Patterns of Faunal Processing at Section 27 of Pincevent: The Use of Spatial Analysis and Ethnoarchaeological Data in the Interpretation of Archaeological Site Structure

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The late Upper Paleolithic site of Pincevent exhibits extraordinary preservation not only of artifacts, bones, and features but also of their spatial distributions and the relationships among artifacts and features. Section 27 is a residential habitation unit, consisting of a large principal hearth which serves as a focal point for the organization of artifactual and faunal debris. A variety of mathematically based pattern recognition studies are applied to the distribution of faunal remains and are used in conjunction with ethnoarchaeological data for the interpretation of spatial patterning and site structure. These results yield information relevant to specific activities and overall site function. © 1994 Academic Press, Inc.

INTRODUCTION

It has been strongly suggested (Binford 1977:8–9) that intrasite spatial distribution is one of the domains of archaeologically recoverable data that might serve as a reference dimension against which to view past human behavior relative to ethnographically observable modern human behavior. We will apply several analytic and search procedures to a well-documented Paleolithic case in order to infer prehistoric behavior in the organization of space. These mathematically based pattern recognition studies are applied to the distribution of faunal remains and are used in conjunction with ethnoarchaeological data for the interpretation of spatial patterning and site structure.

Over the past three decades, several ethnoarchaeological studies have noted a consistent pattern: debris and by-products of activities, rather than the actual formal tools utilized, are often the best indicators of the nature and location of a given activity. Diane Gifford-Gonzalez, for example, in her ethnoarchaeological research, noted that refuse patterns alter according to duration of occupation. Refuse on short-term, single-occupation . . . camps is nearly all primary, dropped and left at its location of use. Refuse is predominantly food waste; it lies either at locations of initial butchering or in and around hearths. (Gifford 1980:98)

Referring to White and Peterson’s (1969) finding that tool manufacturing by-products, rather than the tools used or manufactured, were present and reflected the activities on Australian Aborigine sites, Binford noted that among the Nuna-
miut the best material index of activities at a site was bone-processing debris as opposed to curated material, such as re-touched tools that are carried from one camp to another and that are not left at activity locations (Binford 1973:244). It is not just the items themselves that can yield information, however. At the level of the site, artifact spatial configuration can be as important as the artifact content. We believe that these perspectives can be very profitably applied to our site.

THE DATA: PINCEVENT, SECTION 27

The late Upper Paleolithic site of Pincevent exhibits extraordinary preservation not only of artifacts, bones, and features but also of their spatial distributions and the relationships among artifacts and features. Section 36, which contains three hearth-focused habitation units, has been the case study for numerous spatial analyses that require high integrity site preservation (Leroi-Gourhan and Brézillon 1972; Enloe 1983; Simek and Larick 1983; Simek 1984a, 1984b, 1987; Johnson 1984). Section 27, for which a monograph is currently being produced, is the locus of another residential habitation unit, consisting of a large principal hearth on the border of squares L89 and M89, which serves as a focal point for the organization of artifactual and faunal debris (Bodu et al. 1990: 150). This analysis deals with the internal distribution of faunal material at this hearth-centered domestic unit.

The fauna of Section 27, like the rest of the contemporaneous occupation surface of level IV-20 (David 1972, 1992), is dominated by reindeer (*Rangifer tarandus*). In fact, at this hearth, no other species have been identified in the faunal remains. The number of specimens is 1595, of which 896 have been identified as to species and skeletal element. The remaining 699 specimens are unidentified bone splinters, measuring less than 2.5 cm in length. The identified specimens represent at least 19 individual carcasses. Differential representation of skeletal elements is exhibited in Fig. 1, based on minimum animal units. The assemblage is dominated by metacarpals and by crania. Other appendicular elements of both fore- and hindlimbs are well represented, whereas axial elements of the vertebral column are commonly missing. This is the kind of representational profile one commonly sees in a faunal assemblage that has been transported from a kill and initial butchering site to a residential or consumption site. Tightly clustered dental eruption and wear data indicate an occupation between September and October (David and Enloe 1992). This, along with sedimentological analyses, suggests a short-term occupation of this site.

PROCEDURES

The goal of our analysis is to identify patterns within the distribution of faunal remains at Section 27. For this purpose, we used three methods for examining the remains. The first and simplest method was to inspect visually the distribution of remains plotted on maps of the site. These maps were generated from vertical photographs of the excavated occupation surface of each meter square, displaying all classes of artifacts, bones, and stones (Fig. 2). From these, maps were generated to display all of the faunal remains (Fig. 3) and subsequently each of the skeletal elements separately. Figure 3 shows that the faunal remains replicate the general configuration of all types of debris seen in Fig. 2. While this general impression is useful and important for interpretation, the number of identified bone specimens makes identifying patterns difficult. The relationships among elements, including those within a given element class, between elements of different types and among different associations of faunal elements, for instance after grouping all forelimb bones to compare
with all hindlimb bones, make visual inspection impractical.

For the purpose of further identifying the relationships among skeletal elements, two mathematically based techniques for identifying patterns were employed. The specimen locations on the distribution map were digitized by using a Summagraphic 1212 digitizing tablet run through a CAD software program, which yielded X and Y Cartesian coordinates for each item. By grouping specimens within arbitrary 50-cm and 1-m² units, we employed the Topo module of the Surfer version 4.0 (Golden Software 1990) mapping program to display density contour plots of specific skeletal elements and aggregated sets of elements (Fig. 4). The smooth contour lines that were generated display general trends within the distribution of the specimens. This method is technically frustrating and time consuming, but the output consists of density contour maps, which more clearly display trends in the distribution of elements than do piece-plotted maps.

Unfortunately, we find that this method has significant drawbacks. By grouping data into arbitrary units, an indeterminate amount of error is entered into the analysis. Second, the size of the units directly affects the contours. By increasing or decreasing the unit size, the patterns displayed can be changed. We inspected a large number of distribution plots using 50 × 50-cm squares, but ultimately chose 1 × 1-m square units because the smaller units often produced poor results, due to very low numbers of specimens per unit. Nonetheless, the 1-m square grid units remain an arbitrary choice and are also arbitrary in their placement. For instance, a grid line might divide a single concentration into two adjacent squares, or a single square might lump together two separate smaller concentrations. Steve Kuhn (personal
communication 1992) has suggested that this problem might be mitigated by shifting the arbitrarily placed grid 50 cm in any direction to see if the configuration changes significantly.

The second quantitative method we applied was the K-means clustering procedure. The X-Y coordinates of each specimen from all 24 represented elements and several aggregated sets of data were processed through the program in Keith Kintigh's (1992) Tools for Quantitative Archaeology software package. The results of the K-Means procedure are a sequence of descriptive statistics and a map of artifact clusters for each set of information clustered. The K-means clustering procedure is a non-hierarchical cluster analysis algorithm, which is designed to discover separate clusters of objects. It analyzes possible clusters and seeks to find clusters with the smallest intracluster variances and the largest intercluster distances. In other words, the program attempts to identify real divisions between aggregated sets of objects. Figure 5 compares the five and seven cluster solutions for the entire identified faunal assemblage. Generally, if a cluster is produced that does not fit the data, it is usually easy to identify. For instance, if a large cluster appears where only a few highly dispersed items are located, the cluster probably should be considered invalid. Plotting the individual specimens along with the K-means clusters, in conjunction with the descriptive statistics, allows the general validity of the clustering results to be examined.

The K-means procedure reduces the total complexity of the distribution of speci-
mens and presents it in a much simpler map. In this way, the spatial patterning of specimens and sets of specimens can be more easily described and the relationships among artifact types readily compared. Nonetheless, by clustering specimens in this way, as by plotting density contours, some information is lost. In order to overcome this problem, the process of interpretation required the integrated use of the original point-plotted distributions, the $K$-means and density contour plots, and contextual information such as the location of hearths and the nature of the local environment. Determination of the number of cluster solutions was dependent on the element, with three to six cluster solutions corresponding most closely with density peaks indicated by the Surfer contours.

**SPATIAL PATTERNING AT SECTION 27 OF PINCEVENT**

We will briefly go through both inspection procedures for the most frequently represented elements. Distributions that are particularly significant will be discussed in detail later.

The cranium elements contour map and the $K$-means plot (Fig. 6) show patterns that are very similar to those from the general distribution of all identified specimens. This is also true for the mandible contour and the $K$-means maps (Fig. 7). Figure 8 displays contour and $K$-means
maps for the forelimb, including the humerus and radius. The distal forelimb (Fig. 9) is best represented by the metacarpal, which is the most frequently represented element in the faunal assemblage. Moving to the hindlimb, Fig. 10 displays the contour plot and K-means clusters for the femur and tibia. Metatarsals occurred in low frequencies; their density contours and K-means clusters are shown in Fig. 11.

Interpretation

These mathematically based search procedures can only serve as alternative display procedures for the spatial information inherent in the distribution of faunal material. They do not, in and of themselves, explain how these observable patterns came into being. We must look into another realm of research in order to link these patterns to past human behavior. We suggest that ethnoarchaeology offers the most directly applicable interpretive framework for understanding or recognizing the human behavioral dynamics that might have been responsible for the creation of the patterns observed in the spatial distribution of archaeological faunal assemblages.

How do we move from the archaeo-

cal patterning to the ethnoarchaeological information that might help explain it? We know that the possibilities for social and spatial structure in the prehistoric past are not limited to the examples observable in the ethnographic present (Wobst 1978: 303). As Hutterer so elegantly stated:

For archaeologists, the thorny issue (is) how the ethnographic record of contemporary hunter-gatherers can be used in building models for the organization of prehistoric hunting societies. It is highly unlikely that any living hunter-gatherer group can serve as a ready-made model for a prehistoric situation. However, while the ethnographic record is in itself clearly not an archive of earlier evolutionary forms, it
can be used as an arena within which to investigate organizational relationships among sets of variables relevant to the formulation of models for prehistoric situations. (1989:57)

The principles that govern the inferences drawn from ethnographic cases for application to archaeological interpretation are not those of ethnographic identity or direct ethnographic analogy, but rather the relationships among those sets of variables, both assemblage content and spatial distribution, that result in the particular organization seen by the pattern recognition procedures. The point here is an insistence on the method of ethnoarchaeology rather than ethnographic analogy. We must avoid the “Nunamiutization” of the Upper Paleolithic as much as we must avoid the “!Kung Sanization” of the Lower Paleolithic or any other archaeological interpretive case. As archaeologists, we must understand the relationships be-
between human behavioral variables and their resultant material patterns; those relationships must go beyond the identification of a particular pattern in a single ethnographic group and its application to an archaeological case. The previously noted relationships between manufacturing or processing debris and the kinds of activities responsible for them are equally valid for the Dassanetch of Kenya, the Aborigines of Australia, and the Nunamiut of Alaska.

**PATTERN INTERPRETATION AT PINCEVENT**

Our first interpretive conclusion is that there is relatively undifferentiated deposition of debris regardless of skeletal element identification, with a few minor ex-
exceptions that we shall discuss later. This general "U"-shaped configuration (Fig. 3) mirrors the distribution of all debris, including lithics and bones (Fig. 2). We suggest that this pattern probably results from a composite of a number of contributing behaviors. How can we break these apart to discern some of these contributing behaviors?

First, the scale of the units of observation determines the configuration of the patterning. For example, shifting the scale from 1-m to 50-cm units in the density plots yields a more complex pattern. In the upper graph of Fig. 12, the 1-m scale indicates a conical distribution with a single concentration centered in square M90. In the lower graph, with a 50-cm scale, this
single concentration is broken into two concentrations, centered in squares L89 and M91. When the seven-cluster K-means solution is superimposed over the single concentration of 1-m scale density plot (Fig. 13), the concentration corresponds to three clusters. The K-means 5 and 7 cluster solutions (see Fig. 5) both separated this central part of the site into three primary clusters. What might be responsible for the presence of two or three concentrations?

The size of debris may be a primary factor influencing the eventual or final resting place of debris generated during the occupation of a site. According to Gifford's ethnoarchaeological research among the Dasanetch in northern Kenya, "Elements less than 2.5 cm in maximum dimension ap-
Fig. 9. Comparison of density contour plot and optimal K-means cluster solution for metacarpal fragments.

appear highly likely to become primary refuse, even when most larger items are discarded away from their location of use” (1980:102). In the Section 27 material, we can compare the density contours of the identified specimens, which were generally large fragments, with those of the unidentified splinters of bone, the majority of which were less than 2.5 cm in length (Fig. 14). The first important difference between the two plots is that the primary concentration of splinters is in square L89; this corresponds to one of the clusters noted in the K-means solutions (Fig. 13). The primary concentration of larger identified specimens is in squares L91, M91, and N91; this corresponds to the other two clusters in the central concentration shown
in Fig. 13. The concentration of identified specimens located in square L91 can be differentiated by a lack of splinters. Schiffer has suggested that "smaller items are more likely to become primary refuse in activity areas" (1983:679); the splinters in square L89 may therefore represent a location of bone breaking for the extraction of marrow, resulting in the production of small primary refuse, corresponding to Binford's (1983:153) "drop" mode of discard.

The concentrations of larger identified fragments in squares L91, M91, and N91 correspond to what Schiffer refers to as the McKellar Hypothesis (McKellar 1983;
Schiffer 1983), in which size sorting is attributed to cleaning up of larger fragments. In this case, the larger fragments were not deposited at the actual location of the marrow production, but were individually tossed away from the primary activity area. This kind of behavior may also be responsible for the somewhat dispersed array of materials to the northwest.

However, the other two K-means clusters in this area suggest differences in the mode of deposition for each part of this concentration. The northern concentration in squares M91 and N91 includes the second highest density of unidentified splinters as well as the highest concentration of identified specimens. This size-heterogeneous concentration may be produced by a
Fig. 12. Comparison of 1-m (upper) and 50-cm (lower) units of observation for generating density contour plots. The coarser 1-m scale indicates only one concentration centered in square M90; the finer 50-cm scale reveals two separate concentrations in squares L89 and M91.

Combination of tossing and dumping behavior (Binford 1983:153, 155). Thus, it may include both larger fragments tossed onto the midden and secondarily deposited material that was dumped from the hearth. This would include ash, cinders, firecracked rock, and small bone splinters. The concentration in square L91 is more homogeneous in fragment size, lacking the splinters. Figure 15 shows a schematicized drawing based on a vertical photograph of the hearth and midden. This
The figure shows a superimposition of seven cluster K-means solution over a 1-m density contour plot for the Section 27 faunal material. Note that the single concentration indicated in the contour plot can be separated into three separate clusters by the K-means solution.

Another pattern concerns differential use or processing within the array of skeletal elements. We noted in the survey of the various skeletal element distributions that the only major deviation from the general pattern was exhibited by the meaty portions of the forelimbs. The humerus and radius are significantly lacking or less well represented in the L89 square (Fig. 8), which we have interpreted as the center of the locus for marrow-cracking activity. If marrow processing is spatially segregated from the purely meat processing, we suggest that the latter, whether for immediate consumption or for storage, occurred either at or around square N91, or that the debris from that processing activity was tossed onto the northern portion of the heterogeneous dump. In support of this suggestion, the longest rib segments, which may represent the most easily dried...
and stored meat from the carcass, were located in square P92 to the north of this heterogeneous dump.

In contrast, the meaty portions of rear limbs (Fig. 10) were deposited bimodally in the same manner as the metacarpals and metatarsals, which are most valuable for marrow rather than meat. Why are rear limbs treated differently than front limbs? According to Binford’s (1978) marrow utility indices, tibias have the highest marrow utility and may have been treated as pri-
mary marrow bones after meat had been removed or consumed and processed along with the metacarpals and metatarsals, which have little or no meat and whose primary utility is for marrow.

Another pattern that may relate to more specialized behavior is indicated by the small cluster of elements located away from the main concentration. Figure 16 shows the density contours representing the pelvic fragments. Of particular importance is the dense concentration of this element in square L97. Here, in addition to the pelvic elements, we find a cervical vertebra and a scapula fragment. These axial elements are extremely rare in the Section 27 assemblage and indeed in the entire Pincevent assemblage. They are more often found in assemblages representing initial butchering in such sites as Verberie (Audouze 1987; Audouze and Enloe 1991), rather than the appendicular elements that dominate the Pincevent residential assemblage. The distinct spatial segregation of this small group of elements is consistent with ethnoarchaeological reports of initial butchering and disarticulation of carcasses as an activity that requires extensive space, that is very messy, and that conflicts with other activities (Binford 1983:123–124). Therefore, it tends to take place away from central hearth foci, as we see in this case. Additionally, the cutmark evidence supports the suggestion that disarticulation occurred in this location. Most of the cutmarks on the entire occupation surface at Pincevent level IV-20 appear characteristic of meat removal. All of the pelvic specimens at L97 bear cutmarks around their acetabular sockets, confirming the disarticulation hypothesis.

CONCLUSIONS

The purpose of this article has been to draw both methodological and substantive conclusions from the spatial organization of archaeological remains. The former should enable other researchers to choose methods for the interpretation of spatial data on a variety of archaeological sites, while the latter should enhance our understanding of domestic space organization in the late Upper Paleolithic of the Paris Basin.
Fig. 16. Distribution of pelvic fragments in two major concentrations: (1) with most of the rest of the faunal debris (center), and (2) in an isolated cluster (right), away from the other faunal material.

Methodologically, it has been demonstrated that the same data set has the potential to yield many different patterns in the distribution of objects across space. The variety of patterns observable depends on the methods of display and the scale of the units of observation. We noted different patterns when we changed the scale of the units from 1 m to 50 cm for the density contour plots. The organization of the patterns changed when we varied the number of clusters in K-means solutions. The interplay seen through combinations of both of these methods allowed us to pull out still other patterns that were not evident in any single display method. While we have found that the concurrent use of several methods for summarizing and displaying spatial distributions can be useful for identifying patterns, these methods cannot be used directly to interpret what the patterns mean. For this, one has recourse only to the ethnoarchaeological research which yields information about the potential or actual behaviors behind the spatial patterning of remains left in the archaeological record.

Substantively, the integration of procedures for array and display of spatial distribution with ethnoarchaeological data gathered under controlled situations has allowed us to use the distribution of faunal material to gain insight into the organization of labor and maintenance activities in the vicinity of a single domestic unit in a prehistoric hunter-gatherer campsite. The hearth in Section 27 of level IV-20 at Pincevent served as the focal point for the organization of production and redistribution of debris from a number of different activities. Most faunal debris is distributed in a pattern similar to other classes of material, such as lithic debris or fire-cracked rock. Certain specific activities appear to
have resulted in distinctive and identifiable patterns of artifact assemblage content and distribution. Bone breaking for marrow processing resulted in concentration of splinters and identifiable fragments adjacent to the hearth, the location of that activity. In contrast, maintenance and cleaning of certain kinds of debris, notably larger fragments, resulted in secondary, heterogeneous dumps of material away from the hearth. Processing meat for storage on the other side of the dump from the hearth might be indicated by differential representation of high meat utility elements compared to high marrow utility elements. Carcass dismemberment and initial butchering, suggested by element representation and cutmarks, are further indicated by spatial segregation from the primary concentrations of other debris. This composite pattern can be compared to the organization of other, contemporaneous domestic units on the same site. There are indeed great similarities to the overall organization of space use found at those other domestic units, which supports the interpretation of the redundantly organized modules as similar residential households.

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