-40%	50	127.46 (23.17)	81.44 (22.00)
40-60%	12	130.48 (29.76)	86.55 (21.78)
60-90%	6	131.36 (34.36)	88.42 (27.76)

Table 6. Gouzeaucourt Level H and Cagny-la-Garenne classified according to Roe's index for determining Ovate and Pointed assemblages. Roe's index, abbreviated here as RLMW, quantifies the relative location of the maximum width as the base length / length. Handaxes with values not exceeding 0.35 are classified as pointed. Values greater than 0.35 but not exceeding 0.55 represent ovate handaxes. The rest, where the maximum width is closer to the tip than the base, are classified as cleavers.

	Gouzeaucourt Level H		Cagny-la-Garenne	
	N	Percent	N	Percent
RLMW \leq 0.35	12	6.7	56	46.6
0.35 < RLMW \leq 0.55	162	90.0	62	51.7
0.55 < RLMW	6	3.3	2	1.7
	180	100.0	120	100.0

Table 7. Relationship between tip length and handaxe shape. See the text for an explanation of how these aspects of shape are quantified.

	Gouzeaucourt Level H (N=180)		Cagny-la-Garenne (N=120)	
	R	P	R	P
Tip Length to Elongation	0.502	0.000	0.562	0.000
Tip Length to Edge Shape (Bordes)	0.577	0.000	0.609	0.000
Tip Length to Edge Shape (Roe)	0.427	0.000	0.359	0.000
Tip Length to RLMW ¹	0.620	0.000	0.688	0.000
Tip Length to Refinement	0.183	0.018	-0.428	0.000

¹Relative location of the maximum width or base length / length. This is Roe's index for determining whether a handaxe is classified as pointed, ovate or a cleaver.