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Joseph M. Herbert
University of Tennessee, Knoxville

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To the Graduate Council:

I am submitting herewith a thesis written by Joseph M. Herbert entitled "Archaeological Investigations of Hayes Shelter (40ML143) and Archaic Period Lithic Technology in the Central Duck River Basin, Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

Walter E. Klippel, Major Professor

We have read this thesis and recommend its acceptance:

Jeff Chapman, Jan F. Simek, Michael H. Logan

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

168
24

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ARCHAEOLOGICAL INVESTIGATIONS OF HAYES SHELTER (40ML143) AND ARCHAIC PERIOD LITHIC TECHNOLOGY IN THE CENTRAL DUCK RIVER BASIN, TENNESSEE

A Thesis

Presented for the

Master of Arts

Degree

The University of Tennessee, Knoxville

Joseph M. Herbert

June 1986

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The preparation of the manuscript was facilitated with the help of many technical craftpersons. Pam Poe typed continuously evolving versions of the manuscript with the effectiveness of one who has seen many an anguished graduate student struggling to make the deadlines. Terry Faulkner is responsible for the artful illustration of data which, admittedly, do not lend themselves easily to such. Richard "Mac" McDougald sacrificed hours for first-rate photographic service

from his true love--filming the Vol's practice sessions. Jay Lamar graciously cast her unerring and ever-vigilant editorial eye on the painfully misshapen first draft and offered precising criticisms which, reflecting her nature, glowed with encouragement.

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Many of my fellow graduate students have contributed in perhaps less tangible ways to the development of this thesis. The concern for developing accurate models of hunter-gatherer adaptations in the Nashville Basin through sound archaeological techniques which I have shared with Dan Amick, Jack Hofman, Bill Turner, Charlie Hall and Chuck Faulkner has been stimulating. Each has contributed to the development of this thesis through their own efforts and our friendship.

ABSTRACT

Hayes Shelter (40ML143) is a small rockshelter site located on the Duck River in Middle Tennessee. Archaeological investigations were conducted at the site during the summers of 1982 and 1983 by the University of Tennessee Department of Anthropology as part of the Columbia Archaeological Project. This thesis presents the results of these investigations and compares the lithic assemblages from Hayes Shelter with those recovered from seven additional sheltered sites and eight open sites in or near the Central Duck River Basin.

By comparing the lithic assemblages from these 16 sites, information was gained on patterns of variability in the distribution of raw material types, tools, debitage, and flake debris. The resulting data suggest that on a regional basis, raw material selection strategies during the Middle Archaic commonly included locally available, but inferior quality cherts, while the strategies of the later periods relied on these resources less frequently. Models of prehistoric organizational strategies advanced through previous research have attempted to explain this pattern as reflecting a fundamental shift in settlement strategy, a shift necessitated by population crowding and resource scarcity resulting from the arid climatic conditions of the Hypsithermal Interval (ca. 8000 - 6000 B.P.).

According to previous models, the distribution of lithics in tool and debitage classes and among flake debris reduction stages are also expected to show a shift at the Late Archaic transition. Middle

Archaic assemblages are expected to be more homogeneous (more evenly distributed), while the later assemblages should have less even distributions, reflecting a more complex logistical strategy involving more long-distance transport of raw materials which were reduced in stages at various sites. However, the data in this study do not support the expected pattern. The composition of both Middle and Late Archaic assemblages in this sample appears to be influenced by resource selection, and this, in turn, is largely a function of site location. Change in raw material selection coincides with a climatic shift marked by increased precipitation at the close of the Hypsithermal Interval. It is suggested that restricted precipitation and a concomitant reduction in river and tributary discharge rates may have diminished the availability of usable chert gravels otherwise transported as bedload and deposited as lag gravel in the Central Duck River system.

As a preliminary investigation of the regional patterns of lithic technology during the Archaic Period, this study suggests that site location (with respect to lithic resources) and site type (sheltered versus open-air) have considerable influence on the composition of lithic assemblages.

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CHAPTER I

GENERAL INTRODUCTION

Archaeological investigations of Hayes Shelter were undertaken as one of many Phase II mitigative efforts initiated as part of the Columbia Archaeological Project under contract with the Tennessee Valley Authority. This thesis describes the site, the excavation, and the analysis of artifacts recovered and examines certain aspects of lithic assemblage variability both in the shelter deposits and from several sites in the Central Duck River Basin.

The strategy consonant with Phase II archaeological testing imposes certain limitations on the scope of the sample recovered. The research undertaken in this study is constrained by the parameters of the sample and focuses on a single problem in these contexts, lithic assemblage technology. The classification system and analytical techniques employed were selected specifically to measure this dimension of artifact variability and are outlined in Chapter II. A description of the site, a discussion of the field recovery techniques, and the presentation of a tentative paleoenvironmental model for the region compose Chapter III. A more detailed discussion of the fill is undertaken in Chapter IV, and the results of artifact analysis are presented in Chapter V. Comparisons of the lithic data from the Hayes Shelter to assemblages from 15 additional sites are presented in Chapter VI, and the conclusions of this research are described in the final chapter (VII).

Research Orientation

This project was undertaken on a contract basis with the Tennessee Valley Authority and was instigated in order to bring the agency into partial compliance with Federal regulations concerning the management of cultural properties expected to be impacted by the development of the proposed Columbia Reservoir. Numerous sites have been identified through the archaeological reconnaissance of the project area and many of these have received further testing. The results of these investigations appear in a variety of forms, including reports to TVA, manuscripts on file, theses, dissertations, and published and presented papers (for a partial bibliography see Amick and Crothers 1984).

The selection of the Hayes Shelter site for excavation was prompted primarily by two conditions: first, the site's physiographic features which suggested the potential for deeply buried cultural deposits, and second, it lies in close proximity to the Hayes shell-midden site which is just across Caney Creek. These were important criteria in the context of Phase II testing. Since artifact analyses of the materials recovered from the Hayes midden site are as yet incomplete, comparison with these data was not possible. The data from Hayes Shelter, however, represent a valuable rockshelter sample which is appropriate for addressing several research questions concerning prehistoric behavioral patterns on both intrasite and regional scales.

The excavations at Hayes Shelter followed the initial survey and identification of the site in 1981. These excavations were the first to be conducted at the site and were implemented as an exploratory operation designed to determine the nature of the cultural deposits through limited testing. Testing involved a single 1 x 3 m excavation under the shelter overhang.

Fortunately, the development of a geomorphological model of the terrace structure in the Central Duck River Basin was a primary goal of the Columbia Archaeological Project and has proven useful in the chronological assessment of cultural deposits in the Basin (Amick 1983, 1984a, 1984b, 1985a; Amick et al. 1986; Brakenridge 1982, 1984; Hofman 1981, 1983; Klippel and Turner 1983; Mahaffy 1983). The interpretation of the stratigraphic units at the shelter was enhanced by this research. Seven strata above the bedrock substratum (ca. 150 cm deep) were identified in the shelter deposits on the basis of visual and textural characteristics. The geomorphological characteristics of these strata and associated diagnostic artifacts suggest occupations which extend from the Middle Archaic to the Historic Periods.

The constraints of the Phase II sampling strategy placed several limitations on the analytical methods employed to interpret the cultural materials recovered. The excavated area was not large enough to justify studies designed to investigate the intrasite spatial patterning of artifacts. Refitting experiments which might identify

the patterns of horizontal and vertical spatial association of artifacts were unwarranted for similar reasons. Interpretation of specific stratigraphic units based on the sedimentary profiles exposed in this single trench must be considered tentative as evidence for vertical mixing due to both solifluxion and cryoturbation is apparent in the analyzed deposits. The sample of artifacts recovered is relatively small and includes very few culturally diagnostic lithic and ceramic specimens which might further substantiate the chronological interpretations of the stratigraphic assemblages.

Problem Context

Although the limitations identified above restricted the contexts in which archaeological problems might otherwise have been addressed, the Hayes Shelter sample provides an excellent opportunity to address the problem of lithic technological variability within the shelter. A total of 7882 lithic artifacts are recorded from the excavation, most of which are unretouched. The variety of raw materials represented in the site yields interesting information about apparent differences in the use of these resources over time. Another source of information about the prehistoric technological process is evident in the frequency distribution of artifacts among defined reduction stage-classes.

Thus, the central research problem addressed at the intrasite level is the prehistoric use of lithic raw materials and how the strategy of resource selection may relate to the reduction process.

Results of lithic analyses suggest that patterned variability in these two dimensions (raw material and reduction stage distributions) is evident. These results are presented in Chapter IV.

In an attempt to integrate the lithics from Hayes Shelter on a regional scale, these data are compared to lithic assemblages from 15 other sites in or near the Central Duck River Basin. All sites in the comparison (except Topsy and Fattybread Branch) were excavated as part of the Columbia Archaeological Project, though no comprehensive research design specified that these sites, and not others in the basin, should be excavated. Eight rockshelter sites and seven open-air sites are used for comparison. Each of the sites was excavated under the constraints of specific contractual agreements, and the lithic assemblages from each represent a systematic rather than random sample.

These 15 sites were selected for comparison with the Hayes Shelter data for two reasons. The first regards the geographic location of the sites and their spatial relationship to the regional distribution of lithic resources. Lithic resources in three environmental subareas (Inner and Outer Nashville Basin and Highland Rim) are different. Sites were selected to represent each of these lithic source areas. Although excavations at the other sites were initiated independently of this research, their locations represent a spatial gradient of lithic resources which are rich in the Highland Rim and poor in the Inner Nashville Basin.

The second reason for selection of these particular sites has to do with the system of lithic classification employed in the analyses. A similar technological classification system was used for each assemblage, and this allowed the comparison of the results on a regional scale. The results of these comparisons are discussed in Chapter VI.

Interpretation of lithic data from Hayes Shelter through comparison to assemblages from several sites in the region provides an excellent opportunity to evaluate models of prehistoric organizational strategies which have been developed through previous research. The data presented here do not support interpretations which attempt to explain assemblage variability in terms of subsistence strategy complexity at any particular time and place, but they do suggest that site location with respect to lithic resources is primarily responsible for assemblage patterning regardless of sociocultural considerations. These conclusions are discussed further in Chapter VII.

CHAPTER II

METHODS OF ANALYSIS

In order to approach the problem of assemblage variability at Hayes Shelter, a system of artifact classification was implemented which is appropriate to the measure of the variables of interest. Since integration of the data from the shelter on a regional basis was desirable, the classification system employed is similar to those used in analyses of comparative assemblages.

The lithic classification system employs classes which are designed to identify technological stages in the reduction process for bifacial tools. Technological classification schemes based on lithic reduction models have long been of interest to lithic analysts (Bradley 1975; Callahan 1979; Collins 1975; Crabtree 1966, 1972; Johnson 1979, 1981a, 1981b, 1984; Muto 1971; Raab et al. 1979; Stahle and Dunn 1982). The utility of this type of classification system has also been demonstrated by its application in the analysis of assemblages from sites in the immediate study area (Amick 1982, 1984a, 1985c; Amick et al. 1986; Entorf 1985; Hall 1985; Hofman 1983, 1984a).

The following sections describe the methods of laboratory analysis, including the definition of the classes employed in the lithic analysis and the analytical techniques employed in assemblage comparisons.

Laboratory Methods

Rubble Volume

Assessing the fill volume from each level was the preliminary step in artifact analysis. For meaningful comparisons of artifact frequency by level, the density or ratio of frequency of artifacts to fill volume must be determined. This depends on the volume displaced by the limestone rubble in each level. The volume of limestone detritus was calculated by determining the weight and converting it to volume using a ratio derived from the average of six samples of three size grades using the following procedure.

Two samples from the .64 cm, 1.27 cm, and 10 cm mesh fractions were used in the computation of the weight/volume conversion. Dry weights (g) were taken on each sample, and volume was calculated as liquid displacement (ml). The weight to volume conversion factor (2.5 g/cm^3) was then calculated as the average of the six samples.

Large slabs or blocks of rubble were weighed in the field, and the weight was assigned to the level from which the block was removed. Obviously, larger blocks displaced fill in more than one level. Mapping the blocks at each level floor and recording anterior elevations allowed me to calculate the approximate number of cubic centimeters displaced in each of the levels. These values were deducted or added to the level totals as appropriate to accurately assess the volume of the portion of the block displacing fill in each of the levels. The adjusted values of total rubble volume were deducted from 100,000 cm^3, or the total volume of a 10 cm level, and

provided an approximate volume of the actual soil in each level. Since the percent of limestone detritus volume reached .45 in the lower levels of the unit under the dripline, the importance of this factor in biasing artifact frequency comparisons is not to be underestimated. Artifact tabulations are calculated as units (weight or number) per cm^3 of actual soil to correct for variations in displacement of detritus.

Sediment Analysis

The investigation of the culture-bearing sediments at Hayes Shelter was designed to define as nearly as practically possible the characteristics and processes of the biophysical environment which provided the medium for, and dynamic interaction with, such socioeconomic systems as subsistence activities. The utility of sedimentological analyses for this purpose has been widely recognized (Butzer 1971, 1978, 1982; Gladfelter 1981; Hassan 1978; Shackley 1975), and numerous investigations have demonstrated the potential of this approach for interpreting the sediments of rockshelters (Ahler 1976; Burgess and Jacobson 1984; Butzer 1981; Farrand 1975a, 1975b:27-68; Laville 1976; Laville et al. 1980; Schmid 1970).

Soils Analysis. The physical properties of the sediments from Hayes Shelter were examined in some detail. Soil analysis focused on six samples, one selected from each of the major stratigraphic units. The sample from Stratum VII was taken from the unit closest to the back wall of the shelter since the stratum was thicker and more clearly defined in this unit. The other five samples were recovered

from the central unit (1019N1001E). The sample column was thus centrally located approximately 1.5 m inside the dripline and 1.75 m from the rear wall. Vertical sample locations were selected to best represent the strata, defined by macroscopic analyses of color, texture and pedogenic structure, so that transitional zones and areas of possible mixing were avoided.

The soil analysis concentrated on particle size data. Since the shelter is located against the bluff, just 18 m east of the Duck and only 10 m above its current water level (Figure 3.2), alluviation has been the primary sediment source. For this reason, the use of particle angularity as a measure of frost activity was not practical (Butzer 1964:160-164; Cornwall 1958:30-34; Shackley 1972). Size distribution for clay (<.002 mm) and silt (.0625-.002 mm) particles was determined by hydrometer, while grain size fractions ranging from .0625 mm (4 phi) to 4 mm (-2.0 phi) were determined by wet sieving (Ahler 1973:7; Folk 1974:25-30; Klippel 1971b:178-180). Data on the distribution of the textural classes are graphically presented as relative percentages of pebble (<2.00 mm), sand (2.00-.0625 mm), silt, and clay ratios (Folk 1974:41-43).

Limestone Detritus. The analysis of the detritus also included sorting materials into four size fractions employing 10, 1.27, .64, and .15 cm mesh screens. Relative percentages of detritus in these categories provide evidence for variation in the character of the paleoclimate, though the nature of the variation may reflect postdepositional climatic conditions and human occupational influences

as well as factors influencing the original deposition of the sediments (Farrand 1975a:25).

Another source of information concerning erosional dynamics in a generalized way is the fluvial clastic materials (Basanta 1964; Butzer 1981:150; Folk and Ward 1957; Mason and Folk 1958; Royse 1968). Quartzite and chert pebbles with waterworn cortical exteriors, probably redeposited bedload from terrace erosion, were size sorted as described above. The relative percentages of the frequency of these clastics in each fraction are described in the following section.

Ferricrete detritus is another source of data reflecting the paleoenvironment and the dynamics of the sedimentary process and has particular bearing on the interpretation of the alluvial sediments in this area (Brakenridge 1984; Klippel and Turner 1983). These pebbles are ferruginous nodules formed within soils overlaying limestone bedrock as pedogenic iron ore is transformed into hematitic or limonitic concretions within a horizon of fluctuating groundwater (Butzer 1981:140). Their frequency in the shelter sediments is cautiously employed as an indicator of the relative age of the deposit, though the apparent waterworn cortex present on many suggests secondary deposition. As all of these concretions were less than .64 cm in diameter, and as concretion size yields little information on the sedimentary process, a simple frequency is employed.

Lithic Analysis

All materials were washed and passed through a nested series of size-graded screens including 2.45 cm^2, 1.27 cm^2 and .64 cm^2 mesh.

Once sorted into size fractions, artifacts were subdivided by raw material type, and a variety of attributes were recorded for each specimen. The attribute analysis employed in this study follows the format developed for the Columbia Archaeological Project (Hofman and Turner 1979) and also incorporates modifications initiated with the analysis of materials from the Topsy Site (40WY204) (Amick 1982:9-21). A description of the coding format for variables and values used in this study is presented in Appendix A. Artifact categories and attributes are discussed below.

Matrix-Fractured Residua. This category was established to incorporate thermoclasts of residual Ridley chert which were fractured within the limestone matrix composing the shelter overhang. Inspection of the limestone outcrops of Caney Creek indicates that the nodules of Ridley chert currently exposed are highly fractured in the matrix before becoming dislodged through weathering (Figure 2.4). As these sharply angular pieces could conceivably be produced by shattering a nodule with percussion, resulting in failures along incipient fracture planes, some potential for overlap exists between this category and blocky debris. In this study, fragments which showed no negative flake scars originating at an identifiable platform were classified as matrix-fractured residua. As such, these pieces are considered a component of the detritus.

Fire Cracked Rock. This category of artifacts is composed primarily of local chert pieces which were thermally altered, but show no evidence of percussive reduction (House and Smith 1975:76).

Evidence of thermal alteration, including color changes as well as failures due to thermal expansion, are presumed to have been caused by human factors. Inability to distinguish between rocks employed for some purpose and those marked by incidental firing of residua on the surface of the shelter floor prohibits any further speculation on their function. The relative frequency of fire cracked rocks in the shelter sediments may be an indicator of human activities, but certainly the absence of this evidence does not indicate that these activities were not ongoing. Consequently, the interpretive value of these artifacts is tenuous.

Non-flake or Core Debris. This category comprises the non-flake by-products of tool manufacture. The class includes incipient cores or tested cobbles, cores and core fragments, and blocky debris, all of which have negative flake scars but no ventral scar surface which has not been subsequently utilized as a platform for further flake removals.

Incipient cores or tested cobbles are blocks from which no more than three flakes have been removed. If more than three scars are observed, the block is classified as a core. Blocky debris or shatter is defined following Binford and Quimby (1963:278) as cubical or angular chunks which lack the well-defined negative bulbs of percussion, platforms, and regularity or symmetry of flake removal scars demonstrated by cores. Each of these subclasses is interpreted as representing the initial stages of biface or flake tool manufacture.

Flake Debris. Debitage or waste flakes exhibit a ventral (interior) face which shows no flake removal scars other than eraillure and pot-lid scars. Unbroken flakes also retain a striking platform and bulb of force. The debitage from Hayes Shelter was classified following the system presented by Amick (1982:16), which is reproduced in Appendix A. This system identifies characteristics of platform lipping, cortex, and breakage. Combinations of these categories allow the creation of new classes which represent primary, secondary, and tertiary stages of decortication on the basis of full, partial, or absent cortex and the identification of biface thinning flakes on the basis of platform lipping.

This classification system is designed to identify waste produced at each stage in the manufacture of bifacial implements. Application of lithic production trajectory models as a means of interpreting variation in waste flakes has several advantages. By allowing debitage patterns to be interpreted as arising from specific behavioral processes, variation is interpreted through models of culture chronology (Flenniken 1985; Johnson 1981b; Pitts and Jacobi 1979), social stratification (Young and Sheets 1975), and subsistence and settlement (Brose 1978; Goodyear 1974; Raab et al. 1979). Studies employing subsistence and settlement models in the interpretation of debitage data have been employed in attempts to explain variation in assemblages from the Midsouth in terms of resource availability (Amick 1982, 1984b; Johnson 1981b, 1982), environmental and demographic factors (Amick 1984b), and specificity of site function (Hall 1985).

Flake Tools. This category includes both utilized unretouched flakes and flakes with retouched margins, whether bifacial or unifacial. Distinction between marginal attrition resulting from use and that produced by purposive retouch is commonly based on the size, depth, and especially the spatial regularity of scars. Although the pattern of flake removal scars arising from the use of an unmodified flake has a potentially wide range of variability, edge wear formed in this way is expected to be characterized by smaller, shallower scars, often superimposed in multiple steps, irregularly spaced and occurring on a restricted area of the flake. The margins of a retouched flake are expected to show scars of greater depth and breadth more regularly spaced and extending over a greater length.

Accurate distinctions between flake margin attrition arising from purposive retouch and from incidental use may be impossible to make. It is possible, for example, that a flake with an acute margin would be backed or dulled by scraping that edge steeply against another stone, a piece of bone, or wood. The resulting purposive "retouch" would be morphologically classifiable as use-related attrition. Consequently, these categories are not mutually exclusive and thus, are combined for comparative purposes.

The class of flake tools is employed as a technological group rather than inferring functional implementation. Interpretations of tool function based on macroscopic morphological attributes have been demonstrated through independent microwear analyses to be hazardous, if not completely unreliable (Ahler 1971:108; Grieser 1977:114; Nance

1971:271; Odell 1981:338; Wylie 1975:27; Yerkes 1984). This class of flakes (both retouched and unretouched, but showing evidence of use) in Mesolithic assemblages sometimes includes members which demonstrate evidence of use as hafted projectiles (Odell 1981:332-333, Figure 2a). Attempts to isolate functionally specific types such as butchering, woodworking, boneworking, or plant-processing tools without the benefit of microwear analyses are highly speculative without further testing.

Bifaces. Members of this class exhibit two flaked faces originating at a single margin which serves as the platform for flake removal. This broad morphological type is further subdivided by the amount and location of cortex, by the presence of an identifiable haft element, and by temporally isolable stylistic types.

Bifaces are interpreted in this study as technological classes representing production stages in the manufacture of tools. Use of the system of classification which identifies biface attribute clusters as technological production stages has a rich tradition in archaeological lithic analysis (Binford and Papworth 1963; Collins 1974; Holmes 1919; Jelinek 1965; Montet-White 1968; Muto 1971; Sheets 1975). Replication experiments involving flint knapping have been crucial in identifying empirically relevant production stages (Bradley 1975; Collins 1975; Flenniken 1985; Newcomer 1971; Sheets 1975) and still remain the most valuable means for refining classification. Studies implementing the technological classification of bifaces have been employed in the Midsouth with considerable success (Amick 1982,

1984b; Amick et al. 1986; Futato 1980; Johnson 1981b, 1984, 1985; Raspet 1979), and this study draws heavily from their research.

There were remarkably few bifaces (finished types or otherwise) from the shelter excavations. With such a small sample, metric data describing the morphological attributes were not gathered. Late-stage bifaces are described using traditional morphological attributes (Cambron and Hulse 1964; Futato 1977) and are illustrated in Appendix B.

Biface Failures. The recognition of biface failures is another means of understanding tool production and use trajectories. Failures due to thermal stress (Crabtree and Butler 1964; Purdy 1971, 1975), percussive shock initiated during production (Collins 1974; Crabtree 1972; Johnson 1979, 1981a, 1981b), and failures resulting from impact (Ahler 1971) and bending stress sustained while in use (Fleniken 1985; Johnson 1979, 1981a, 1981b) have been recognized in Archaic assemblages from the Midsouth (Amick 1982; Amick et al. 1986; Johnson 1979, 1981a, 1981b). Correlation of thermal and percussive failures with specific stages in the production trajectory has also been observed (Amick 1982; Amick et al. 1986; Futato 1980; Johnson 1981b) and provides information about specific production techniques and the response of various raw materials. The effects of use-failure on reworking and the implications for typological classification have also been considered (Fleniken 1985; Hofman 1984a).

As the number of bifaces was quite low at Hayes Shelter, biface failure data are described for the diagnostic late-stage tools

in Appendix B. In general, late-stage bifaces from Hayes Shelter show failures resulting from stress sustained during use, while early-stage fragments indicate a frequent occurrence of production-related failure.

Raw Materials. The raw material types employed in this study follow descriptions advanced by previous researchers (Amick 1981, 1984b; Denny and McCollough 1974; Faulkner and McCollough 1973; Kline 1978). Research conducted in conjunction with the Columbia Archaeological Project has employed Amick's (1981, 1984b) descriptive study of the available resources in the area and the large comparative collection which was assembled primarily as a result of his field reconnaissance and gravel-bar survey. Identification of types for this analysis and all the studies employed in the comparative tables is based on the macroscopically observable attributes described in these sources and the comparative samples.

Cortex. Seven classes of cortex type were recognized following Amick (1982:10-11; Amick et al. 1986:98, see Appendix A). Types include incipient fracture planes (or joint planes) typically forming as mineral precipitates are deposited on the surfaces of internal joint planes from solution entering joint fissures, characteristic of residual Middle Ordovician cherts. A chalky, buff or yellowish, soft cortex is characteristically present on the exterior surfaces of the replacement cherts which form in the matrices of Ridley and Carters limestones. As these cherts commonly occur as residua in the deflated upland soils and along the valley walls where they are eroded from the

parent matrix, they are simultaneously referred to as matrix/residual cherts (Amick 1982:11; Amick et al. 1986:98). Waterworn cortex is recognized as a thin, smooth, red-brown covering, often with a softer, yellowish subcortical layer. This type is formed on blocks or nodules which have been extensively tumbled as fluvial bedload and is characteristic of the Mississippian Fort Payne and, to some degree, the Upper Ordovician Bigby-Cannon cherts which occur in the lag and strata gravel deposits presently exposed in the Central Duck River Basin.

A final distinction is made to isolate the smooth, thin, white cortex which is characteristic of cherts from the Mississippian St. Louis/Warsaw formation and sometimes of Silurian Brassfield residual chert (Amick et al. 1986:98). These types are further combined as they occur simultaneously (see Appendix A).

In addition to distinguishing types of cortex as a means of interpreting resource procurement location, cortex type has been successfully used to distinguish stages of reduction along the trajectory continuum. For comparative purposes, decortication or early-stage flakes are denoted by full or partial dorsal cortex; tertiary (interior) or intermediate-stage debitage is denoted by flakes lacking cortex and also lacking platform lipping; and late-stage or biface thinning flakes are recognized by platforms which are lipped.

Thermal Alteration. The importance of thermal alteration in lithic production technologies is widely acknowledged. Studies

dealing specifically with the effects of heat treatment on Fort Payne chert specimens indicate that this material responds well to thermal alteration, with slight changes in color occurring at 250°C and with changes in textural luster occurring at 400°C (Hood and McCollough 1976:197-206). Morrow's (1981) results seem to agree with these earlier experiments. Similar experiments on Bigby-Cannon chert indicate little or no perceptible change occurs other than cortex discoloration (Hood and McCollough 1976:207). Johnson and Morrow (1981) have successfully identified color and textural changes resulting from the heat treatment of Fort Payne biface and debitage samples from the Yellow Creek watershed which are correlated with stages of biface reduction. Gloss and color changes are more common on stage 3 (late-stage) than on earlier stage bifaces (Johnson and Morrow 1981:143). This pattern is also noted for debitage where evidence for thermal alteration is more frequently observed on smaller (later stage) flakes (Johnson and Morrow 1981:144). Similar trends for evidence of thermal alteration among bifaces from surface collections in the Central Duck River Basin have been noted (Amick et al. 1986).

The classificatory system used in this analysis follows Amick (1982:14) and is composed of five classes: not heated, possibly heated, definitely heated, heated after final modification, and heated before final modification (for discussion of this system and a classificatory key, see Amick et al. 1986:96-98, Figure 4.27). Possibly heated specimens show only partial color changes, usually

around the margins or frequently involving only a projection. Flakes removed after heat treatment of the parent stock will generally show gloss or luster on the ventral surface. Bifaces will show lustrous flake scars, occasionally with adjacent nonflaked areas showing less luster. These specimens are subsumed under the heated-before-flaking class.

Evidence of such thermal shock as pot-lidding and crazing on the ventral surfaces of flakes indicates heating after final modification. Thermal failures including pot-lidding, expansion, and crenation fractures were also considered heated after final modification. Pieces which simply showed color change and none of the attributes of luster or thermal shock, which would allow them to be placed in either the before or after flaking categories, were classified as definitely heated.

Faunal Analysis

The vertebrate remains from the shelter were size-sorted using standard mesh hardware-cloth screens (2.57, 1.27, and .64 cm^2). Elements were then sorted by class, including a category for unidentifiable specimens. Burned elements were then identified and the groups were weighed. Identifications were made to the most discrete taxonomic level possible, and the portion and side of each identifiable element were recorded when possible. These data appear in Appendix C.

Numerous (24,586) freshwater gastropods were recovered from the Late Archaic levels of the shelter. These were classified to the

genus level. Variations in the frequencies of these are presented in Chapter V. Freshwater mussel shells were also recovered. As most of these were highly fragmented and because the identification of archaeologically recovered specimens is extremely difficult due to the number and similarity of species and the poor state of preservation, the mussel shells were simply weighed for each level. These data are also described in Chapter V.

Botanical Analysis

The sheer volume of materials recovered in the grade 3 (.64> x >.16 cm) fraction necessitated that only a sample of plant remains be manually sorted. This was accomplished by riffle sorting material of this size from each 10 cm level (less a 2 liter float sample) into equal portions. This was done in three stages. The first was to divide the sample into equal halves (50% samples). This was again sorted into halves to produce a 25% sample, and this sample was further divided to form 12.5% samples. At each stage the two halves were weighed to control for equal amounts in each. If differences were noted between lots, amounts were simply shifted from one lot to the other. The resulting 12.5% sample lots were not all the same weight or volume but varied depending on the character of the fraction from each level. They should, as a result, be more representative of the variation in composition of the grade 3 fraction between levels.

Flotation Procedure

The samples reserved for flotation from the shelter were removed as 20 x 20 cm blocks (approximately 4 liters) from each arbitrary 10 cm level excavated. These blocks were generally taken from the same corner of each unit and hence formed a column sample; however, in some cases, the presence of numerous large roots or limestone boulders necessitated shifting the sample location. All soil and pebble sized rubble was included in these samples with only cobbles and large roots being removed before flotation.

Flotation was accomplished using a machine-assisted technique similar to the SMAP system described by Watson (1976). Light fraction materials were sieved through 500 and 250 μm mesh. Both light and heavy fraction remains were analyzed and identifications were made to the most discrete taxonomic level possible for all nut and seed remains, while wood charcoal was simply weighed. The results of these analyses are described in Chapter V.

Aboriginal Ceramic Analysis

Prehistoric ceramic materials are rare in the Hayes Shelter sample. With those few specimens for which identification could be made, the appropriate references are discussed. The interpretive potential of this very small sample is obviously limited.

Analytical Techniques

The foregoing discussions have indicated that, for specific reasons, variability in the lithic assemblages from Hayes Shelter and

several sites in the region are the focus of this study. Variability in both the distribution of raw material types and technological classes among the assemblages provides information about the patterns of prehistoric utilization of chert resources at the various sites at certain times. As the classification system identifies categories treated on a nominal scale, frequency distributions among these categories are a primary source of interest. The general pattern of the distribution among the classes of raw material, reduction stages, and other variables of interest are first assessed through bivariate frequency tables.

Assemblage Diversity

The notion of the diversity of an assemblage or sample population is an intuitively attractive means for comparison. In its most simple form, diversity can be thought of "richness," or the number of different classes of items in a collection. However, a more precise definition combines richness with the distribution of observations among categories ("evenness"). As developed in the biological sciences, the information-theoretic notion of diversity attempts to identify the "degree of uncertainty attached to the specific identity of any randomly selected individual" such that, "the greater the number of species and the more nearly equal their proportions, the greater the uncertainty and hence the diversity" (Pielou 1966:131). In other words, observations distributed evenly among many categories result in high diversity; when most of the observations occur in a few categories and some of these dominate the pattern (an uneven

distribution) the data exhibit low diversity. Various mathematical formulae have been advanced in biological literature which attempt to summarize the diversity of a sample population with a single value, or index, which may then be compared to the diversity index of another sample (Lloyd et al. 1968; Pielou 1966, 1969, 1975). Each of the measures attempt to summarize the variability in two dimensions, the number of classes, and the proportion of the distribution among the classes. A quantitative expression proposed as a measure of diversity is that of Shannon (1948):

$$H^1 = - \sum_{i=1}^{k} P_i \log P_i$$

However, some measures treat each dimension (richness and evenness) separately.

Assemblage Evenness

In many archaeological situations, including this study, the number of classes is quite small. For example, the class of debitage might be condensed into three categories composed of early, middle, or late stage debris. When samples are large, the probability of recovering a lithic assemblage which does not include at least a few members from each of these categories is low. In such circumstances, the number of categories represented is not what is of interest, but rather, the proportional distribution or evenness of the artifacts among categories. For this reason, the measure of evenness is considered more appropriate for the data examined here and is

preferred over combinatory measures of diversity. The quantitative expression of the measure of evenness (J^1) is:

$$J^1 = \frac{H1}{H^1 max}$$

where

$$H^1 \text{ max} = \log k \text{ (Zar 1984:34).}$$

Interpretation of the degree of evenness exhibited among various sets of observations or assemblages through the comparison of their calculated indices is difficult, for the number of classes is potentially affected by the sample size. For example, if, in comparing two archaeological assemblages, one is composed of 150 artifacts of 36 different classes and another of 70 artifacts in 28 classes, it seems plausible to say that the former assemblage is more diverse, for it has the greater number of classes (Kintigh 1984:44). But this interpretation is premature until we can determine what the expected values would be for both sites given their sample sizes.

Kintigh (1984) has developed a method for determining the expected values for both richness and evenness through a simulation program. The program constructs a large number of assemblages for each of a number of different sample sizes, based on the known distribution of the actual archaeological sample. For example, to determine the expected values for an assemblage with a sample size of 50, 50 observations are randomly and independently chosen with the probabilities of selecting the denotata of a certain class determined by the proportional freuqncies among the classes in the actual

archaeological sample. The first simulated selection of 50 might have five classes represented, the next simulation having seven, and so on, until the number of samples simulated is large enough that the mean and standard deviation of the frequency distribution among the classes are reliable estimates of these values for a random choice model for the given sample size (Kintigh 1984:45). The level of confidence of the predictability of these estimates increases with the number of simulations, since, by the Central Limit Theorem, the simulated pattern is parametric.

The utility of this procedure for the comparison of archaeological samples is that the expected mean and standard deviation are computed for each sample size. Comparison between samples, then, becomes the comparison of their deviation from the expected range at a given level of confidence. Assessment of the relationship among the various samples compared is conveniently facilitated by a plot of the calculated values of the actual samples against the expected mean and range of deviation for a number of sample sizes.

The simulation technique of generating theoretical expectations based on archaeologically derived frequency distributions is employed in this study not only for the raw material and debitage reduction stage lithic artifacts from the Hayes Shelter assemblages (as determined by stratigraphic association), but also in the comparison of these aspects of the lithic assemblages from the other sites in the region. As indicated, evenness rather than richness indices are employed. This circumvents the problem of incorporating the

dimensions of class richness and proportional distribution into a single index, as the value is scaled to the maximum diversity. The plots which illustrate the expected and calculated values were generated using a computer assisted program provided by Kintigh.

CHAPTER III

SITE DESCRIPTION

Hayes Rockshelter (40ML143) is a small erosional feature beneath a limestone bluff along the right bank of the Duck River in Marshall County, Tennessee. It is located near Venable Spring (River mile 177), just upstream of the confluence of Caney Creek with the Duck River (35°36' N 86°46' E, Figure 3.1). This location is within the proposed Columbia Reservoir area.

It was during the preliminary site survey of this area in the Spring of 1981 that cultural materials were found and the shelter was recognized as a site. Actually, the first excavations were conducted by a resident groundhog whose burrowing brought a variety of lithic debris, bone, and shell to the surface. This material was enough to satisfy the surveyors and the author that cultural materials were buried in the shelter sediments. Materials reported in this study were recovered from the excavation of a 3 x 1 m trench between the rear wall and the dripline (Figure 3.2).

As the waterscreen posts were being set, about three meters down the slope, additional cultural deposits were discovered. The abundance of material unearthed prompted further investigations in this area. A single 1 m^2 unit excavated on the slope exposed a small profile area, but the observable strata could not be readily correlated with those under the shelter. Consequently, the materials

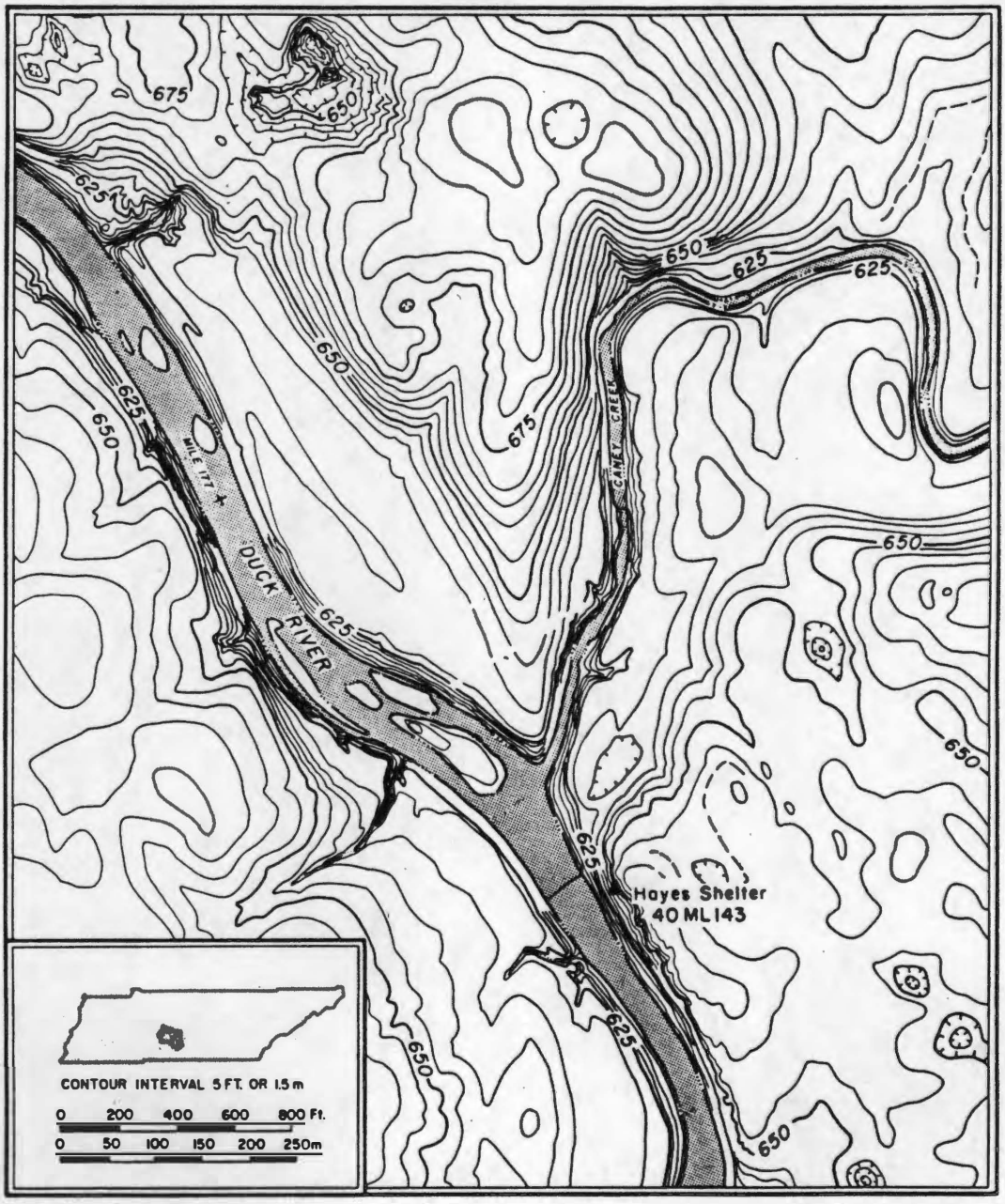


Figure 3.1. Topographic map of Hayes Shelter site area.

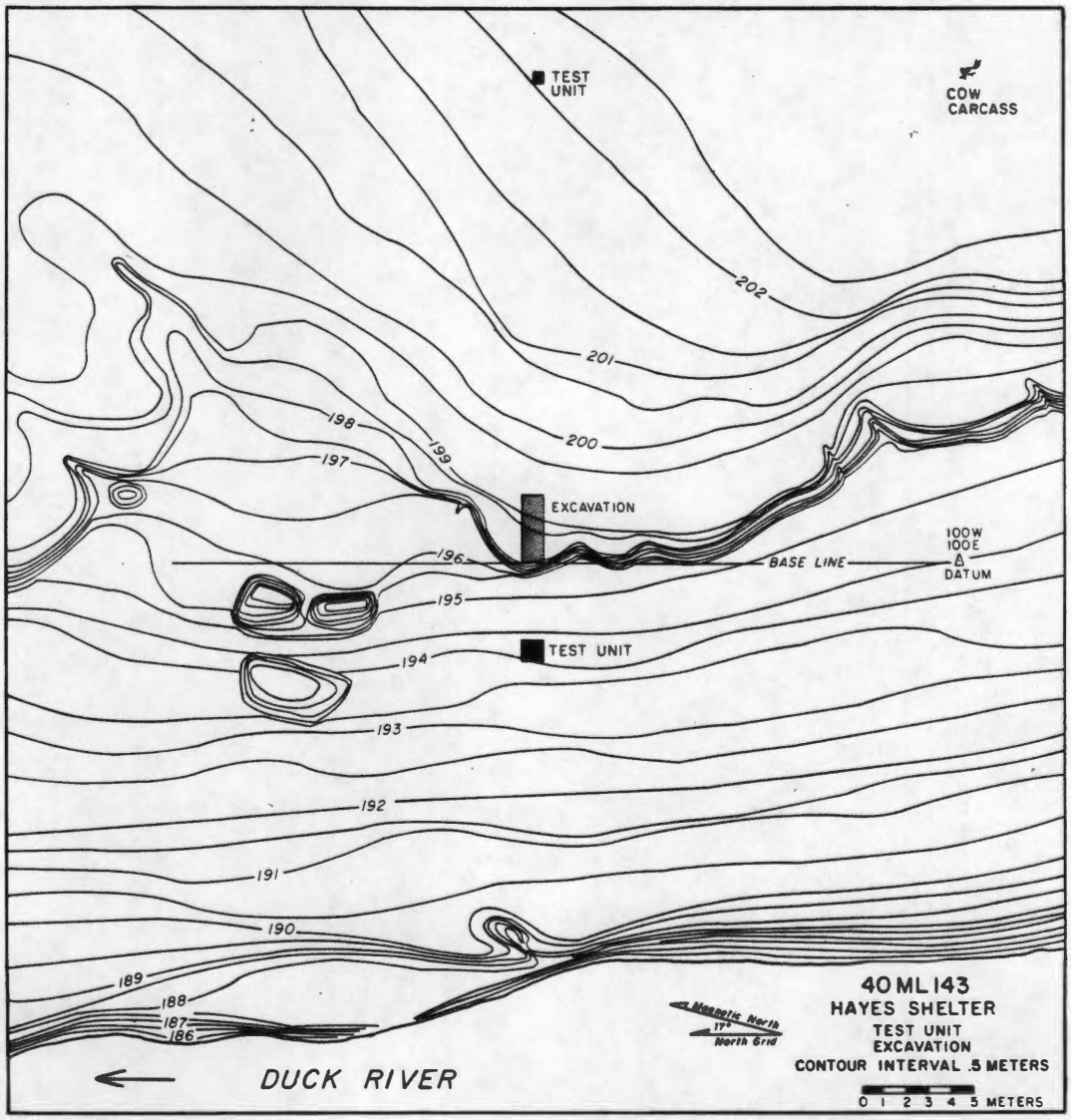


Figure 3.2. Hayes Shelter site contour map.

from this test are not included in any comparative analyses in the text.

Site Environment

As Figure 3.3 illustrates, Hayes Rockshelter is located in the central or inner Nashville Basin. A summary of the geographical features of the Nashville Basin and adjacent Highland Rim Province is presented by Amick et al. (1986:7-17). The environmental characteristics of the inner and outer basin areas and the surrounding Highland Rim have prompted the development of environmental models which attempt to segregate the biotic or abiotic resources from each of these areas (Braun 1950; DeSelm 1959; Edwards et al. 1974; Fenneman 1938; Harmon et al. 1959; Quarterman 1950a, 1950b). The physiographic subdivisions have generally been established on the basis of geological formations, and this method is employed here.

It should be noted, however, that although this analytical technique may be useful for comparative modeling, it arbitrarily reduces the complexity of the biophysical features in the study area in order to develop the analytical model of an environmental gradient. If the imposition of such analytical units on contemporary biotic communities results in narrow, imprecise models (Crites 1983:3), its application to the development of paleoenvironmental models is even more hazardous (Graham 1976:347; 1979:52; King and Graham 1981). Recognition of the limited and potentially misleading nature of the

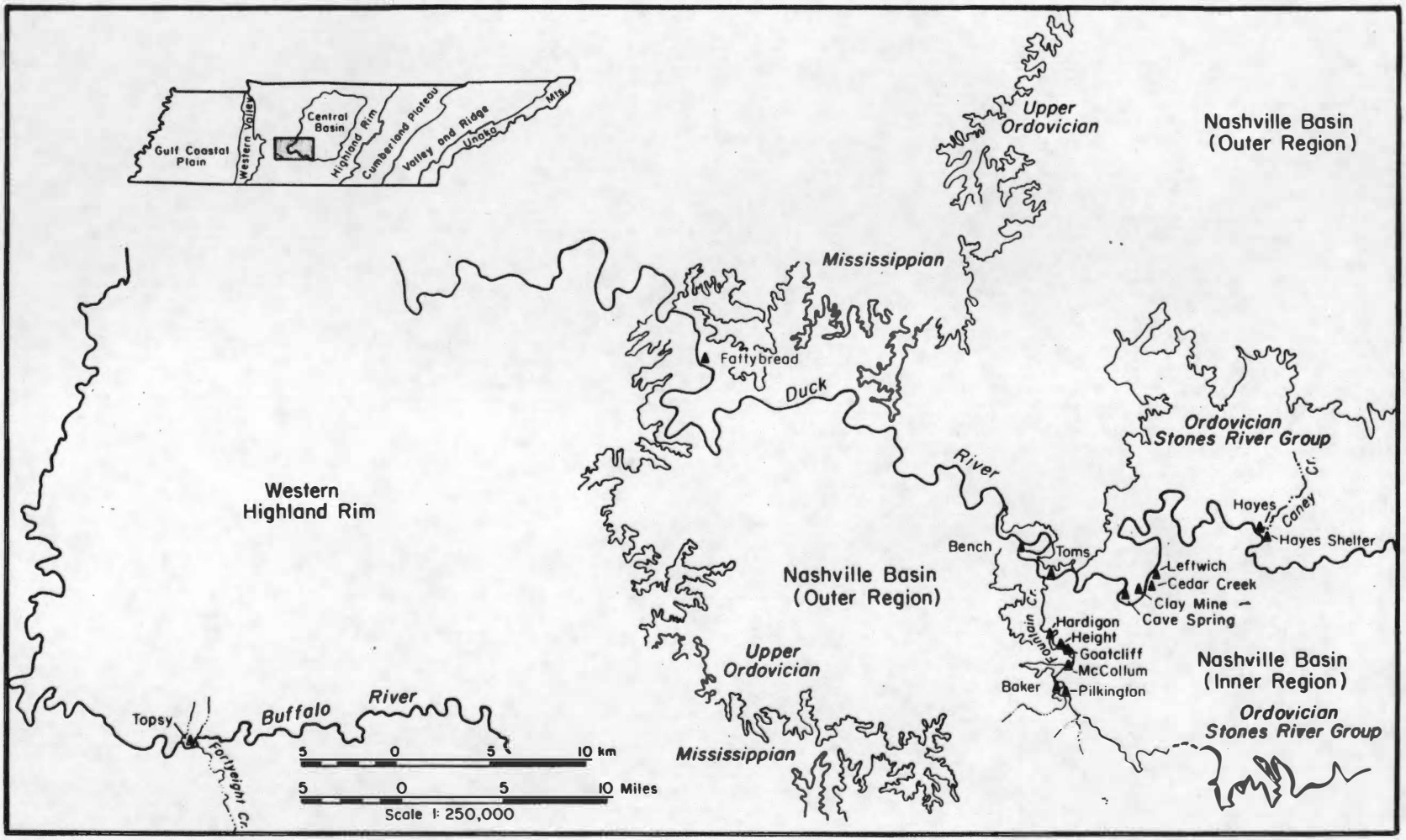


Figure 3.3. Central Duck River drainage and the location of 16 sites used in the comparative analysis.

model requires that we exercise considerable discretion when implying the effects that these hypothetically distinct environmental areas may have had on prehistoric sociocultural systems.

The shelter is situated approximately 18 m from the present bank of the Duck and its floor is about 10 m above the normal pool level (Figure 3.2). U.S. Weather Bureau and U.S.G.S. records of flood stage river heights were initiated in 1925 at river mile 132 (Tennessee Valley Authority 1972:Appendix K). Hall (1985:28) has summarized these data and indicates that the mean flood stage elevation between 1925 and 1970 was approximately 11 m over the summer river level. Over this 45 year period, overbank flooding occurred 62 times for an average of 1.4 floods per year. These occurred during the months of November through May, with 73% of the floods occurring in the months of January, February or March. The shelter is expected to have been periodically inundated during prehistoric as well as historic times. The contour map of the site also indicates a significant potential for colluviation from the shallow soils on the bluff (Figure 3.2).

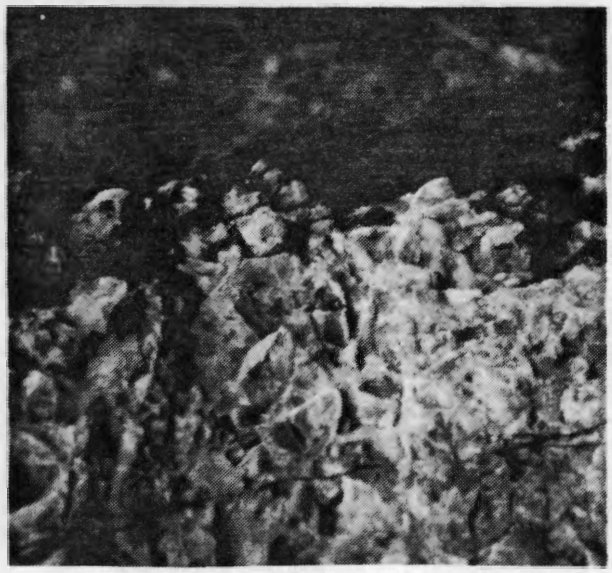
Inner Nashville Basin

The inner Nashville Basin area is underlain by Ordovician limestones of the Stones River Group, including the Ridley, Carters, and Lebanon Formations which extend areally to the base of the Hermitage Formation (Figure 3.3). This substrate is highly calcarious and easily eroded and is frequently accompanied by poorly developed soils with limited drainage (Edwards et al. 1974:2, 4). The undulating upland surface of the inner basin area is frequently

interrupted by exposures of limestone. These conditions favor the development of "cedar glade" vegetational communities (Quarterman 1950a, 1950b) which occupy about 6% of the basin area (Crites 1983; Quarterman 1950a). The shallow soils of the upland areas, then, support heterogeneous, xeric vegetation which includes cedar-oak and hickory-cedar-oak communities frequently interspersed with areas of herbaceous flora (Baskin and Baskin 1975; Crites 1983).

Ridley and Carters cherts derived from the Middle Ordovician, Stones River Group, are generally restricted to the Inner Nashville Basin (Figure 3.3). These chert types are formed through replacement and have several characteristics which are considered inferior for tool manufacture. Ridley and Carters chert is recoverable at outcrops, when nodules or blebs are weathered from the exposed bedrock, and in minor proportions in gravel bars (Amick 1984b:104). The texture of these types is coarse and the weathered surfaces develop a soft, chalky, white to buff or grey cortex. As a nodular replacement chert, fossiliferous inclusions, inconsistencies in density, and the irregularity of bedding planes characterize this type. These attributes apparently result in a chert that is highly conducive to frost spalling within the parent matrix and to percussive failure along inclusive points of weakness.

In the Ridley outcrop at Hayes Shelter, nodules are commonly exposed in the bluff face (Figure 3.4, A). These nodules are invariably frost-fractured into splinters and angular fragments long before they are completely freed from the matrix. The resulting



A

B

Figure 3.4. Ridley chert thermoclasts from the Hayes Shelter limestone bluff.

detritus is generally sharply angular and less than 5 cm in maximum diameter (Figure 3.4, B). The restrictions that these attributes place on the Middle Ordovician resources for tool manufacture are perhaps reflected in the data from Hayes Shelter as high frequencies of blocky debris and low frequencies of tools. The spatially restricted distribution of these Stones River Group resources to the Inner Nashville Basin is also an important consideration in attempting to explain patterns evident in the archaeological record.

Outer Nashville Basin

The Upper Ordovician and Silurian limestones underlaying the outer basin area are rich in silica and phosphate and somewhat more erosion resistant than those of the inner basin (Wilson 1949:76, 179). The soils in this area are generally deeper and more fertile due to the phosphatic substrate. Although the uplands of the outer area are more dissected with narrow ridges and valley floors, the less frequent exposures of limestone and deeper soils allow a more homogeneous forestation of deciduous hardwoods in this area. The cedar-oak taxa characteristic of the inner area are augmented in the outer area by a greater variety of deciduous types.

Prehistorically exploited chert resources derived from the Upper Ordovician, Bigby-Cannon and Silurian, Brassfield formations are primarily restricted to Outer Nashville Basin sources (Figure 3.3). Although often more homogeneous and vitreous than the Middle Ordovician cherts, the availability of the Upper Ordovician cherts is very limited (Amick 1984b:52-57). They occur most often as waterworn

nodules in exposed strath gravel deposits and tend toward the smaller size ranges. As a result, these resources occur only in minor proportions in the archaeological record.

Highland Rim

The Highland Rim Province surrounds the Nashville Basin with gently rolling plains that are steeply dissected by dendritic streams. The erosion resistant Mississippian Limestone substrate is less karstic than in the basin area and supports deep, cherty soils (Smalley 1980). The forested regions of the rim are characterized by broadleaf deciduous taxa of the Western Mesophytic forest (Braun 1950) and exhibit greater homogeneity than the mosaic pattern typical of the Nashville Basin. Arboreal species include hickory, oak, walnut, maple, beech, and ash (Braun 1950:154).

The Mississippian Fort Payne Formation in the Highland Rim Province is the most significant chert-bearing formation in the study area. Nodules or blocks derived from massive beds are generally available throughout the Highland Rim and also occur as residua in the Nashville Basin, especially as lag gravels in the outer region (Amick 1984b:64).

Although no attempt was made in this study to identify the subtypes of Fort Payne recovered from archaeological context, most specimens appear to be the "blue-grey and tan" or "laminated" variety. This type is usually fine-grained or nearly vitreous and is highly tractable as a material for tool manufacture. As blocks tend to be

large and homogeneous on the headwaters of tributaries in the Highland Rim, this is an ideal resource for biface technologies.

Amick's (1984b:83-84, Table 4.2) survey indicates that there is little systematic downstream gravel-size decrease in the inner basin area, with gravel size variability being affected primarily by tributary confluences. Mean size and weight data of gravel samples from bars within the inner basin area, however, indicate that both the Ordovician source materials (Ridley and Carters) have slightly higher average values than do Fort Payne gravels from this area (Amick 1984b: Appendix C, Table C.8). Additional samples from sources on the headwaters of tributaries of the Duck indicate that although the average abundance of gravel is greatest in the Western Outer Basin, the average size is larger in the Western Highland Rim (Amick 1984b:87).

Paleoenvironment

Broadscale paleoclimatic changes are inferred for the Late Quaternary in Eastern North America from palynological records. During full glacial conditions, the Polar Frontal Zone was relatively stable, resulting in major vegetational zones which occupied fixed geographic positions with respect to the Laurentide Ice Sheet (Bryson and Wendland 1967). An apparent increase in solar radiation between 17,000 and 16,000 B.P. intensified the Bermuda High Pressure System over the central Atlantic Ocean and triggered a northward penetration of the Maritime Tropical Airmass (Delcourt and Delcourt 1984).

Increased mean summer temperatures and increased rainfall across the midlatitudes in Eastern North American resulted in deglaciation of the southern flank of the Laurentide beginning at about 16,500 B.P.

During the subsequent late glacial interval (16,500-12,000 B.P.) the Polar Frontal Zone broadened latitudinally, increasing the vegetational ecotone of mixed conifer-hardwoods between the boreal and temperate deciduous regions (P. Delcourt 1985:280). Knox (1983) suggests that the zonal atmospheric flow across the midwestern U.S. at this time would have reduced the number and intensity of storms, inhibiting flooding and stabilizing alluvial aggradation of the river systems. As a result of the diminished severity of winter temperatures and an extension of the growing season, mixed spruce, fir, and deciduous taxa eliminated the jack pine forests (H. Delcourt 1979:270).

The early Holocene (12,500-8000 B.P.) includes the period of maximum seasonality of solar radiation (Berger 1978). During this period, the meridional flow of the Arctic Airmass in winter and the Maritime Tropical Airmass during the summer accentuated seasonal fluctuations of temperatures across eastern North America (Delcourt and Delcourt 1984:280). As the Polar Frontal Zone was pushed northward by the Pacific Airmass, a meridional atmospheric regime replaced the former zonal flow. During the period of meridional flow, the frequency and severity of storms was increased, destabilizing river systems and resulting in episodes of sediment removal and incision (Knox 1983). Palynological data from Anderson Pond, on the

eastern Highland Rim, indicate a major expansion of mixed mesophytic forest taxa after 12,500 B.P. (H. Delcourt 1979:270).

eastern Highland Rim, indicate a major expansion of mixed mesophytic forest taxa after 12,500 B.P. (H. Delcourt 1979:270).

During the Middle Holocene (8000-4000 B.P.), a long-term strengthening of the mean westerly atmospheric circulation expanded the midcontinental region of warmth and aridity (Bryson et al. 1970; Delcourt and Delcourt 1984). The increased influence of the Pacific Airmass over the Arctic and Maritime Tropical Airmasses reached its peak during the Hypsithermal Interval (Delcourt and Delcourt 1984:281). This zonal atmospheric flow resulted in a reduction in the magnitude and frequency of storms and in an overall reduction in annual precipitation during this period.

Geomorphological evidence from the Duck River indicates a period of agradation and stabilization between 7200 and 6500 B.P. which Brakenridge (1984:23) speculates resulted from reduced trunk-stream flooding and river discharge, which may have decreased by as much as 56% during this period. The drier climate at this time enhanced the eastward expansion of the prairie vegetation in the central United States (Bernabo and Webb 1977), and it is logical to assume that the deciduous taxa of the Inner Nashville Basin would have been replaced, to some extent, by more xeric nonarboreal vegetation. Some evidence for such a transition may be offered by the paleontological remains from Cheek Bend Cave in the Inner Nashville Basin. Increases in the occurrence of the least shrew (*Cryptotis parva*) in the mid-Holocene

sediments may indicate the presence of grassland habitat in this area (Klippel and Parmalee 1982). In addition, the absence of meadow vole (Mycrotus pennsylvanicus) in the Late Holocene deposits may indicate its disappearance during the Hypsithermal Interval (Klippel 1986).

Palynological data from Anderson Pond indicate that during the period from 8000 to 5000 B.P., mixed mesophytic forest taxa were restricted, perhaps being limited to northeast-facing gorges in Middle Tennessee (H. Delcourt 1979:271). The arboreal pollen spectra, however, indicate that the influx of oak, ash, hickory, beech, alder, buttonbush, and Virginia willow increases during this period (H. Delcourt 1979:267, Figure 8). Apparently, as drought stress eliminated some of the upperstory competition, the more xeric taxa such as oak and hickory expanded in the Highland Rim. Increases in their pollen influx indicates that the flowering and nut- and mast-producing capabilities of these species may have actually increased during the mid-Holocene (Delcourt and Delcourt, personal communication 1986).

Within the last 4000 years, the climate in this area has been characterized by meridional atmospheric flow combining the Arctic, Pacific, and Maritime Tropical airmasses in a variety of ways (Delcourt and Delcourt 1984:281). Geomorphological evidence from the Duck indicates renewed overbank sedimentation on the previously stable floodplain surface at the close of the Prairie Maximum (Brakenridge 1984:24). Palynological evidence also suggests that the effective moisture increased markedly at 5000 B.P. (H. Delcourt 1979; King and

Allen 1977; Solomon et al. 1980). Mesic deciduous forest taxa are represented at Anderson Pond after 5000 B.P., as the spectra are similar to those from 200 B.P.

Field Recovery Techniques

The baseline at Hayes Shelter was established as nearly parallel to the face of the bluff as possible (Figure 3.5). This oriented the grid at 17° west of magnetic north so that the excavation of contiguous units on a single north axis opened a trench roughly perpendicular to the back wall of the shelter. Three adjacent units (1 m^2) were excavated, which exposed a three meter profile extending from the back wall to just outside the dripline (Figure 3.6). All test excavations conformed to the metric grid originating from the baseline.

An elevation datum was established by a spike at the base of a large oak tree along the dripline at the northernmost end of the shelter (Figure 3.5). Although the absolute elevation (AMSL) of this datum was not determined, Kelsh maps and 3.75 minute series topographic maps provide elevation references. The elevation of the datum used for establishing contour elevations for the topographic map of the immediate area around the shelter (Figure 3.2) was inferred from the Kelsh sheets.

Excavation proceeded in each 1 m^2 unit by 10 cm levels. Walls were kept plumb while floors were parallel to the surface plane. This strategy was employed in an attempt to closely align the levels with

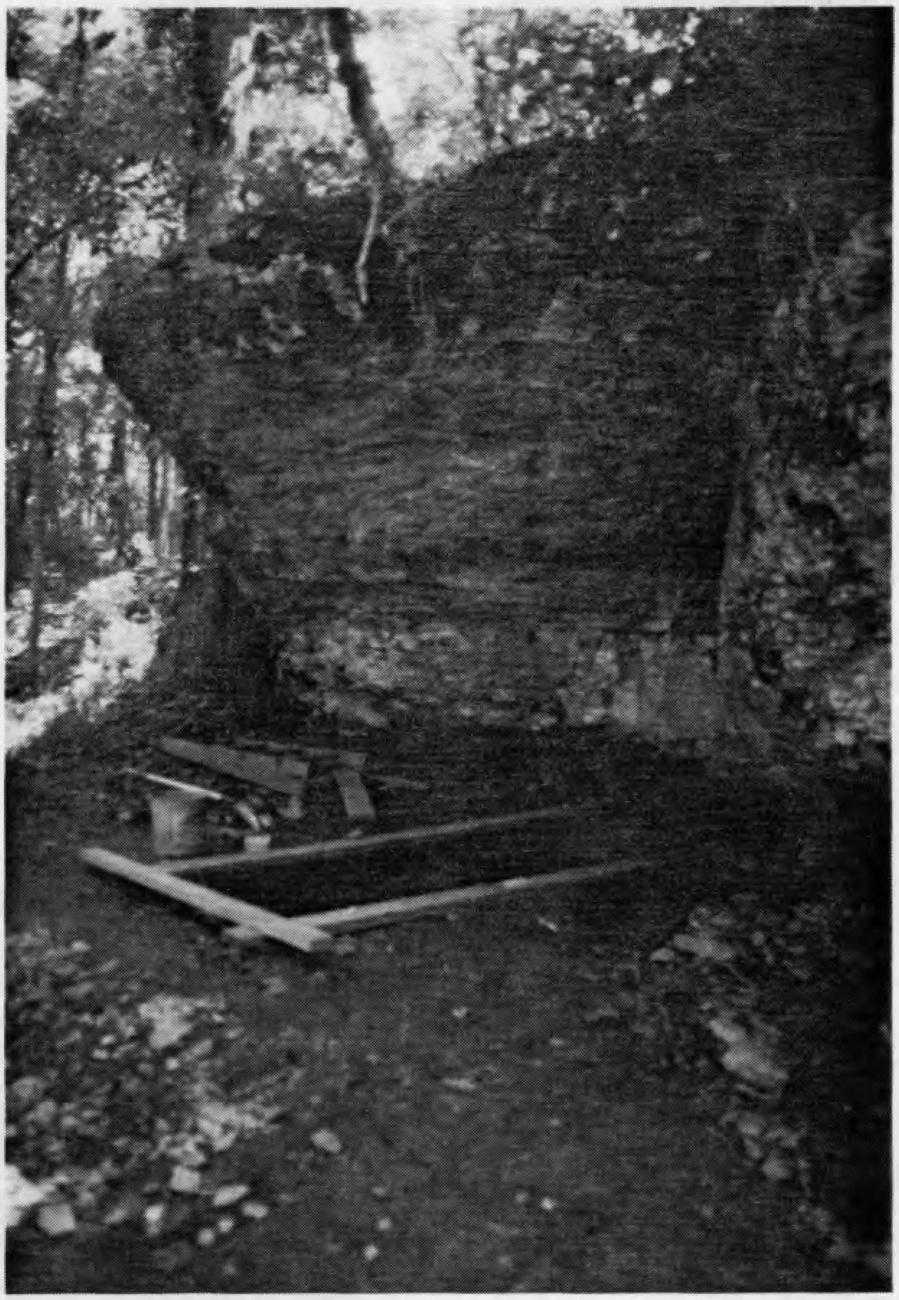


Figure 3.5. Hayes Shelter excavations.

natural strata. As natural strata were usually difficult to discern during excavation, this method provided a more accurate system of vertical control for artifact comparison than would leveling unit floors (Figure 3.6).

Excavation techniques were prescribed primarily by the size of the excavation units and the density of limestone detritus. All excavations proceeded by hand trowelling. A 20 cm^2 block yielding approximately four liters of soil was removed from each 10 cm level. One 100 gram sample was taken from each block and used for sedimentary analysis; the remainder was processed by flotation for the retrieval of botanical remains. These techniques are described in the section on laboratory methods.

The major logistical obstacle in the excavation of these test units was the density of limestone rubble. As each level floor reached its terminal depth, all limestone blocks larger than 10 cm were mapped, and the elevation of their superior surfaces was recorded. The location of all diagnostic lithics and ceramics observed during excavation was also recorded in both horizontal and vertical planes.

Excavated fill was processed in the field by waterscreening. Nested screens of 1.27 cm (½ inch), .64 cm (¼ inch), and .15 cm (1/16 inch) mesh were used to initially sort artifact and rubble by these size fractions. Once removed, larger limestone blocks were weighed on the site and discarded. Detritus less than 10 cm in diameter was kept for further analysis.

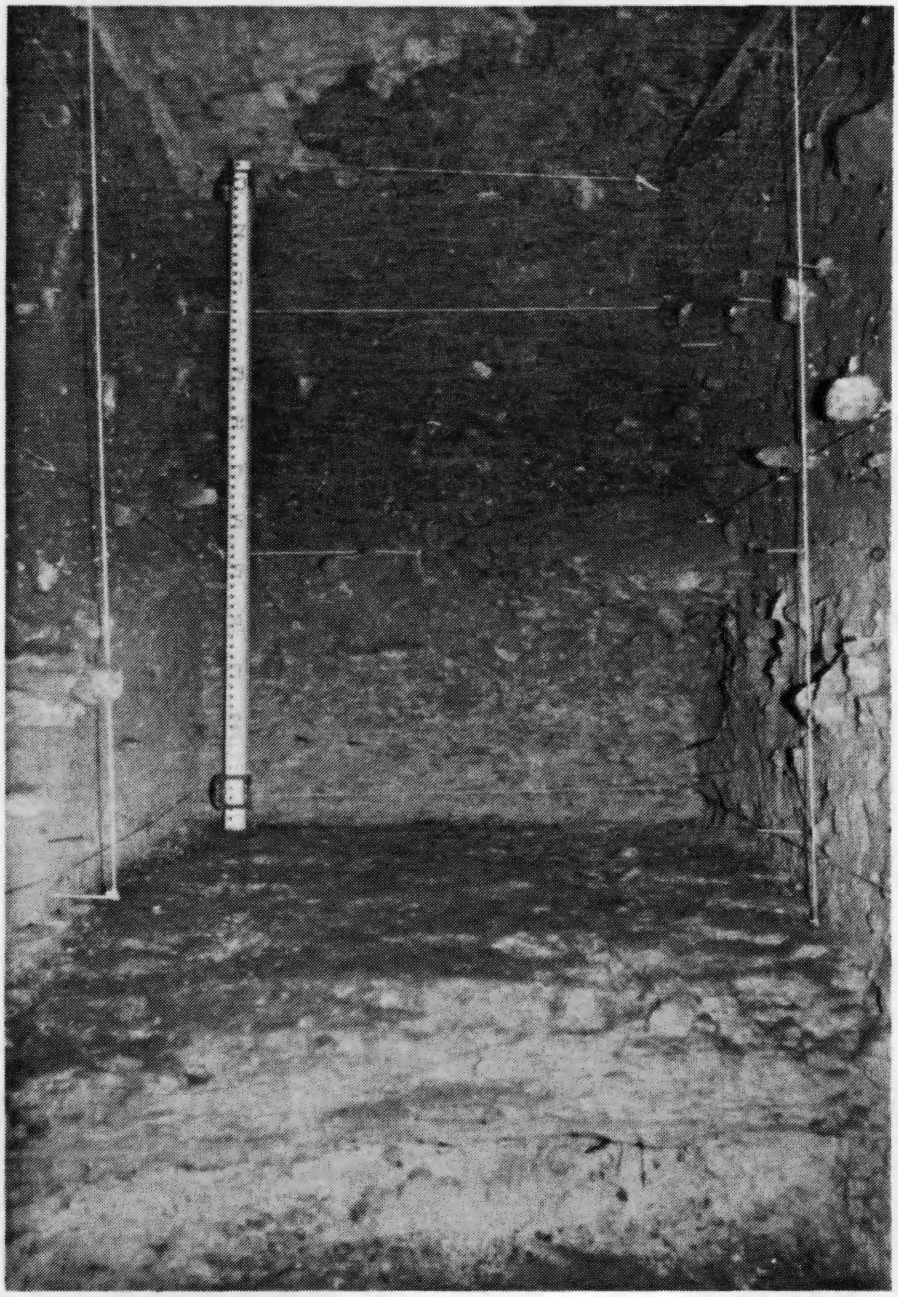


Figure 3.6. Shelter excavation profile (east).

CHAPTER IV

SHELTER FILL

Analysis of Sediments

The nature of the sedimentological record at Hayes Shelter is of primary importance from an archaeological perspective for two reasons, first as a basis for the interpretation of the spatial contexts from which the cultural materials were recovered, and second, for its potential to inform us about the environment in which the prehistoric socioeconomic systems functioned. These two aspects will be considered as the data are described in the following sections.

As previously explained, the test units were excavated in 10 cm levels with the upper limit of the top level parallel to the ground surface. Since walls were plumbed, the resulting levels were rhombohedral but contained the same volume of sediment. The benefits of this technique in the excavation and analysis of the sediments were realized as the subsurface macrostratigraphic units were found to be roughly parallel to the ground surface (Figure 4.1).

In the analysis of the deposits at Hayes Shelter, data from several sources are assessed. These include the calcareous detritus, fine soil components, illuvial clastics and ferricrete pebbles. The following sections are primarily descriptive. However, the potential of the data to reflect the nature of the processes of sedimentation and postdepositional alteration is a principal consideration in the analysis.

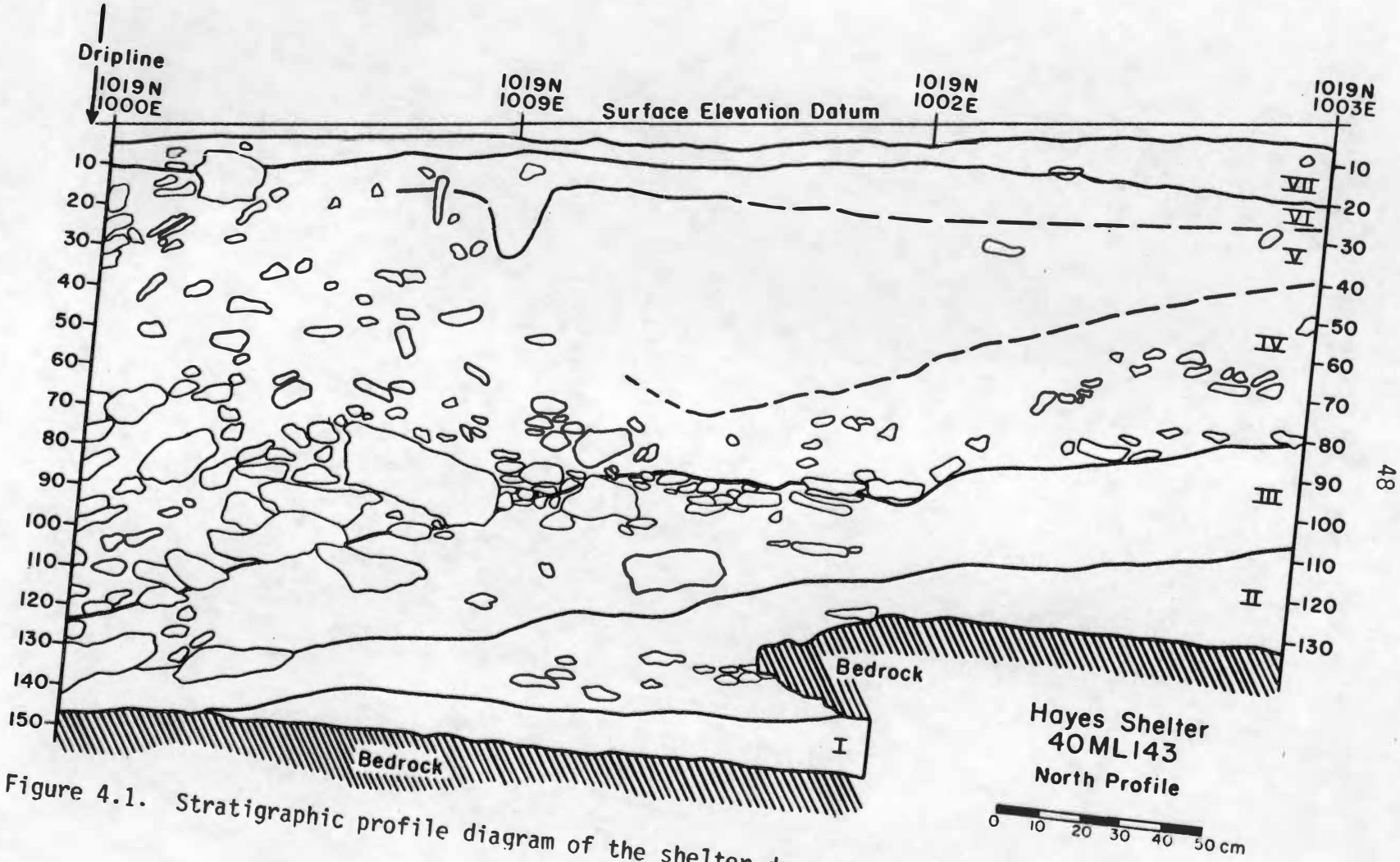


Figure 4.1. Stratigraphic profile diagram of the shelter deposits.

Calcareous Detritus

The illustration of the northern walls of the three 1 m^2 units excavated under the limestone overhang (Figure 4.1) provides a general impression of the spatial patterns of the detritus which were mapped *in situ* in this profile. Immediately apparent is the density of rubble in the westernmost unit (1019N1000E), was excavated just inside the dripline, as compared to the relatively rubble free unit at the back of the overhang (1019N1000E). As this pattern extends below the occupational levels, it is assumed that regardless of postdepositional influences, the basic distribution that exists at this scale is a consequence of primary thermoclasticism. As a function of freezing, larger and more numerous rubble fragments were detached from the rock face receiving the most exposure to surface water. This process is further evidenced by accelerated fracturing (and accentuated concavities) where fissures have developed, allowing groundwater from the rock face above to penetrate greater distances into the overhang (cf. Farrand 1975a:18). Exposure to water has been demonstrated through replication experiment to be the primary source of variation in the rate and nature of the fracturing of calcareous rock (Laville 1976:138). In addition to exposure to surface moisture, variation in temperature (the intensity of freezing) and time (the number of freeze-thaw cycles) conditions the size and quantity of rubble (Butzer 1981:148; Farrand 1975a:19; Laville 1976:138-139).

Given the nature of the variability in the size and amount of rubble between units illustrated in Figure 4.1, the central unit

(1019N1001E) was selected for a column sample. Situated about halfway between the back wall and the dripline, the shelter face directly over this unit has less exposure to surface moisture than the bluff face, but ample moisture to promote thermoclastic spalling. This unit is also situated on the crestslope and, as a result, is subject to less solifluction than the unit nearest the dripline. And since it is centrally located, the archaeological record in this unit is assumed to be representative of the three units excavated under the overhang.

Although patterns at this scale may reflect some overall trends in climate, detritus resulting from primary thermoclastic roof spalling is certainly subject to further postdepositional frost shattering, thereby altering the initial pattern (Farrand 1975a; Laville 1976). The processes of both primary and postdepositional thermoclasticism, however, operate under the same set of climatic variables and may be postdicted, to some degree, on the basis of experimental results (Guillien and Lantridou 1970; Malaurie 1968; Tricart 1967), as presented in Laville (1976).

Interpretations of the experimental results of the process of frost spalling in limestone have been varied (Farrand 1975a:19; Laville 1976:138). Laville (1976:132) suggests that on a general level, mild freezing results in an abundance of fine debris, while more severe freezing results in coarse debris. Farrand (1975a:19) suggests that both smaller fragments and greater quantities of debris are the result of more freeze-thaw cycles, greater intensity of freezing and a greater degree of saturation.

In accordance with this research, a number of assumptions are made for the interpretation of the calcareous clastic component of the shelter sediments. Cool, mesic conditions accompanied by frequent but mild frost episodes promote spalling of the rock at a more constant rate and result, primarily, in the production of detritus of the smaller size grades. Conversely, cold conditions accompanied by severe freezing result in the detachment of larger blocks from the roof and walls. Under either condition, whether severe or moderate winter temperatures were realized, fewer annual freeze-thaw cycles would result in less detritus while more cycles would produce greater quantities of detritus.

In addition to temperature cycles, variation in the availability of moisture is a most important variable in the spalling process, though the effect of wet-dry cycles on the spalling of shelter roofs and walls without freezing is not clearly understood (Farrand 1972:229, 1975a:18). In the case of Hayes Shelter, the amount of available surface moisture on the rock face seems to have had a direct influence on the variation in the type, amount, and distribution of debris. Paleoclimatic data from palynological, paleontological and geomorphological studies also suggest that the availability of moisture has been a critical factor in shaping the environment of the Nashville Basin (Brakenridge 1984:23; H. Delcourt 1979:270-271; Klippel and Parmalee 1982). This is especially true as edaphic conditions predispose vegetation (and certain fauna) to exaggerated response to drought stress in much of the inner basin area.

The pronounced variation in frequency of detritus of any size grade between the unit against the back wall and that under the dripline at Hayes Shelter clearly demonstrates that the availability of moisture is a critical factor in the formation of detrital patterns. The paleoenvironmental studies cited above further indicate that major long-term fluctuations in available moisture were experienced during the Holocene. A positive correlation exists between the amount of annual precipitation and the amount of detritus produced, regardless of the character of the freeze-thaw cycles.

The assumptions presented above are experimental generalities. The patterns observed in the detritus cannot be crosstabulated as might wrinkled green or smooth yellow peas to postdict in Mendelian-fashion the critical paleoenvironmental conditions. These tenets do, however, provide a foundation for attempting to explain significant variations in the rubble deposits which appear to change through time. Data derived from the combination of the variables specific to Hayes Shelter are assessed with these assumptions in mind.

Linear statistical models procedures indicate that the null hypothesis (HØ: that there is no significant difference in the volume distribution of detritus from the various size grades and levels from unit 1019N1001E) must be rejected based on a probability of .0001 and an F statistic of 13.72. Table 4.1 presents basic descriptive statics for the volumes for each level. In general, larger means in levels 7-11 and 14 suggest periods of greater thermoclastic activity. Levels 7 and 8 also have high standard deviations and low values for

Table 4.1. Descriptive statistics of calcareous detritus by level for unit 1019N10001E.

Level	Mean Weight(g)	Standard Deviation	Skewness	Kurtosis
1	3740	4685	1.69	3.19
2	2488	3451	1.92	3.72
3	6118	10176	2.98	3.94
4	3434	3835	1.84	3.53
5	3775	1874	1.11	.23
6	3236	1685	.78	.89
7	8335	7968	1.26	.76
8	11017	10091	.93	-.87
9	10882	9734	.02	-5.89
10	10736	9929	1.82	3.34
11	10546	6207	1.29	2.31
12	6563	2606	.02	-5.38
13	7404	2732	1.06	1.31
14	10781	5279	.78	1.07
15	6120	3769	.79	-1.48

skewness, but are highly platykurtic. This indication of poorly sorted fractions suggests a more intense primary thermoclastic activity and perhaps less secondary frost fracturing, which would tend to produce sizes with a unimodal distribution (Farrand 1975a:18).

Standard (Z) scores calculated for the volume of detritus from the four size grades in each level indicate the patterns of deviation from the mean (Table 4.2). In the largest size grade (1), volumes are substantially lower than expected in the upper 4 levels and higher than expected in the middle levels. Grade 2 fraction scores are more complex, while grades 3 and 4 indicate a pattern of scores lower than expected in the upper levels and higher than expected in the lower levels.

Graphically, this may be more easily visualized as plots of the relative row percent and individual column percents of each size grade (Figure 4.2). Relative row percentages indicate that grade 2 is the predominant fraction in every level except 13. This is perhaps more clearly illustrated as cumulative percentages (Figure 4.3).

The frequency of detritus greater than 10 cm is low in the upper levels, increasing in level 5 and peaking in level 9, dropping again in levels 10-12, and elevated again in level 13. This pattern suggests an episode of increased primary thermoclastic activity beginning with level 9 and dropping steeply to level 6. A concomitant drop is noted in the grade 2 clastics at level 6. Also noted during this period are an increase in fluvial clastics (corticated pebbles), in the range of well-sorted soil grain sizes, and in the silt ratio

Table 4.2. Standard (Z) scores for detritus volume by level for unit 1019N1001E.

Level	SAS Grade 1 >10cm	Grade 2 10> x >1.26cm	Grade 3 1.28> x >.64cm	Grade 4 .64> x .16cm>
1	-1.2167	-0.5122	-0.5064	-0.62947
2	-1.1595	-0.9315	-1.0956	-0.98028
3	-1.1250	1.0117	-1.0331	-0.82625
4	-0.8181	-0.7218	-1.1164	-0.80439
5	-0.4584	-1.1154	-0.4106	-0.57008
6	-0.5778	-1.2361	-0.7427	-0.55540
7	0.4694	0.7324	-0.3917	-0.49698
8	1.2913	1.4373	0.1910	-0.45293
9	2.2912*	0.8213	-0.2654	-0.61414
10	0.3423	1.5833	0.5231	0.24999
11	0.6134	0.7197	0.7516	1.36279
12	-0.4541	-0.7154	0.7099	1.34843
13	0.8883	-1.1282	0.7724	1.03352
14	-0.2253	0.5101	2.7023*	2.22691*
15	0.1390	-0.4552	-0.0883	-0.29172

* High normal deviate scores indicate that there is low probability of randomly selecting an observation from the sample population with greater standard deviation from the mean.

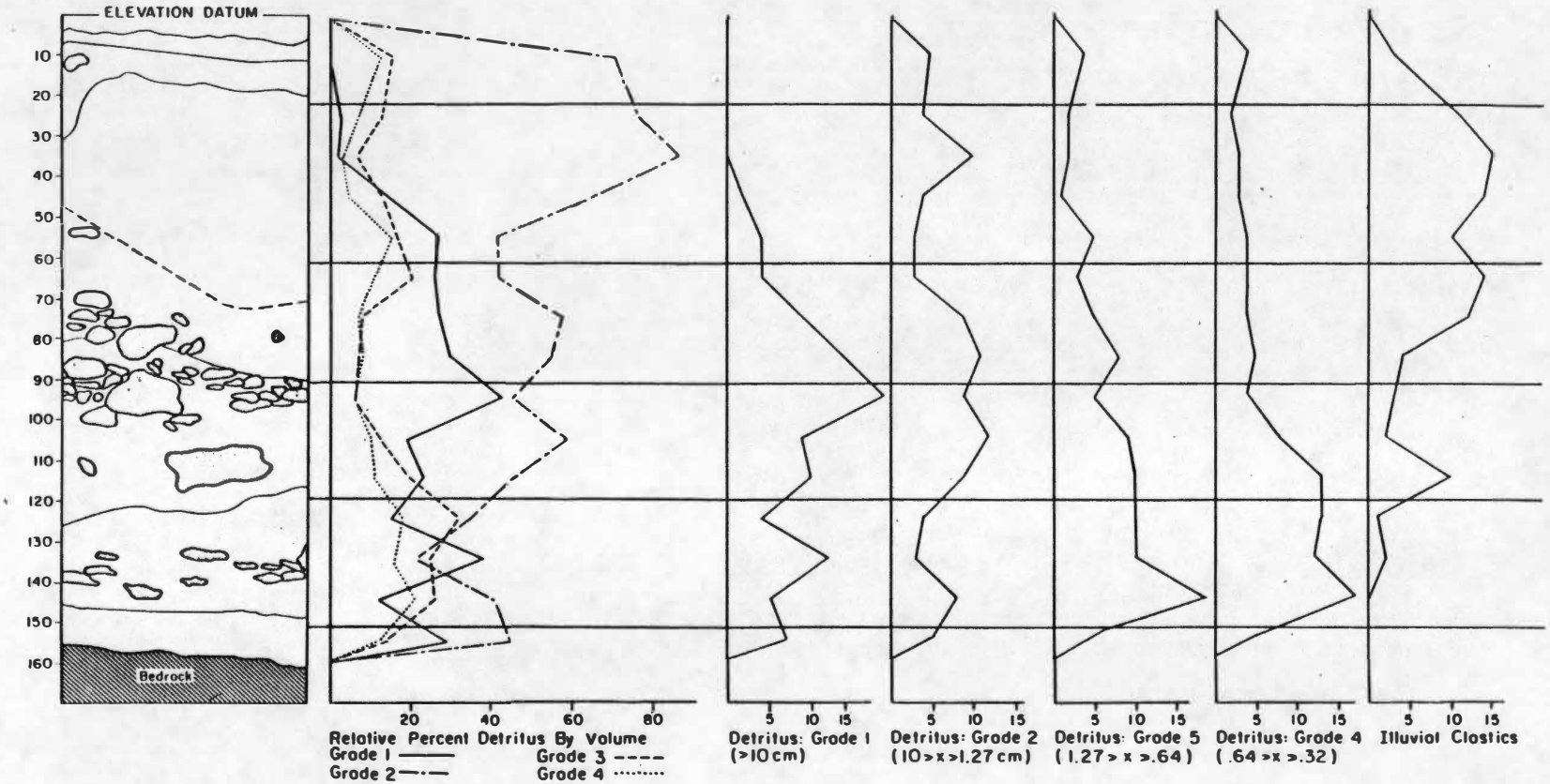


Figure 4.2. Vertical distribution of limestone detritus and illuvial clastics.

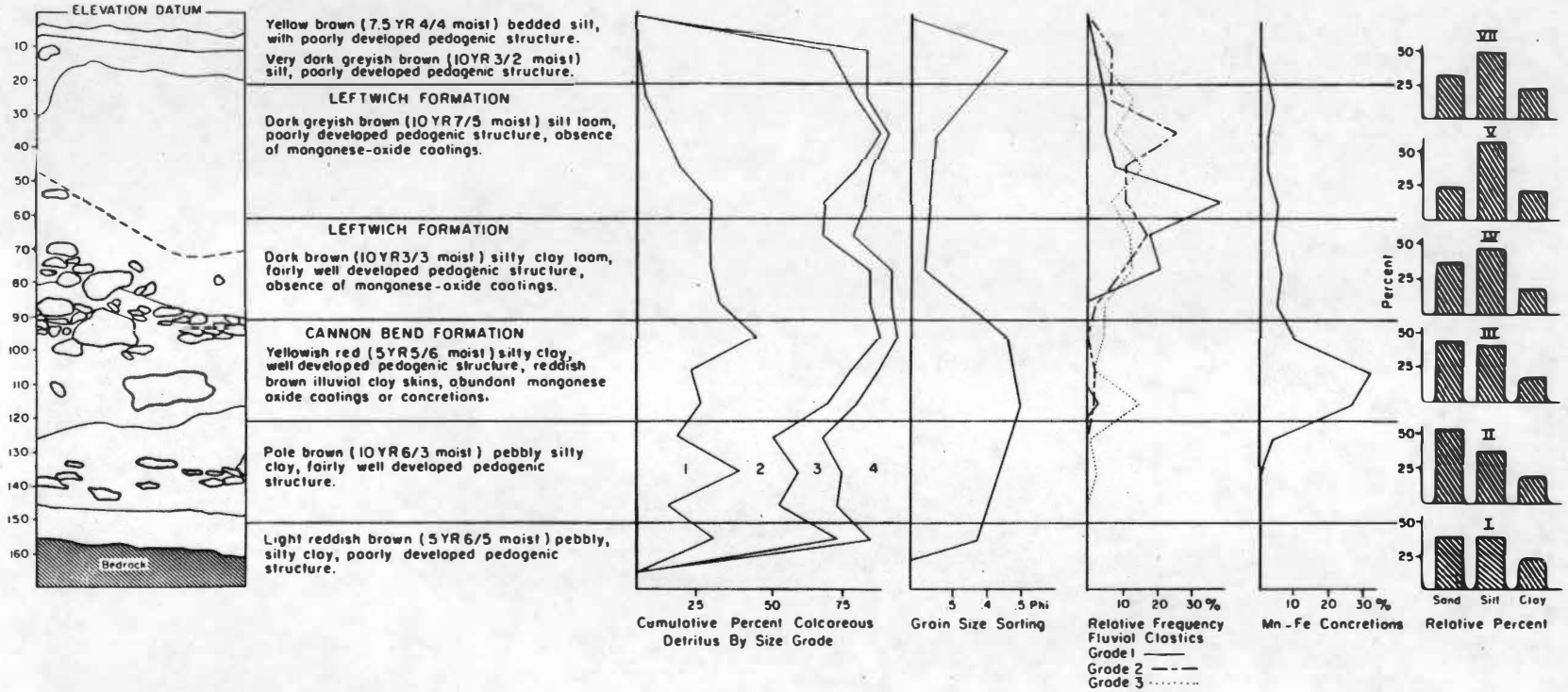


Figure 4.3. Vertical distribution of the sedimentary components.

(Figure 4.2). Given the assumptions concerning the importance of available moisture on the thermoclastic process, it is apparent that precipitation increased dramatically during the period represented in levels 6-9, resulting in rapid primary thermoclasticism and a high energy illuvial depositional environment.

Sharp drops in the frequency of larger fraction (grades 1 and 2) detritus at level 6 suggest a decrease in precipitation during this period. While there is also a drop in the frequency of illuvial clastics in level 6, no change is noted in grain-size sorting (Figure 4.2).

In the smaller fraction (grades 3 and 4), a basic trend can be seen in the plots of column and row percentages (Figure 4.2). Relative frequency rises in levels 5 and 6 in response to the sharp decrease in detritus from the larger grades. Not until level 10, however, do significant increases occur. This increase peaks in level 14 where the weathering of detritus is most severe, reflecting the decomposition of bedrock shelf. It is apparent that this pattern is produced from *in situ* weathering of bedrock and post-depositional or secondary thermoclasticism over a long period of time in a dry, cool or cold climate.

Soil Components

Grain-size

Fine soil components from the shelter sediments were investigated through particle-size analysis. The samples were selected from six

levels representative of the macrostratigraphic units. The standard deviation of phi sizes indicates a period of poor sorting in Strata I-III (levels 9-15), suggesting a low energy depositional environment (Figure 4.3) (Butzer 1981:150). Well-sorted sizes are noted for Strata IV and V, representing an increase in hydrodynamic energy during this time. Being comprised of sediments representing the Historic, Mississippian and Late Woodland periods, sorting in Strata I and II is expected to be good. The relative proximity of the sample from these strata to the modern surface of the shelter floor (10 cm below surface) and to contemporary groundhog disturbance increases the chances that post-depositional mixing has occurred and throws doubt on the results obtained in this analysis.

Textural Classes

Results of the analysis of textural classes including sand, silt and clay are graphically presented for each strata sampled (Figure 4.3). The sand category phi sizes range from 4.0 to 2.0 and hence include granules slightly larger than coarse sand (Folk 1974:25). Relative percentages of these three components indicate that Stratum I sand and silt ratios were almost equal, with a relatively large clay component as well. Although minerological and morphological analyses of the fine soil components were not conducted with these sediments, it is expected that they are derived, in part, from the decomposition of the limestone fill. This is expected to be a particularly important source for the sand component in Strata I-III.

As the grain sizes are more well sorted in the upper strata, there is a corresponding increase in the relative frequency of silt and a slight reduction in sand. These data support the interpretation that the sediments composing Strata IV-VII were deposited in a hydrodynamic environment of higher energy. Although exact sand-silt-clay ratios from the shelter fill do not correspond well with those analyzed from open-site alluvial terraces along the Duck (Brakenridge 1984:16), the tendency for higher percentages of silt in the younger deposits suggests an increase in alluviation in the upper strata beginning with Stratum IV.

Illuvial Clastics

The analysis of the coarse illuvial clastics from the shelter fill consisted of simply size sorting and quantifying the corticated pebbles. The four fractions correspond to the same screen mesh sizes employed with the calcareous detritus. It is expected that the majority of this gravel was deposited as coarse fluvial bedload. The presence of the smaller fraction in level 13 suggests that initial aggradation of alluvial sediments may have begun at this time. Evidence for increased fluvial deposition is provided by the marked increase in gravel in level 11, but this is followed by reduced frequency in levels 10-8. A major phase of sediment aggradation is indicated for the upper levels, beginning with level 7. There is a reduction in the overall occurrence of gravel in level 5 (Figure 4.2) which is masked in the plot of relative row percentages (Figure 4.3)

by the presence of numerous larger fraction pebbles. This pattern may, in part, be influenced by differential vertical movement of the various sizes of gravel (Baker 1978) or by sampling bias. The absence of fine fraction illuvial clastics in level 1 is undoubtedly a sampling error, but has little affect on the overall patterns illustrated.

Ferric Concretions

The quantity of ferrous and/or manganese concretions present in the shelter sediments are presented as a plot of column percents in Figure 4.3. A sharp increase in level 11 suggests that Stratum III may be a paleosol representing a period of relative flood-plain stability. Marked pedogenic soil structure and a low silt to sand and clay ratio support this interpretation. The significant reduction in concretions in level 9 suggests the initiation of a period in which sedimentation was dominant over pedogenisis.

Stratigraphy

Seven strata are identified at Hayes Shelter on the basis of the macroscopic characteristics of soil color, texture, and pedogenic structure (Figure 4.1). Analyses of sediment samples from these visibly distinguishable units further demonstrate their distinctiveness. Comparison with descriptions of terrace formations from elsewhere on the Duck (Amick 1983, 1984b; Brakenridge 1982, 1984; Hofman 1981) provide a basis for the assessment of the relative

chronological contexts of cultural materials and for the implementation of a preliminary paleoenvironmental model.

Stratum I

The strata immediately above the Ordovician Ridley Formation limestone in units 1019N1000E and 1019N1001E is approximately 10 cm thick and is characterized as a light reddish brown (5 YR 6/3, moist), pebbly, silty clay with poorly developed pedogenic structure. Soil color, when trowelled, appears as a buff tan due to decomposing detritus. Analysis indicates that the soil is composed of a high percentage of clay-size particles in this stratum (Figure 4.3). Limestone detritus in this level was densely packed and tabular. The soft, friable texture of the detritus suggests that it may be largely derived from decomposing bedrock. In addition to the tabular, friable detritus, the matrix included dense, highly eroded rubble in the smaller size fractions (<.64 cm).

Though sediment analyses indicate that the clay and sand component is relatively high in this strata (Figure 4.3), the pedogenic structure is poorly developed. It is expected that many of the matrix components are derived from the decomposition of the surrounding bedrock. Grain-size indicates poor sorting (Figure 4.3), which reflects a low energy hydrodynamic depositional environment (Butzer 1981:150). These data suggest that Stratum I is characterized primarily by the *in situ* decomposition of the bedrock resulting in the development of saphrolitic residuum extending about 10 cm above the bedrock.

Stratum II

This stratum varies in thickness, ranging from 10-35 cm above the Paleozoic bedrock. In the center unit (1010N1001E) soil color is pale brown (10 YR 6/3, moist) and texture consists of pebbly, silty clay with a relatively well-developed pedogenic structure. Soil samples from this stratum indicate poor sorting of grain sizes with a high relative percent of granule and sand size particles with respect to silt and clay. Frequencies of ferric concretions are low in this stratum and fluvial clastics occur infrequently only in the smallest fraction (Figure 4.3). Relative frequency of limestone detritus in this stratum indicates an increase in the grade 1 (>10 cm) fraction (Figure 4.3). This is, in part, influenced by the apparent in situ decomposition of the bedrock ledge which occupies much of levels 13 and 14 (Figure 4.3).

As with Stratum I, the detritus in this stratum was densely packed and tended to be tabular, oriented horizontally, in layers or lenses especially near the bedrock ledge. Relatively high frequencies of detritus in the smaller size grades (3 and 4) suggest extensive thermoclasticism. Based on the assumptions outlined, the detritus in this stratum appears to have been subjected to a high frequency of freeze-thaw cycles producing high relative frequencies of small fraction rubble. The evidence for decomposition of the bedrock suggests that the pattern exhibited by the fine fraction rubble is the result of secondary, rather than primary, thermoclastic action. Direct indications of paleoclimatic variables for this period are

largely masked by the effects of post-depositional frost action. Sufficient moisture and freezing for secondary thermoclasticism are implied.

Grain-size sorting, fluvial clastics, and soil textural patterns indicate a period of low hydrodynamic energy and restricted alluvial deposition (Figure 4.3). The very limited presence of ferro-manganese concretions further suggests a reduced rate of pedogenisis. The sedimentological character of Stratum II is significantly influenced by the decomposition of the surrounding limestone. The age of the stratum can only be inferred from its stratigraphic position, but is probably Pleistocene-Early Holocene age.

Stratum III

The contact between Strata II and III is fairly distinct between 130 and 105 cm (below datum) and Stratum III ranges from 25 to 50 cm in thickness. Soil color for Stratum III is yellowish red (5 YR 5/6, moist). Texture is a silty clay with well-developed structure of subangular peds which exhibit reddish-brown illuvial clay skins. Ferro-manganese concretions are common in this stratum.

Detritus in Stratum III from the central unit is characterized by a pronounced decrease in the frequency of the smaller fraction (<.64 cm) and a marked increase in the larger fraction (Figure 4.2). Initial increases in the frequency of large fraction rubble begin in level 11 and peak in level 9 (Figure 4.2). Level 9 also shows a distinct pattern of a very high frequency of grade 1 rubble and decreases in each of the smaller fractions (Figure 4.2). Inspection

of the north profile wall shows the overall pattern of the largest blocks of rubble deposited toward the middle of Stratum III with smaller grade 1 clasts densely packed in level 9 (Figure 4.2).

The presence of the very large boulders of roof spall in the middle levels of Stratum III suggests a period of more intense freezing in terms of absolute minimum temperatures and/or the duration of freezing cycles or a significant increase in available moisture. The increase in the smaller grade 1 blocks (obvious in Figure 4.2) also suggests a shift in climate, perhaps reflecting amelioration of frigid temperatures and/or changes in the available moisture.

The grain-size sorting index decreases only slightly during this period but drops precipitously, reflecting better size sorting in levels 7 and 8 (Figure 4.3). There is an increase in illuvial clastics in level 11 (Figure 4.3) which reflects increases in the grade 3 ($.64 > x < .32$ cm) fraction. This represents an increased influx of illuvial sediment, but with moderate hydrodynamic energy. Textural class ratios indicate an increase in the percent of silt-size particles (Figure 4.3), also reflecting a more active illuvial environment.

A dramatic increase in the number of ferro-manganese concretions is also noted in this stratum (Figure 4.3). The presence of these concretions indicates a period of floodplain stability and the possible development of a paleosol. The pedogenic structure of subangular blocks from levels in this stratum also support this interpretation. Apparently, evidence for pedogenisis and sedimentary

deposition, indicate that illuvial aggradation was proceding coevally, perhaps as the inwashing of fine sediments from higher portions of the floodplain.

Macroscopic parameters of color, texture, and structure for Stratum III correspond reasonably well with the description of Cannon Bend Formation soils from open sites on the Duck (Brakenridge 1984:13). Textural sand-silt-clay ratios, however, show a higher percentage of silt than expected. If this interpretation is assumed, the age of lower limits of this strata at its contact with Stratum II would be approximately 10,000 B.P. and the upper limits, or contact with Stratum IV, 6400 B.P. (Brakenridge 1984:19). The 3600 year period represented by Stratum III spans the Early and most of the Middle Archaic Periods as the culture chronology is currently understood for the Duck River valley (Amick et al. 1985:21, Appendix A; Brakenridge 1984:19; Hall et al. 1985:63).

Stratum IV

The lower limits of Stratum IV range from 50-70 cm above the bedrock floor to about 80 cm below the surface datum. The contact between Strata III and IV is clearly discernible through the observation of macroscopic soil characters. Soils in Stratum IV are generally a dark brown color (10 YR 3/3, moist) and exhibit relatively well-developed pedogenic structure, although the blocks lack the red clay skins typical of Stratum III. Grain-size sorting shows dramatic increases in this stratum and silt is the predominant soil textural class. Illuvial clastics also increase significantly in this stratum

as the frequency of ferro-manganese pebbles is sharply reduced (Figure 4.3).

The contact between Strata III and IV is also easily distinguished in the central unit (1019N1001E) by a concentration of limestone detritus in level 9 (Figure 4.3). Relative percentages of the size fraction in level 9 indicate a significant increase in the grade 1 detritus with reductions in the frequency of each of the other grades (Figure 4.3). If, as assumed, the production of small fraction detritus depends on frequent freeze-thaw cycles and adequate moisture to promote frost fracturing (secondary), then the reduction in small fraction rubble in this level may indicate a warmer or dryer period. The apparent increase in grade 1 detritus in this level, then, may denote a period when secondary thermoclasticism was significantly reduced.

The overall trend in the frequency of rubble in Stratum IV shows a reduction in all size grades (Figure 4.2). Relative frequencies indicate a slight increase in the smaller (<.64 cm) fraction in the uppermost level (Figure 4.3). This trend suggests that the climatic conditions necessary for the primary fracturing of spalls under this area of the overhang were increasingly poor during this period, while conditions necessary for increased secondary thermoclasticism became more common toward the end of the period. The inference here is that freezing cycles were becoming more frequent and/or moisture was more available through the period in which Stratum IV was deposited.

A dramatic drop in the grain-size sorting index in Stratum IV, denoting sediment deposition in a high energy environment, suggests that the availability of moisture significantly increased during the period in question (Figure 4.3). This pattern is complimented by an increase in the relative percentage of silt sized particles and in the frequency of illuvial clastics (Figure 4.3).

The macroscopic characteristics of the soil in Stratum IV closely approximates descriptions by Brakenridge (1984:16) for Leftwich formation soils with higher percentages of silt and an infrequent occurrence of manganese concretions. Although Brakenridge identifies several depositional phases within the Leftwich formation, its contact with the Cannon Bend soils apparently dates to about 6400 B.P. (Brakenridge 1984:19). Artifacts recovered from the lower member of the Leftwich formation soils from buried site contexts elsewhere on the Duck have been confidently dated to the Middle and Late Archaic periods (Amick 1983, 1985a; Brakenridge 1984:19; Hofman 1981, 1982, 1984a).

Stratum V

The contact between Strata IV and V is identified with difficulty, as it is discontinuous across the north profile (Figure 4.1). The distinction, where observable, may represent the contact between the Leftwich formation subunits T1b1 and T1b2 (Brakenridge 1984:16-19). The contrast between Strata V and VI soils is somewhat sharper and occurs about 20 cm below the surface datum.

Soils in this stratum are a dark greyish-brown color (10 YR 7/5, moist). Some pedogenic structure is present in this silty loam, but the development is far less than noted for Stratum III and somewhat less than for Stratum IV. Distinctions between Strata IV and V are based primarily on color (a greyish hue in the upper member) and are difficult to distinguish in the midst of abundant limestone rubble.

The large fraction (grade 1) limestone detritus in Stratum V decreases steadily. Grade 2 detritus increases significantly (especially in level 3) and the smaller fraction materials remain constant (Figure 4.3). This pattern is difficult to explain. The absence of larger blocks of rubble in this centrally located area may in part be the result of human intervention, although the excavated sample is certainly too small to attempt an explanation of this sort. The general pattern of large rubble distribution, (Figure 4.3) shows fewer large blocks in this stratum throughout the excavation. As the pattern remains about the same from the base of Stratum V to the surface, it is assumed that no major climatic shifts affecting thermoclasticism have taken place during this period.

Grain-size sorting is approximately the same (well-sorted) in Stratum V as noted for Stratum IV. The percentage of silt-sized particles increases slightly as sand and granules decrease (Figure 4.3). This pattern indicates a high energy hydrodynamic environment with active alluvial sedimentation. The high frequency of illuvial clastics in Stratum V is consistent with this interpretation (Figure 4.3).

If Brakenridge's (1984:19) stratigraphic model is implemented, the base of Stratum V dates to about 3900 B.P. and its contact with Stratum VI (T1b3) to 2600 B.P. Artifacts affiliated with both Late Archaic and Early Woodland culture periods have been recovered from upper Leftwich formation sediments in dated context on other sites in the Duck valley (Amick 1983, 1985; Amick et al. 1985; Brakenridge 1984; Hall 1985; Hall et al. 1985a; Klippel and Parmalee 1982). One of the diagnostic traits of the Leftwich Upper member (T1b2, T1b3) which Brakenridge (1984:16) identifies is the presence of Woodland ceramics. A few unidentifiable small ceramic fragments were found between 30-40 cm below the surface in the central unit at Hayes Shelter.

Stratum VI

This stratum is identified with difficulty as it is discontinuous across the profile (Figure 4.1). The distinction between Strata V and VI is (where observable) made on the basis of darker greyish-brown color (10 YR 3/2, moist), silty texture, and a poorly developed pedogenic structure. This stratum is 15 cm thick at its maximum point and is covered by a thin veneer of bedded silt lenses of historic alluvium.

Small fraction (<.64 cm) limestone detritus appears to increase in levels 1 and 2 (Figure 4.3). This is, in part, a function of sampling bias as the upper two levels (1 and 2) were excavated as one unit. As noted for Stratum V, the continuity of the distribution of detritus between Stratum V and the surface indicates that no major

climatic shifts promoted significant changes in the production of thermoclasts during the period in question.

The grain-size sorting index indicates a shift toward greater deviation of sizes, denoting poor sorting (Figure 4.3). This pattern is complemented by a decrease in all grades of illuvial clastics from levels 3-1 (Figure 4.3). The inference is that there was a reduction in the energy of the hydrodynamic environment and in the rate of sedimentation during this period. Although pollen data in the Midwest suggest short-term climatic changes since 4000 B.P. (Bernabo 1981; King 1981), the amount of vegetational change and inferred climatic change in Tennessee during this period are relatively small (H. Delcourt 1979). The pattern exhibited by the sedimentary data from this stratum is not easily related to independent records of Quaternary environmental change.

Although radiocarbon assays have not been made on samples from the T1b3 formation, diagnostic artifacts and dates in the formations above and below the T1b3 suggest a date of 2600 B.P. for the contact with Stratum V and 150 B.P. (A.D. 1800) for the base of Stratum VII (Brakenridge 1984:19). Thus bracketed, this stratum could contain Early Middle Woodland through Historic Period artifacts (Amick et al. 1986, Appendix A).

Stratum VII

Stratum VII is composed of yellow brown (7.5 YR 5/4, moist) silt which is bedded or deposited in thin lenses. The texture of the soil is fine sandy silt which tends to be very dry and exhibits no

pedogenic developmental structure. This stratum is considered to be historic alluvium, as excavations produced numerous modern artifacts including wire nails and .22 caliber cartridges. Brakenridge (1984:19) suggests that the deposit began to accrete about 150 B.P.

Conclusion

The seven sedimentary units identified at Hayes Shelter are defined on the basis of variation in the macroscopic color, texture, and structure, the size distribution of detritus, soil grain size ratios, and the frequency of illuvial clastics and ferricrete pebbles. These units are associated with the model of episodic alluvial sedimentation and the formation of the terrace sequence as previously developed for the Central Duck River Basin (Brakenridge 1982, 1984). Lacking absolute dates, the association of sedimentary units with those previously identified allows the implementation of this general relative chronological scale.

Strata I and II are interpreted as primarily influenced by the decomposition of the Ordovician limestone bedrock directly below them. They do not correspond well to any previously identified terrace formation and are virtually sterile of human occupational debris.

Stratum III, characterized by red brown color, well-developed pedogenic structure and the common occurrence of ferricrete pebbles, is associated with the Cannon Bend formation (Brakenridge 1984:13). The suggested chronological range is from 10,000 to 6400 B.P., and encompasses the Early and most of the Middle Archaic Periods.

Detritus patterns from the central unit indicate a significant increase in the frequency of larger fraction clasts which are interpreted as indicating a dramatic increase in available surface moisture at the end of this period. It is suggested that this may represent climatic amelioration at the end of the Hypsithermal Interval.

On the basis of soil characteristics, Strata IV, V, and VI are associated with the Leftwich formation (Brakenridge 1984:16). These include dark, grey-brown color, fairly well-developed pedogenic structure, and the occasional but less frequent occurrence of ferricrete pebbles. Also noted in these strata are very well-sorted grain-sizes, higher percentages of clay in the textural classes, and an increase in illuvially deposited clastics. This suggests a dramatic increase in precipitation resulting in active floodplain deposition during this period. It is suggested that Stratum IV corresponds to the Late Middle and Late Archaic Periods, while Stratum V represents Late and Terminal Archaic times, with Early Woodland manifestations occurring as Stratum VI was deposited.

Stratum VII corresponds with the Sowell Mill formation (Brakenridge 1984:19) and is composed of historic alluvial deposits. It is assumed to have begun to accrete about 150 years B.P.

In addition to this assessment of the sediments as a means of establishing a relative chronology and environmental setting for the strata defined, temporally restricted artifact types and faunal specimens are employed. In the following sections, the analysis of

the cultural debris and floral and faunal remains will further establish the chronology and paleoenvironmental scenario.

Cultural Deposits

The relative proportions of cultural materials are presented in Figures 4.4 and 4.5. In each graph the relative percent (column) and the percent per cubic centimeter are plotted. The volume measures were calculated as described in Chapter III and control for the variability in the actual soil volume from each level through an estimation of the displacement of the limestone detritus. These figures (4.4 and 4.5) demonstrate that the relative percentages corrected for the volume in each level closely approximate those simply calculated as column percentages. Comparisons in the subsequent chapters were, consequently, conducted without correcting for volumetric variability.

The lithic debris from the shelter is simply divided into flake and non-flake categories. Frequencies indicate that both classes occur throughout the deposits beginning in the Middle Archaic stratum (III). In this stratum non-flake debris is much more common than flake debris. This pattern is restricted to the Middle Archaic stratum, with later frequencies from these two classes covarying similarly. Judging from the flake debris the most intensive occupation of the shelter occurred during the Late Archaic Period with a slight drop during the Terminal Archaic and Early Woodland (Figure 4.4). The frequency of small pieces of fired clay may also indicate

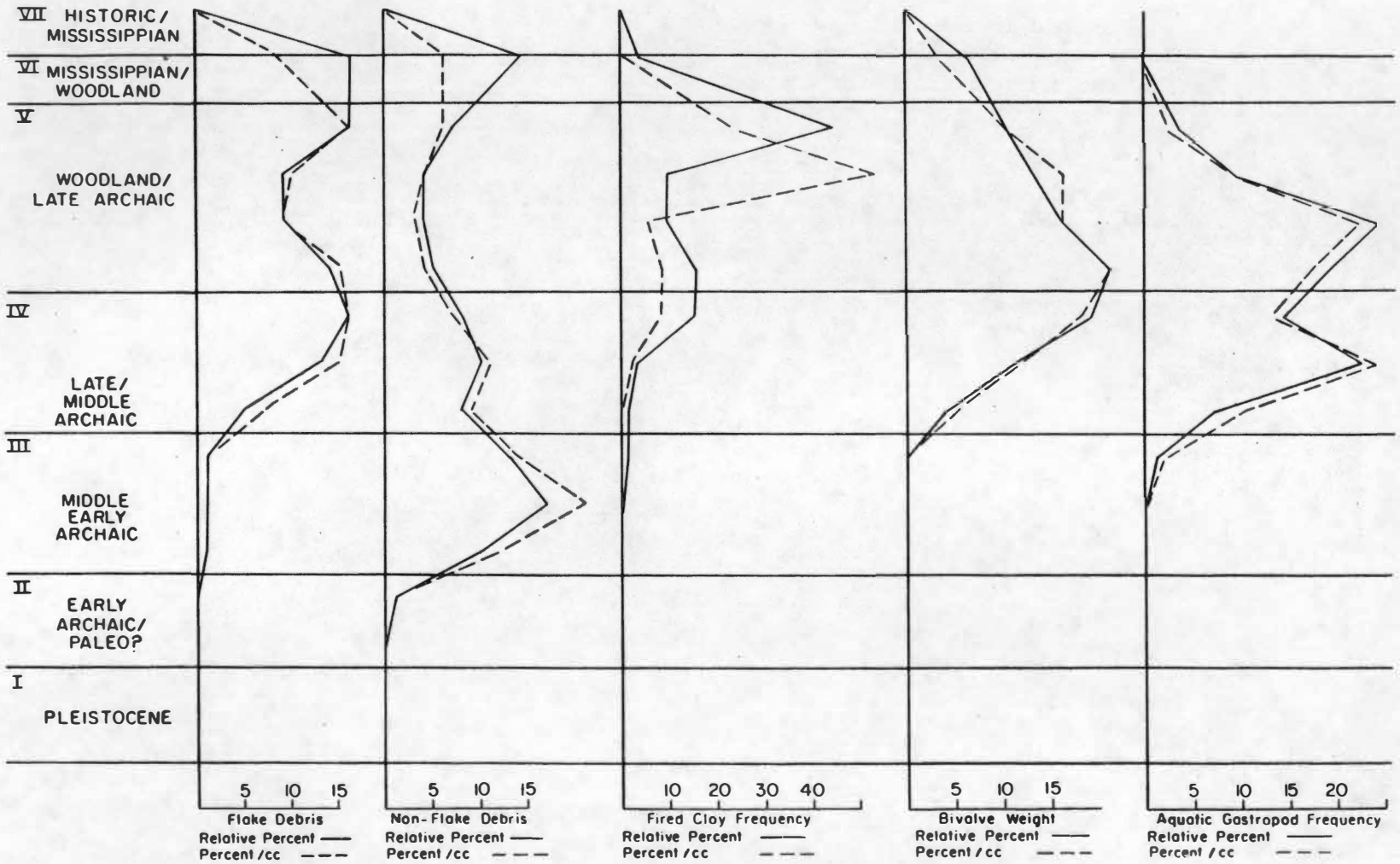


Figure 4.4. Vertical distribution of selected artifact categories.

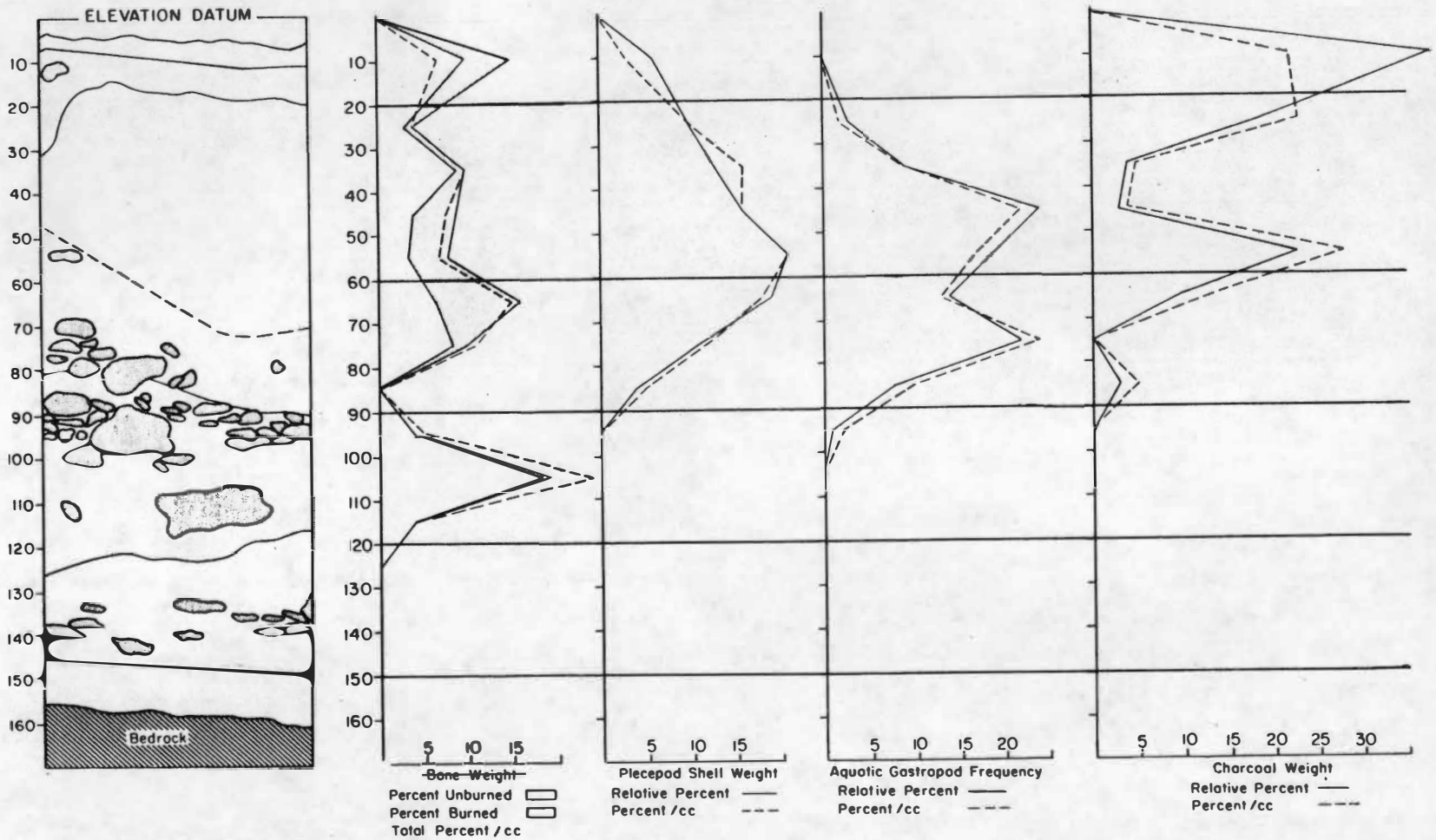


Figure 4.5. Vertical distribution of the faunal and floral remains.

the intensity of use and show a similar pattern. These objects are most numerous in the Late Woodland- and Mississippian-age sediments.

The frequency of faunal and floral remains also points to the Late Middle Archaic as the period when the shelter first began to be used. The high frequency of unburned bone in the Middle Archaic stratum (Figure 4.5) is a result of numerous snake vertebrae in this stratum which may be naturally rather than culturally introduced. Bivalve and aquatic gastropod frequencies suggest a Late Archaic time for their first use which appears to decline in Woodland and Mississippian times. Percentages of charcoal (both wood and nutshell) closely mirror the frequency of pieces of fired clay presented in Figure 4.4 and reflect a decrease during the Early Woodland and a subsequent increase in the Late Woodland and Mississippian.

The spatial distribution (in two dimensions) of culturally diagnostic artifact types is illustrated in Figure 4.6. The occurrence of meadow vole (Microtus pennsylvanicus) remains in Stratum III suggests an early Middle Holocene association. The diagnostic lithic tools and ceramics are described in Chapter V. Their spatial context helps to substantiate the chronological model for the sedimentary units in a general way, but the potential for vertical mixing is obvious. Hofman (1984a:92-142, 1986) has demonstrated that vertical dispersion of artifacts in the Duck River terrace sediments is commonly as much as 30 cm and may result from a variety of natural causes. Figure 4.6 also illustrates the schema used to associate each level with a stratigraphic unit.

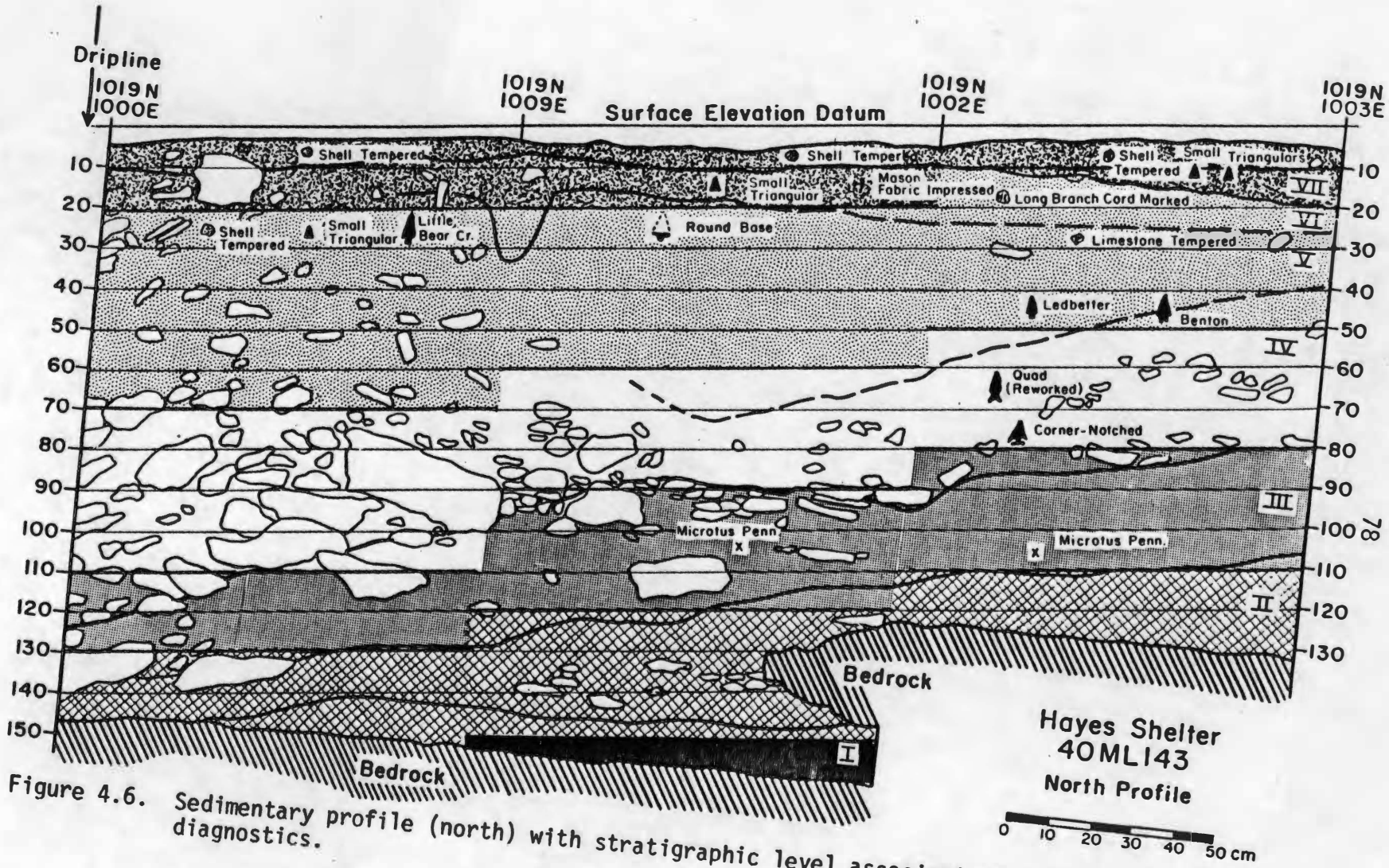


Figure 4.6. Sedimentary profile (north) with stratigraphic level associations and cultural diagnostics.

CHAPTER V

ANALYTICAL RESULTS

Analysis of the remains from Hayes Shelter includes a consideration of the aboriginal lithic and ceramic artifacts, faunal and floral remains, and historic debris. The methods of laboratory analysis and classification were discussed in Chapter II, and a discussion of the results of these investigations follows.

Lithics

It has been noted previously that for the present analysis the lithic classification system is designed to identify technological classes. Artifacts traditionally classified as stylistic types are here considered simply as morphological classes which are temporally limited. Since the means for identifying functional evidence with the requisite microscopic use-wear analysis was beyond the range of this study, functional interpretations are not extended. A description of the debitage, flake tools, bifaces, and temporally restricted bifacial tools follows.

Debitage

Over the past decade debitage analyses have been recognized as a significant aspect of lithic studies. In part, this interest has been stimulated by the recognition that, as an economically unimportant by-product (waste), debitage is perhaps less biased by the socioeconomic behavior patterns which ultimately influence how tools,

produced in the final segments of the reduction/use trajectory, are curated, transported, and reworked (Bamforth 1986; Binford 1979; Jeffries 1982:99; Jelinek 1976:21-22; Terrence 1983). Recent studies in the Midsouth have demonstrated that patterns in lithic debitage are directly influenced by the proximity of the site location to the resource location (Jeffries 1982; Johnson 1981b) and by the specific segments of this reduction process conducted at the site (Amick 1984b, 1985c; Raab et al. 1979; Stahle and Dunn 1982), both of which may be monitored through spatial and temporal comparisons.

The classification of debitage from Hayes Shelter employs seven categories, including blocky debris, primary decortication flakes, secondary decortication flakes, tertiary or interior flakes, biface-thinning flakes, core-rejuvenation flakes, and retouch flakes. These classes are defined in Chapter II and formatted in Appendix A. A bivariate frequency table of debitage among those classes for each of the stratigraphic units is illustrated in Table 5.1. Considering those classes as reflecting stages in the reduction sequence yields some interesting results.

A very strong pattern is reflected by the values for Stratum III (and below) as opposed to the upper strata. Stratum III, which is interpreted as primarily Middle Archaic, exhibits frequencies of blocky debris much higher than expected given row and column totals in the table, while all other later stage debitage frequencies are far smaller than expected. This pattern is reversed for the Late Archaic and Woodland assemblages, where expected values for blocky debris are

Table 5.1. Bivariate frequency distribution of debitage reduction classes by stratigraphic assemblage.

Observed Expected	Debitage Reduction Classes						
	Early			Intermediate	Late		
Stratigraphic Assemblages	Blocky Debris	Primary Decortication Flakes	Secondary Decortication Flakes	Tertiary Flakes	Biface Thinning Flakes	Core Rejuvenation Flakes	Total
VII Historic/Mississippian	13 22.3	0 0.6	21 10.3	24 25.5	2 1.4	0 0.0	60 (.008)
VI Mississippian/Woodland	301 378.3	8 10.4	259 174.8	402 433.1	49 23.2	1 0.3	1020 (.13)
V Terminal/Late	727 1068.5	38 29.4	557 493.8	1498 1223.2	60 65.4	1 0.7	2881 (.37)
IV Late/Middle Archaic	819 1018.0	33 28.0	486 470.5	1344 1165.4	63 62.3	0 0.7	2745 (.35)
III Middle/Early Archaic	842 340.8	1 9.4	15 157.5	58 390.2	3 20.9	0 0.2	919 (.12)
II Early Archaic/Paleo?	206 80.1	0 2.2	6 37.0	3 91.7	1 4.9	0 0.1	216 (.03)
Total	2908 (.37)	80 (.01)	1344 (.17)	3329 (.42)	178 (.02)	2 (.0003)	7841

greater than those observed, while the observed number of later stage flakes are greater than the expected values. (Note that X^2 tests were not performed because expected cell frequencies are too small in many cases.)

The evenness of the distribution of artifacts into the different classes was compared to the expected random evenness given the assemblage sample sizes. The results of this test for the debitage classes are graphically depicted in Figure 5.1. In this plot it is evident that the Mississippian and Woodland assemblages are more even than expected based on their sample size, while the Terminal and predominantly Late Archaic assemblages are slightly less even than expected. The extremely divergent values for the Middle and Early Archaic assemblages (Strata II and III) indicate that their distributions are far less even than expected. The pattern exhibited by these data suggests temporal differences with the later assemblages more evenly distributed.

It is notable that primary decortication flakes and biface thinning flakes are relatively rare from Hayes Shelter. The absence of retouch flakes is undoubtedly a function of the minimum screen size (.64 cm^2), and the scarcity of corticated flakes may be a function of raw material selection.

As one means of internal control, the frequency distribution matrix for debitage from the two units nearest the bluff wall (1019N1001E and 1002N1001E) were compared with the results described above. As these units were composed of reasonably well-defined strata

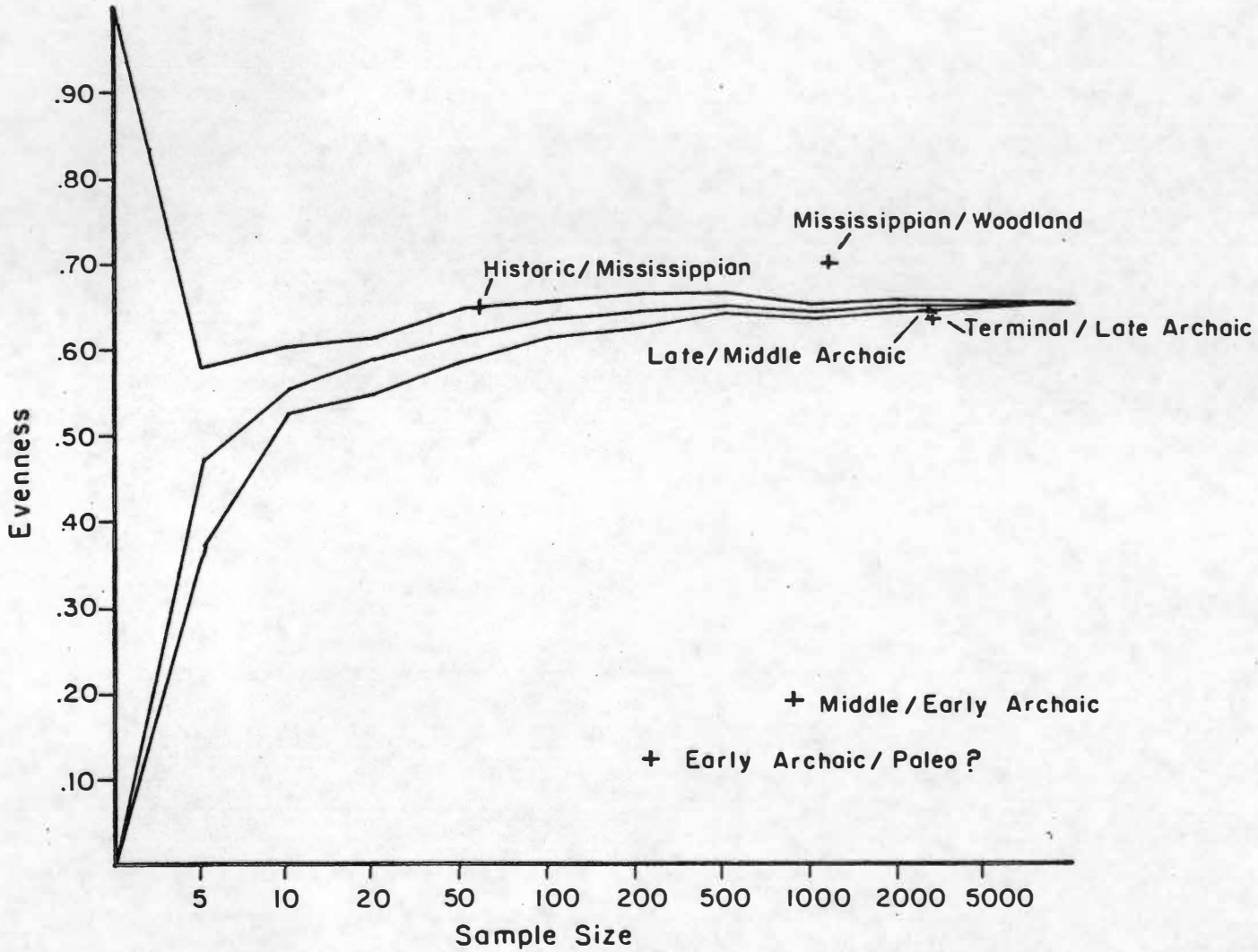


Figure 5.1. Plot of the mean and 95% confidence interval of the evenness of debitage classes for each stratigraphic assemblage.

from which the model of the stratigraphic cultural units was developed, the comparison was considered an appropriate control. Results (Table 5.2) reflect the same general pattern demonstrated for the entire shelter sample. Additional comparisons of results obtained from the sample employing all three units, and those obtained from the two units nearest the back wall (or just the central 1 m^2 unit,) indicate that the patterns reflected in each case were similar. This shows that the patterns of vertical distribution of debitage are not significantly affected by the sample location from the back wall, and also encourages confidence in the consistency of the stratigraphic designations.

The distribution of raw materials among the debitage classes from the shelter units indicates the importance of the locally available Middle Ordovician cherts (Table 5.3). Ridley and Carters cherts account for 73% of the sample total, while Fort Payne comprises 21%, and Upper Ordovician materials only 3%. When the same table is generated for the central unit sample, the percentages of Middle Ordovician (76%), Upper Ordovician (3%), and Mississippian (21%) resources are very similar to the larger sample (Table 5.4).

The question of changing resource selection strategies through time is assessable through a comparison of the distribution of raw materials among the stratigraphic cultural units. Table 5.5 illustrates the distribution of raw materials within the class of debitage. Stratum III shows observed frequencies of Ridley chert higher than expected, while the reverse is true for Fort Payne

Table 5.2. Bivariate frequency distribution of debitage reduction classes by stratigraphic assemblage for the two units nearest the back wall.

Observed Expected	Debitage Reduction Classes						
	Early			Intermediate	Late		
Stratigraphic Cultural Units	Blocky Debris	Primary Decortication Flakes	Secondary Decortication Flakes	Tertiary Flakes	Biface Thinning Flakes	Core Rejuvenation Flakes	Total
VII Historic/Mississippian	13 18.4	0 0.6	21 11.8	24 27.8	2 1.3	0 0.0	60 (.01)
VI Mississippian/Woodland	222 217.5	6 7.3	214 139.9	250 328.4	17 15.8	0 0.1	709 (.13)
V Terminal/Late Archaic	362 542.4	24 18.1	388 348.7	952 818.9	41 39.5	1 0.3	1768 (.32)
IV Late/Middle Archaic	424 669.4	25 22.4	433 430.4	1242 1010.7	58 48.8	0 0.4	2182 (.40)
III Middle/Early Archaic	569 198.2	1 6.6	15 127.4	58 299.2	3 14.4	0 0.1	646 (.12)
II Early Archaic/Paleo?	85 29.1	0 1.0	6 18.7	3 44.0	1 2.1	0 0.0	95 (.02)
Total	1675 (.31)	56 (.01)	1077 (2.0)	2520 (.46)	122 (.02)	1 (.0002)	5460

Table 5.3. Bivariate frequency distribution for raw material types by debitage types.

Observed Expected	Raw Material Types							
	Middle Ordovician		Upper Ordovician and Silurian			Mississippian		
Debitage Types	Ridley	Carter	Bigby-Cannon Fine	Bigby-Cannon Coarse	Brass-field	Fort Payne	Indeter-minate	Total
Blocky Debris	2386 2117.0	1 3.7	18 46.7	11 37.4	0 0.4	282 617.4	208 83.4	2906 (.37)
Primary Decortication Flakes	49 58.3	0 0.1	0 1.3	3 1.0	0 0.0	26 17.0	2 2.3	80 (.01)
Secondary Decortication Flakes	976 979.1	3 1.7	25 21.6	18 17.3	0 0.2	313 285.6	9 38.6	1344 (.17)
Tertiary Flakes	2215 2422.9	6 4.2	79 53.4	68 42.8	1 0.4	951 706.7	6 95.4	3326 (.42)
Biface Thinning Flakes	85 131.1	0 0.2	4 2.9	1 2.3	0 0.0	90 38.2	9 5.2	180 (.02)
Core Rejuvenation Flakes	1 1.5	0 0.0	0 0.0	0 0.0	0 0.0	1 0.4	0 0.1	2 (.0001)
Retouch Flakes	0 2.2	0 0.0	0 0.0	0 0.0	0 0.0	3 0.6	0 0.1	3 (.0004)
Total	5712 (.73)	10 (.001)	126 (.02)	101 (.01)	1 (.0001)	1666 (.21)	225 (.03)	7841

Table 5.4. Bivariate frequency distribution of raw material types by debitage classes for the central unit (1019N1001E).

Observed Expected	Raw Material Types							
	Middle Ordovician		Upper Ordovician and Silurian			Mississippian		
Debitage Classes	Ridley	Carter	Bigby-Cannon Fine	Bigby-Cannon Coarse	Brass-field	Fort Payne	Indeter-minate	Total
Blocky Debris	605 531.3	1 1.7	1 8.6	3 7.9	0 0.2	89 147.1	1 3.3	700 (.24)
Primary Decortication Flakes	26 31.1	0 0.1	0 0.5	2 0.5	0 0.0	13 8.6	0 0.2	41 (.01)
Secondary Decortiation Flakes	540 537.3	2 1.7	10 8.7	9 8.0	0 0.2	139 148.7	8 3.4	708 (.24)
Tertiary Flakes	1031 1078.5	4 3.4	23 17.4	19 16.0	1 0.5	338 298.5	5 6.8	1421 (.48)
Biface Thinning Flakes	26 50.1	0 0.2	2 0.8	0 0.7	0 0.0	38 13.9	0 0.3	66 (.02)
Core Rejuvenation Flakes	1 0.8	0 0.0	0 0.0	0 0.0	0 0.0	0 0.2	0 0.0	1 (.0003)
Total	2229 (.76)	7 (.002)	36 (.01)	33 (.01)	1 (.0003)	617 (.21)	14 (.005)	2937

Table 5.5. Bivariate frequency distribution of raw material types among the debitage by stratigraphic assemblages for all shelter units.

Observed Expected	Raw Material Types							
	Middle Ordovician		Upper Ordovician			Mississippian		
Stratigraphic Assemblages	Ridley	Carter	Bigby-Cannon Fine	Bigby-Cannon Coarse	Brass-field	Fort Payne	Indeter-minate	Total
VII Historic/Mississippian	41 43.8	0 0.1	1 1.0	0 0.8	0 0.0	18 12.7	0 1.7	60 (.008)
VI Mississippian/Woodland	746 744.3	7 1.3	32 16.4	22 13.2	1 0.1	211 215.4	1 29.3	1020 (.13)
V Terminal/Late Archaic	2010 2096.4	3 3.7	50 46.3	50 37.1	0 0.4	757 606.6	3 82.6	2873 (.37)
IV Late/Middle Archaic	1965 1996.4	0 3.5	41 44.1	29 35.3	0 0.3	633 577.7	68 78.7	2736 (.35)
III Middle/Early Archaic	810 670.6	0 1.2	0 14.8	0 11.9	0 0.1	30 194.0	79 26.4	919 (.12)
II Early Archaic/Paleo?	137 157.6	0 0.3	2 3.5	0 2.8	0 0.0	3 45.6	74 6.2	216 (.03)
Total	5709 (.73)	10 (.001)	126 (.02)	101 (.01)	1 (.0001)	1652 (.21)	225 (.03)	7824

materials. Again this pattern is reversed for the Late Archaic assemblages (Strata IV and V) with Fort Payne materials being observed more often than expected and Ridley less. Checked against the data from the two units adjacent to the rear wall, the pattern is somewhat more pronounced (Table 5.6).

In a simulation test, values for the mean and 95% confidence intervals of the evenness of the distribution of debitage among the raw material types were calculated. The plot of these values, together with the observed evenness values for each stratigraphic assemblage, is illustrated in Figure 5.2. In this test, all but two of the samples produce evenness values which are within the interval around the mean which includes at least 95% of the trials. These values are considered to be within the expected range of evenness consistent with a random model. Both the Terminal/Late Archaic and particularly the Middle/Early Archaic assemblages have observed distributions which are less even than expected.

When these results are compared with those from the distributions among debitage classes (Table 5.7), three modes of variability exist. The Historic/Mississippian, Mississippian/Woodland, and Early Archaic/Paleo? assemblages exhibit distributions among the debitage classes which are less even or more even than expected and distributions among the raw material types which are within the random model interval about the mean. A second mode is illustrated by the Late/Middle Archaic assemblage which is randomly distributed with respect to both debitage classes and raw material types. And a third

Table 5.6. Bivariate frequency table of raw material types among the debitage by stratigraphic assemblages for the two units adjacent the rear wall.

Observed Expected	Raw Material Types							
	Middle Ordovician		Upper Ordovician			Mississippian		
Stratigraphic Assemblages	Ridley	Carters	Bigby-Cannon Fine	Bigby-Cannon Coarse	Brass-field	Fort Payne	Indeter-minate	Total
VII Historic/Mississippian	41 44.3	0 0.1	1 0.6	0 0.5	0 0.0	18 13.3	0 1.1	60 (.01)
VI Mississippian/Woodland	570 523.3	7 0.9	15 7.7	7 6.2	1 0.1	108 157.5	1 13.3	709 (.13)
V Terminal/Late Archaic	1255 1299.0	0 2.3	17 19.0	19 15.5	0 0.3	466 390.9	3 32.9	1760 (.32)
IV Late/Middle Archaic	1537 1610.5	0 2.8	24 23.6	22 19.2	0 0.4	586 484.7	13 40.8	2182 (.40)
III Middle/Early Archaic	541 476.8	0 0.8	0 7.0	0 5.7	0 0.1	30 143.5	75 12.1	646 (.12)
II Paleo?	80 70.1	0 0.1	2 1.0	0 0.8	0 0.0	3 21.1	10 1.8	95 (.02)
Total	4024 (.74)	7 (.001)	59 (.01)	48 (.009)	1 (.0001)	1211 (.22)	102 (.02)	5452

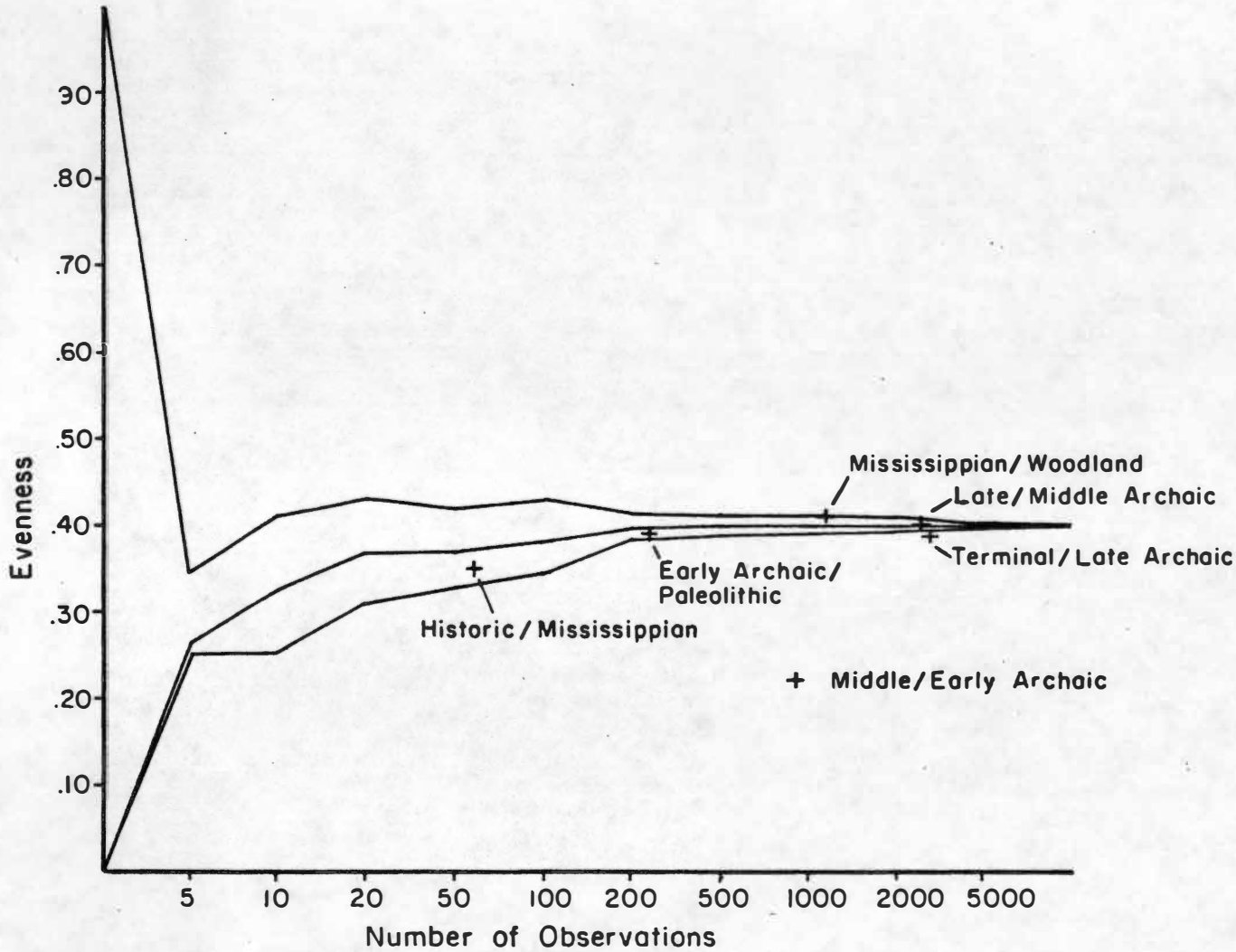


Figure 5.2. Plot of the mean and 95% confidence interval of the evenness of raw material types in the debitage assemblages for each stratigraphic unit.

Table 5.7. Deviation from the mean evenness of raw material in the debitage assemblages from each stratigraphic unit.

Stratigraphic Assemblages	Variable Classes	Deviation From the Mean Expected Evenness		
		Less Even	Random	More Even
VII Historic/ Mississippian	Debitage			x
	Raw Material		x	
VI Mississippian/ Woodland	Debitage			x
	Raw Material		x	
V Terminal/ Late Archaic	Debitage	x		
	Raw Material	x		
IV Late/ Middle Archaic	Debitage		x	
	Raw Material		x	
III Middle/ Early Archaic	Debitage	x		
	Raw Material	x		
II Early Archaic/ Paleo	Debitage	x		
	Raw Material		x	

mode is represented by the Terminal/Late Archaic and Middle/Early Archaic assemblages which show distributions less even than expected for both debitage and raw material classes. In the Terminal/Late Archaic debitage class sample (n = 2881) the 95% confidence interval for evenness is between .6472 and .6548, with 48% of the 25 simulated trials having values greater than .625 (Table 5.8). Although the calculated evenness score is below the lower 95% interval limit, some of the trial scores were as low as the calculated value. This is also true of the values for the raw material distributions in the same assemblage. In the Middle/Early Archaic assemblage, the calculated evenness values in both the debitage and raw material class distributions were far lower than any of the trial scores (Table 5.8). This suggests the possibility of some correlation between the raw material and debitage class distributional patterns in the Middle Archaic assemblage (Stratum III) and certainly points out the deviation of this assemblage when compared to the Late Archaic and later assemblages.

The distribution of cortex and raw material types within the debitage is indicative of both the quality of the material for tool manufacture and the resource procurement location. The frequency distribution table for these variables indicates that observed values for pieces bearing joint-plane (incipient fracture) surfaces and joint-plane/residual (matrix) surfaces are higher than expected for Ridley chert (Table 5.9). The reverse is true for Fort Payne materials, where observed values are less than expected in these

Table 5.8. A comparison of evenness values for the raw material classes in the debitage assemblages from each stratigraphic unit.

Stratigraphic Assemblages	Variable Classes	Calculated Evenness	95% Confidence Interval About the Mean			% Trials = or Between the Mean and Observed Evenness
			Lower	Mean	Upper	
VIII Historic/ Mississippian	Debitage	.6578	.5989	.6275	.6571	.625 < 47% < .675
	Raw Material	.3544	.3677	.3973	.4350	.350 < 56% < .400
VI Mississippian/ Woodland	Debitage	.7065	.6431	.6476	.6532	100% < = .650
	Raw Material	.4080	.3896	.4025	.4176	.400 < 60% < .425
V Terminal/ Late Archaic	Debitage	.6394	.6472	.6510	.6548	.625 < 48% < .650
	Raw Material	.3889	.4021	.4093	.4160	.375 < 96% < .400
IV Late/Middle Archaic	Debitage	.6456	.6449	.6495	.6575	.625 < 64% < .650
	Raw Material	.4005	.3988	.4062	.4132	.400 < 72% < .425
III Middle/ Early Archaic	Debitage	.1941	.6419	.6493	.6552	100% > = .600
	Raw Material	.2230	.3926	.4033	.4131	100% > = .375
II Early Archaic/ Paleo?	Debitage	.1278	.6333	.6468	.6663	100% > = .575
	Raw Material	.3898	.3859	.4026	.4233	.375 > 78% > .425

Table 5.9. Bivariate frequency distribution of raw material types by cortex types for the debitage.

Observed Expected Cortex Type	Raw Material Types Middle Ordovician Ridley	Carter	Upper Ordovician Bigby-Cannon Fine	Bigby-Cannon Coarse	Brass-field	Mississippian Fort Payne	Indeter-minate	Total
No Cortex	914 1247.9	2 2.2	34 27.5	19 22.1	0 0.2	582 364.0	162 49.2	1713 (.22)
Joint Plane (Incipient Fracture)	2332 2237.2	4 3.9	54 49.3	55 39.6	1 0.4	618 652.5	7 88.1	3071 (.39)
Residual (Matrix)	932 780.2	2 1.4	3 17.2	2 13.8	0 0.1	76 227.6	56 30.7	1071 (.14)
Waterworn	19 137.0	0 0.2	8 3.0	7 2.4	0 0.0	154 39.9	0 5.4	188 (.02)
Nodular (Matrix)	2 1.5	0 0.0	0 0.0	0 0.0	0 0.0	0 0.4	0 0.1	2 (.0003)
Residual/Joint	1479 1148.8	2 2.0	11 25.3	3 20.3	0 0.2	82 335.1	0 45.3	1577 (.20)
Waterworn/Joint	34 159.5	0 0.3	16 3.5	15 2.8	0 0.0	154 46.5	0 6.3	219 (.03)
Total	5712 (.73)	10 (.001)	126 (.02)	101 (.01)	1 (.0001)	1666 (.21)	225 (.03)	7841

categories and greater than expected for waterworn cortex types. The indication here is that joint-plane fractures are much more common in association with Ridley than with Fort Payne cherts. As the tendency to fracture along these preexisting planes reduces the control of flake removal, Ridley chert is considered less desirable. The high frequency of residual cortex in Ridley chert and waterworn cortex in Fort Payne chert suggests that the procurement location for Ridley was at the formation outcrop or adjacent residual soils. The source location for Fort Payne, on the other hand, was more likely lag gravel bars. These results are expected on the basis of Amick's (1981, 1984b) gravel bar survey. In addition, the frequency of Ridley debitage which lacks any type of cortex is less than expected, while Fort Payne flakes with no cortex present are much more frequent than expected. This situation suggests that the initial cortex removal of Fort Payne river gravels was being conducted off the site while Ridley residual decortication was being carried out under the shelter.

The consideration of thermal alteration, including categories of debitage not heated, possibly heated, definitely heated, heated after flaking and heated before final modification distributed among the raw material types, also provides information on the technological system. The shelter sample indicates that Ridley and Fort Payne cherts are characterized by different patterns of heat treatment (Table 5.10). More flakes of Ridley showing no evidence of thermal alteration were observed than expected, while the contrary was true for Fort Payne materials. This pattern is reinforced since more possibly heated

Table 5.10. Bivariate frequency distribution of raw material types by thermal alteration classes for the debitage.

Observed Expected	Raw Material Types							
	Middle Ordovician		Upper Ordovician and Silurian			Mississippian		
Thermal Alteration Classes	Ridley	Carters	Bigby-Cannon Fine	Bigby-Cannon Coarse	Brass-field	Fort Payne	Indeter-minate	Total
Not Heated	1373 1234.0	4 2.2	3 27.2	3 21.8	0 0.2	103 360.0	208 48.6	1694 (.22)
Possibly Heated	2588 2875.2	6 5.0	94 63.4	79 50.8	0 0.5	1163 838.7	17 113.3	3947 (.50)
Definitely Heated	1710 1529.0	0 2.7	25 33.7	17 27.0	1 0.3	346 446.0	0 60.2	2099 (.27)
Heated After Flaking	40 70.7	0 0.1	4 1.6	1 1.2	0 0.0	52 20.6	0 2.8	97 (.01)
Heated Before Final Modification	0 2.2	0 0.0	0 0.0	1 0.0	0 0.0	2 0.6	0 0.1	3 (.0004)
Total	5711 (.73)	10 (.001)	126 (.02)	101 (.01)	1 (.0001)	1666 (.21)	225 (.03)	7840

pieces of Fort Payne are observed than expected; the opposite is true for Ridley. The fact that there are fewer definitely heated pieces of Fort Payne and more Ridley than expected is curious. This suggests that the process of heat treatment was perhaps different for these two materials, though the nature of the difference is undetermined.

In summary, the debitage from Hayes Shelter provides information on the technological systems of lithic tool manufacture through prehistory. The following interpretations are cautiously advanced. Middle Ordovician cherts, especially the Ridley residual chert which is currently eroding from the exposed bluff matrix, was the predominant resource exploited in this location throughout prehistory. There is, however, an apparent increase in the use of Fort Payne which coincides with the Late Archaic Period and restricted use of this material at the shelter during the Middle Archaic.

Patterns noted for the presence of various cortex types suggest that both Fort Payne and Ridley chert resources underwent preliminary reduction at or near the procurement source. The common occurrence of waterworn cortex and the infrequency of primary decortication flakes suggests that Fort Payne was most likely procured from active lag gravel bars. In contrast, the source for Ridley was likely frost-spalled residuum beneath the bluff and along the eroding valley walls. Since the porous nature of the more coarse-grained Ridley chert results in the usual occurrence of internal joint planes which fail under the stress of percussion, blocky debris is more commonly associated with Ridley than with Fort Payne.

Technological Classes

The second phase of the lithic analysis assessed flake tools (utilized and retouched flakes, including traditional forms such as scrapers, etc.,), bifaces (including nondiagnostic projectile point fragments as well as blanks and preforms), and projectile point/knives (pp/ks). As noted, the relative scarcity of these tool types and the limitations imposed by the requisite methodology of functional analyses guided this study away from the specific investigation of the individual specimens composing the classes to a broader consideration of the technological relationship of tool types to other classes in the reduction and use trajectory.

On a broad scale, differences among the frequencies of flake tools, bifaces, and pp/ks from the Middle Archaic levels (Stratum III) and the more recent strata (Strata IV-VII, Table 5.11), and evenness values for the distribution among debitage and tool classes (which are far lower than expected in the Middle/Early Archaic assemblage, Figure 5.3), suggest that the patterns of use of the shelter area were different during the Middle Archaic than at later times. The distribution of non-flake debris, flake debris, and tools among the stratigraphic units illustrates a preponderance of early-stage debris in the lower levels (Table 5.12). The data from raw material distributions indicate that the composition of materials among these three groups is far from even and suggests the importance of raw material selection on the types of debris generated in the reduction process.

Table 5.11. Bivariate frequency distribution of lithic classes, including tools, by stratigraphic assemblage.

Observed Expected	Lithic Classes Including Tools									
	Non-Flake Debris			Flake Debris			Tool			
Stratigraphic Assemblages	Blocky Debris	Incipient Cores	Cores	Decorti-cation Flakes	Interme-diate Flakes	Biface Thinning Flakes	Flake Tools	Bifaces	PP/Ks	Total
VII Historic/ Mississippian	13 23.3	0 0.0	0 0.0	21 11.4	24 26.6	2 1.4	0 0.1	3 0.2	2 0.1	65 (.008)
VI Mississippian/ Woodland	301 381.0	0 0.1	1 0.1	267 186.6	403 436.5	49 23.3	3 0.9	7 2.8	1 1.3	1032 (.13)
V Terminal/Late Archaic	727 1066.7	0 0.4	0 0.4	595 522.3	1499 1221.8	60 65.3	1 2.6	4 7.7	4 3.7	2890 (.37)
IV Late/Middle Archaic	819 1017.6	0 0.3	0 0.3	519 498.3	1344 1165.6	63 62.3	2 2.4	7 7.3	3 3.5	2757 (.35)
III Middle/Early Archaic	842 339.7	1 0.1	0 0.1	16 166.3	58 389.1	3 20.8	1 0.8	0 2.5	0 1.2	921 (.12)
II Early Archaic/ Paleo?	206 79.8	0 0.0	0 0.0	6 39.1	3 91.4	1 4.9	0 0.2	0 0.6	0 0.3	216 (.03)
Total	2908 (.37)	1 (.0001)	1 (.0001)	1424 (.18)	3331 (.42)	178 (.02)	7 (.0009)	21 (.003)	10 (.001)	7881

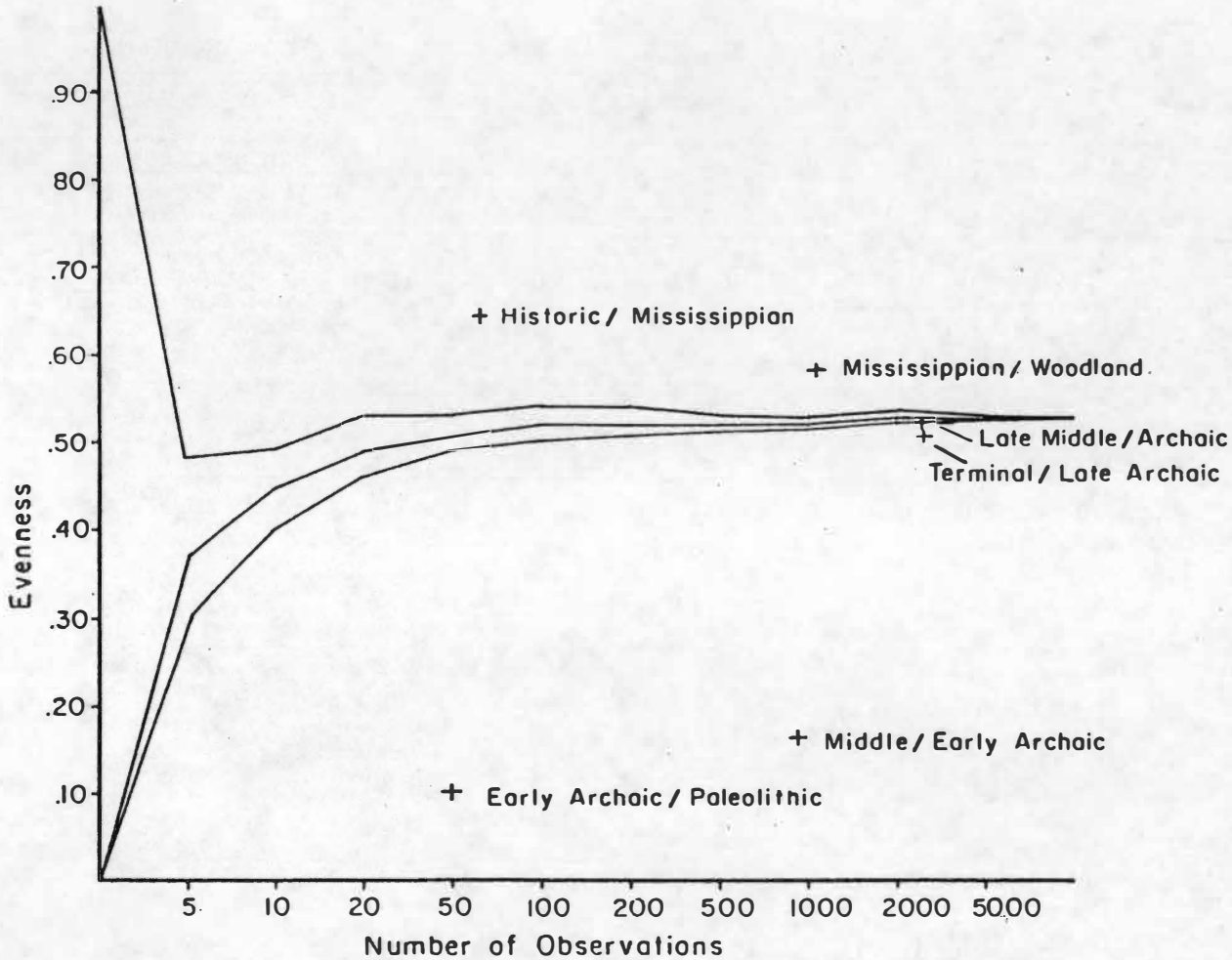


Figure 5.3. Plot of the mean and 95% confidence interval of the evenness of all lithic classes for each stratigraphic assemblage.

Table 5.12. Frequency distribution of non-flake, flake, and tool debris among the stratigraphic cultural units.

Stratigraphic Assemblages	Non-Flake Debris	Flake Debris	Tools	Total
VII-VI Mississippian/Woodland	315 (.287)	766 (.698)	16 (.014)	1097 (.14)
V Terminal/Late Archaic	727 (.252)	2154 (.745)	9 (.003)	2890 (.37)
IV Late/Middle Archaic	819 (.297)	1926 (.699)	12 (.004)	2757 (.004)
III-II Middle/Early Archaic	1049 (.923)	87 (.077)	1 (.0009)	1137 (.14)
Total	2910 (.369)	4933 (.626)	38 (.005)	7881

Lithic raw material type distribution exhibits a pattern suggesting that Fort Payne chert was more frequently associated with the flake tools, bifaces, and pp/ks than Ridley (Table 5.13). Observed values among these tool classes for Ridley chert are consistently lower than expected, while the reverse is true of Fort Payne. The plot of evenness values for these distributions indicates that the earlier trajectory stages (blocky debris and decortication flakes) are less even than expected, while biface thinning flakes, bifaces, and pp/ks have values greater than the mean yet just within the 95% confidence interval (Figure 5.4).

The bifaces from the shelter reveal an interesting pattern (Table 5.14). Forty-eight percent of the bifaces were recovered from the Mississippian/Woodland levels (0-20 cm), 74% were recovered above 50 cm in depth, and all of the bifaces were recovered above level 9, which is interpreted as the Middle/Late Archaic transitional boundary. No bifacial implements were recovered from strictly Middle Archaic context in the shelter excavations. Forty-two percent of the bifaces, including pp/ks, were intermediate stage preforms with no cortex or haft element present (Table 5.14). Nineteen (61%) of the 31 bifaces were made from Fort Payne chert. Seven of these were finished projectile points and the remainder were presumably earlier stage bifaces. Ten (32%) of the bifaces were made from Ridley chert, of these only two were pp/ks. In other words, 20% of the Ridley bifaces were pp/ks, while 36% of the Fort Payne bifaces were pp/ks (Table 5.15). This may indicate a slightly higher rate of abandonment of Ft.

Table 5.13. Bivariate frequency distribution of lithic classes, including tools, by raw material types.

Observed Expected	Raw Material Types								
	Middle Ordovician		Upper Ordovician			Mississippian			
Lithic Classes	Ridley	Carter	Bigby-Cannon Fine	Bigby-Cannon Coarse	Brass-field	Fort Payne	Staint Louis	Indeter-minate	Total
Blocky Debris	2386 2111.4	1 3.7	18 46.8	11 37.3	0 0.4	282 623.0	0 0.4	208 83.0	2906 (.37)
Incipient Cores	0 0.7	0 0.0	0 0.0	0 0.0	0 0.0	1 0.2	0 0.0	0 0.0	1 (.0001)
Cores	0 0.7	0 0.0	0 0.0	0 0.0	0 0.0	1 0.2	0 0.0	0 0.0	1 (.0001)
Decortication Flakes	1025 1034.7	3 1.8	25 23.0	21 18.3	0 0.2	339 305.3	0 0.2	11 40.7	1424 (.18)
Intermediate Flakes	2216 2418.1	6 4.2	79 53.7	68 42.7	1 0.4	952 713.5	0 0.4	6 95.0	3328 (.42)
Biface Thinning Flakes	85 133.0	0 0.2	4 3.0	1 2.3	0 0.0	93 39.2	0 0.0	0 5.2	183 (.02)
Flake Tools	2 5.8	0 0.0	0 0.1	0 0.1	0 0.0	6 1.7	0 0.0	0 0.2	8 (.001)
Bifaces	8 15.3	0 0.0	0 0.3	0 0.3	0 0.0	12 4.5	1 0.0	0 0.6	21 (.003)
PP/Ks	2 7.2	0 0.0	1 0.2	0 0.1	0 0.0	7 2.1	0 0.0	0 0.3	10 (.001)
Total	5724 (.73)	10 (.001)	127 (.02)	101 (.01)	1 (.0001)	1693 (.21)	1 (.0001)	225 (.03)	7882

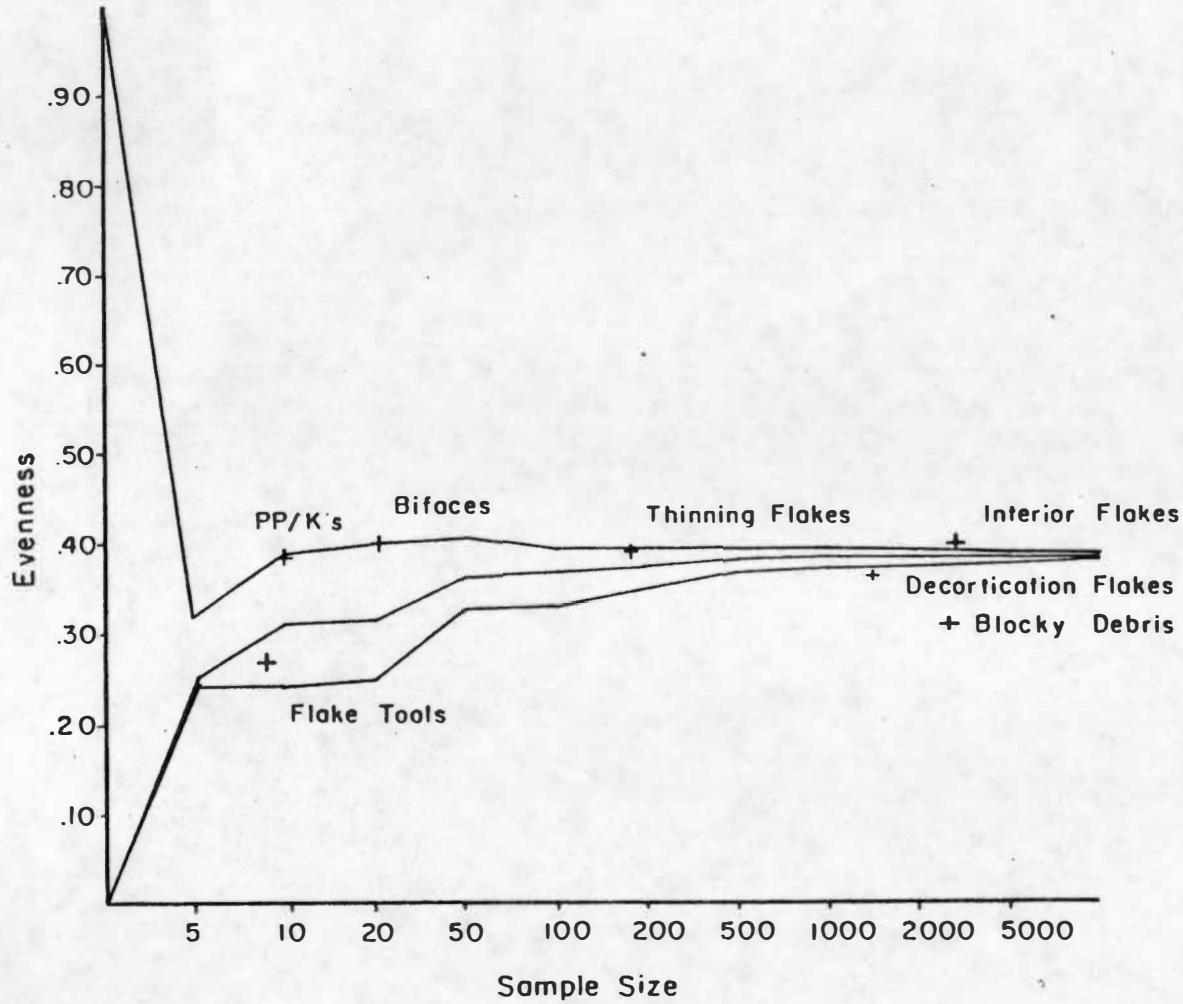


Figure 5.4. Plot of the mean and 95% confidence interval of the evenness of raw material types among the lithic classes.

Table 5.14. Bivariate frequency distrubtion of biface classes by stratigraphic assemblages.

Observed Expected Stratigraphic Culture Units	Biface Classes Biface 1	Biface 2	Biface 3	Biface 4	Projectile Points	Total
VII Historic/ Mississippian	1 0.2	0 0.6	2 2.0	0 0.4	2 1.3	5
VI Mississippian/ Woodland	0 0.3	1 1.2	4 3.9	2 0.8	1 2.6	10
V Terminal/ Late Archaic	0 0.2	1 0.9	2 2.7	1 0.6	4 1.0	7
IV Late/ Middle Archaic	0 0.3	2 1.1	5 3.5	0 0.7	3 1.8	9
Total	1 (.03)	4 (.13)	13 (.42)	3 (.10)	10 (.32)	31

Table 5.15. Bivariate frequency distribution of biface classes by raw material type.

Observed Expected Biface Classes	Raw Material Types Ridley	Bigby-Cannon	Fort Payne	Saint Louis	Total
Biface 1 (2 Faces Corticated)	1 .3	0 0.0	0 0.5	0 0.0	1
Biface 2 (1 Face Corticated)	1 1.3	0 0.1	2 2.0	1 0.0	4
Biface 3 (No Cortex)	6 4.1	0 0.4	7 6.6	0 0.3	13
Biface 4 (Haft Element)	0 0.9	0 0.1	3 1.5	0 0.0	3
Projectile Points	2 2.8	1 0.3	7 4.8	0 0.2	10
Total	10 (.32)	1 (.03)	19 (.61)	1 (.03)	31

Payne pp/ks at the shelter, but the well-represented earlier-stage Fort Payne bifaces indicate that this material type was not entering the site exclusively in finished form.

Diagnostic Tool Types

As previously noted, only 10 bifacial implements, identifiable as morphological types, were recovered from the shelter area. These are described in Appendix B. This density of projectile points per volume (2.5 points/m^3) is quite low. The density is variable between the units, however, with 60% of the pp/ks coming from the unit nearest the back wall.

Small triangular points associated with the Mississippian and Late Woodland culture periods were recovered from the uppermost 30 cm (Figure 4.6). Most of these show a rough random flaking pattern and are quite variable in size and shape. All of the examples recovered from the shelter exhibit blade breakage which is classified as lateral snap failure. Three examples (Figure 5.5, A, C and E) show evidence of reworking on the blade margin suggesting sharpening. No replication experiments that I am aware of demonstrate that stress failures resulting from bending pressure are distinctive enough to be sorted from lateral snap failures (resulting from indirect percussive shock). Consequently, interpretations of the exact cause of blade failures are inconclusive. Lateral snap failure was first identified to recognize a specific form of failure which occurred in the biface reduction process (Crabtree 1972:60; Purdy 1975:134). These small points were formed from flakes and measure less than 2 cm across the

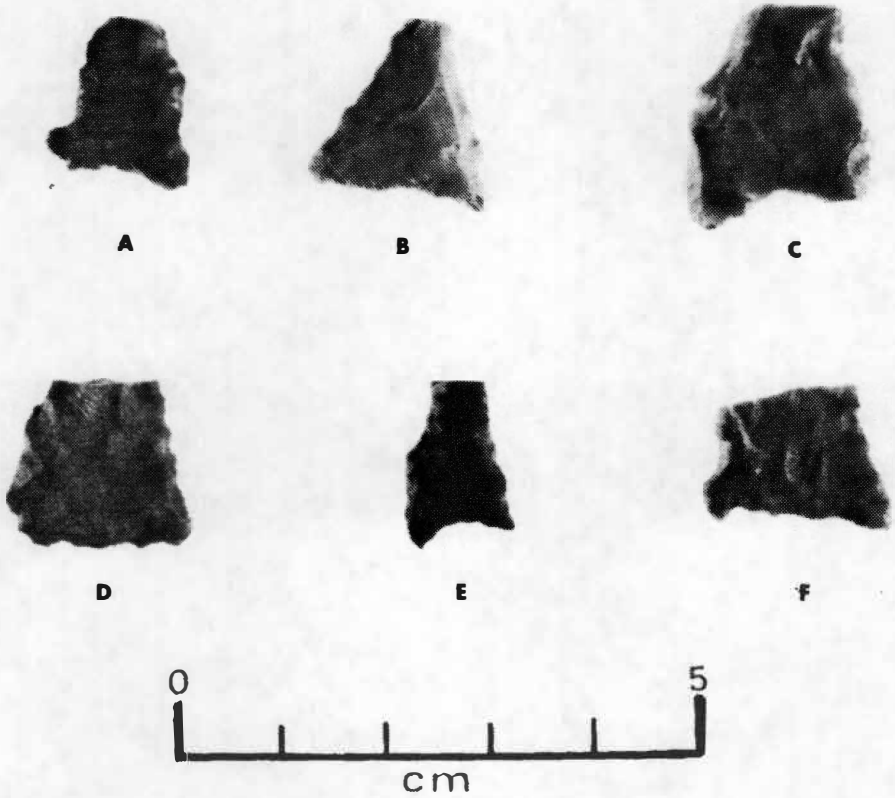


Figure 5.5. A range of small triangular projectile points from Mississippian/Woodland contexts (Levels 1 and 2). Descriptions and proveniences are provided in Appendix B as follows: A, 10; B, 12; C, 2; E, 3; F, 4.

widest point of the base. It is not likely that direct percussion would have played a very important role in their late stage shaping and thinning. The association of this small triangular projectile point form with the Mississippian and Late Woodland culture periods is well documented. The Middle to Late Woodland transition appears to be about 1350 B.P. in the Midsouth (Amick et al. 1986:Appendix A). This date, then, may be assumed as a reasonable terminus post quem for the deposition of the uppermost 20 cm of fill.

Projectile points associated with the Early Woodland/Late Archaic Periods are illustrated in Figure 5.6. Specimens from the shelter (Figure 5.6, A and C) were recovered between 20-30 cm below the surface. The round-base cluster fragment (Figure 5.6, C) shows an interesting form of haft snap (tranverse hinge) which may have been the result of impact or direct pressure and bending during use. Although the Adena round-base point cluster has associated dates extending to 3000 B.P. (Morse 1967:143-147), a more conservative estimate of 2500 B.P., based on dates associated with the Nowlin II (40CF35) data (Keel 1979:297; McCollough and Duvall 1976:114), seems more reasonable for this area.

The Little Bear Creek point type (Figure 5.6, A), also recovered between 20-30 cm below the surface, may date as early as 4000 B.P. (Futato 1983:215; Wynn and Atkinson 1976). The latest dates associated with this type (ca. 2900 B.P.) appear to be Perry Phase (Dye 1980; Futato 1983:214).

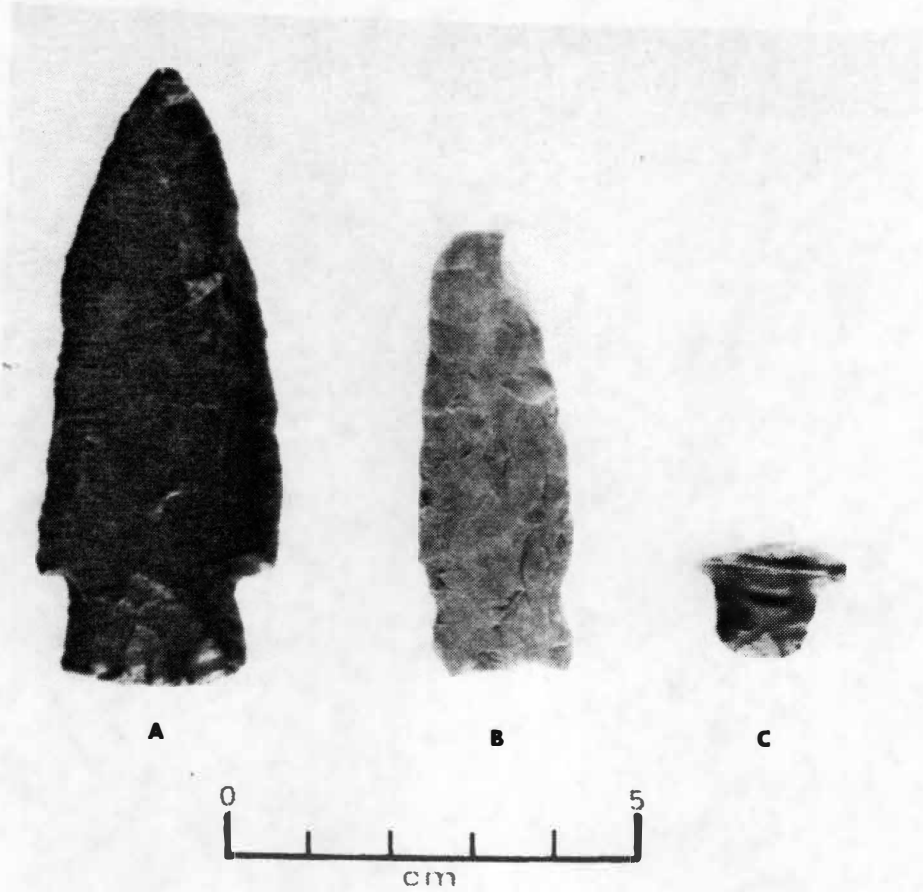


Figure 5.6. Projectile points from Woodland/Late Archaic contexts. Descriptions and provenience information are provided in Appendix B as follows: A, 9; B, 1; C, 13.

Two projectile points were recovered from level 5 (40-50 cm) in unit 1019N1002E (Figure 5.7). Specimen A is classified as a Ledbetter. This Late Archaic type is associated with dates ranging from about 2900 B.P. (Faulkner and McCollough 1974:297) to 4400 B.P. (Klippel and Morey 1985). The Benton type (B) also found in this level has associated dates which range from about 4000 B.P. (Brakenridge 1982, 1984) to 6000 B.P. (Hofman 1984c:3-5).

Both of these points have interesting patterns of use breakage. The Ledbetter point has the remains of a black compound on the haft element and extending down the face of the blade, presumably a glue used in the hafting process (Figure 5.8). The base of the haft element was snapped under bending pressure as the fracture was initiated at one lateral margin and rolled around the opposite stem margin, curling out near the shoulder. This suggests that the force causing the fracture was initiated from the haft.

The Benton point originally failed as a result of a porous fossil inclusion which weakened the blade. After this failure, however, the resulting fracture plane was used as a platform from which flakes were removed longitudinally from the lateral margin and faces (Figure 5.9). A single long flake scar which extends longitudinally down the length of the margin looks remarkably like a crenated fracture in its "sinuous" form (Johnson 1981b:49) but is most definitely the result of percussion. Subsequent smaller flake removals which originate on the snap fracture plane extend down both faces forming a burination. Both of these projectile points likely failed during use and were abandoned

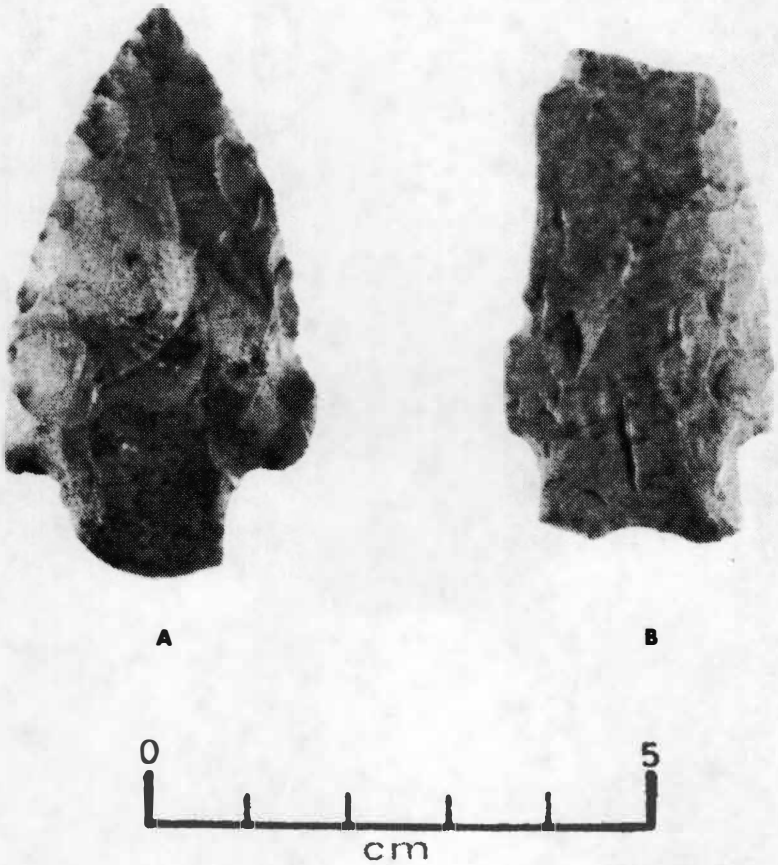


Figure 5.7. Projectile points from Late Archaic contexts. Both from Level 5 (40-50 cm), 1019N1002E. Descriptions provided in Appendix B as follows: A, 14; B, 16.

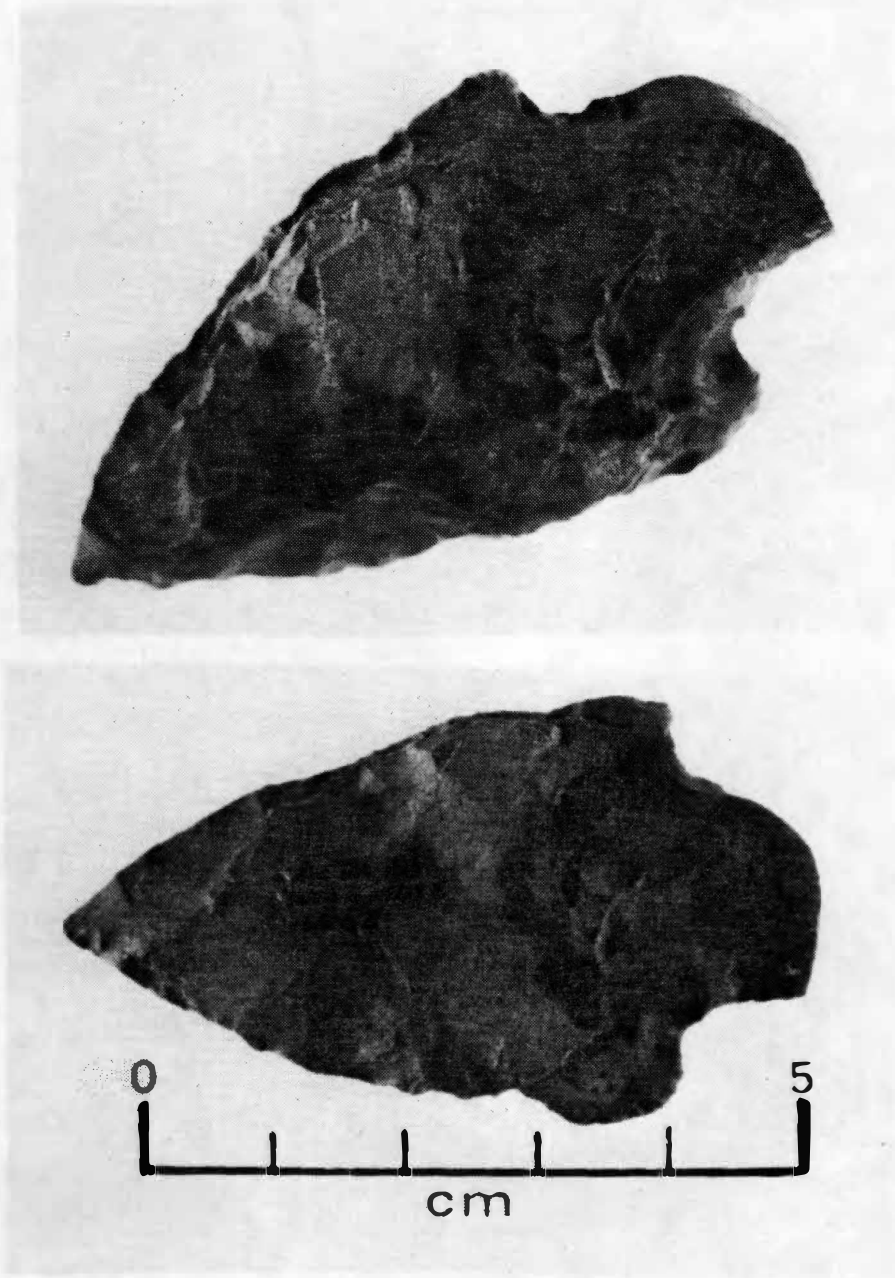


Figure 5.8. Ledbetter Cluster point showing mastic compound and haft snap failure.

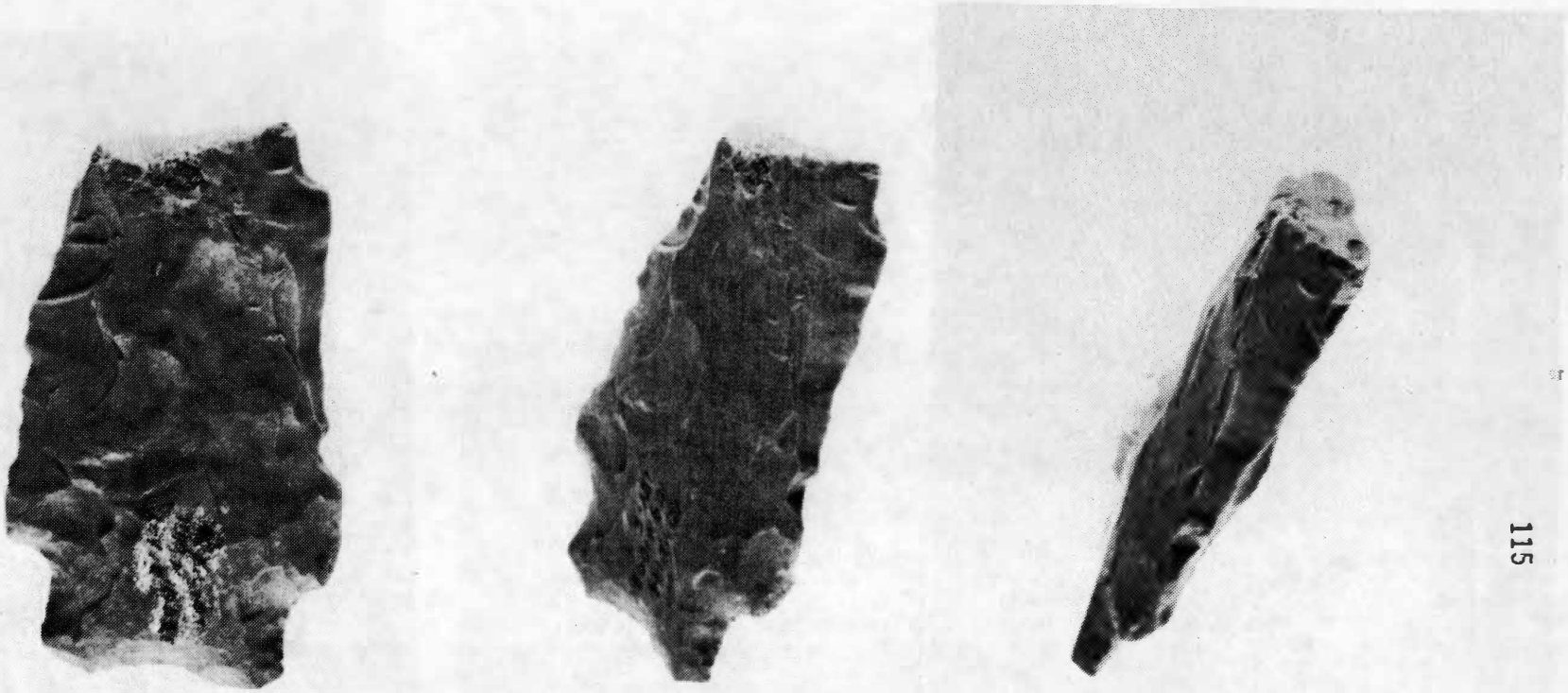


Figure 5.9. Benton Cluster point showing original failure at fossiliferous inclusion and subsequent burination.

in the shelter; the Benton perhaps serving a secondary function after burination.

Two additional points were recovered from the shelter and both present puzzling contextual problems. A Quad point was recovered from level 7 (60-70 cm) in 1019N1002E. Although this type is associated with the transitional Paleo Period or dates ranging from 8000-1000 B.P. (Cambron and Hulse 1960), this specimen shows definite evidence of reworking. Retouch along one margin shows a distinctive difference in patination indicating that this modification took place long after the implement's first abandonment. Similar observations of reuse of previously abandoned projectiles have been noted in this area (Amick 1984a; Hofman 1981).

Another problematical point was recovered in level 8 (70-80 cm) of unit 1019N1002E (Figure 5.10). In this provenience the point would be expected to be associated with the Middle Archaic Period. Its straight-based, corner-notched form more nearly resembles a Terminal Archaic cluster. There is little comfort gained by interpreting it as a basally-notched Eva/Morrow Mountain or Kirk type. Hence, it is consigned to the shadowy ranks of the indeterminate.

The spatial context of the Quad point, which was evidently reworked, can be qualified as an anomalous case of recycling a Paleo Indian period point by Late or Middle Archaic peoples. The corner-notched point cannot be so easily dismissed. Evidence for intrusion was not noted and, consequently, it is suggested that this point reflects an aberrant Early Archaic style.

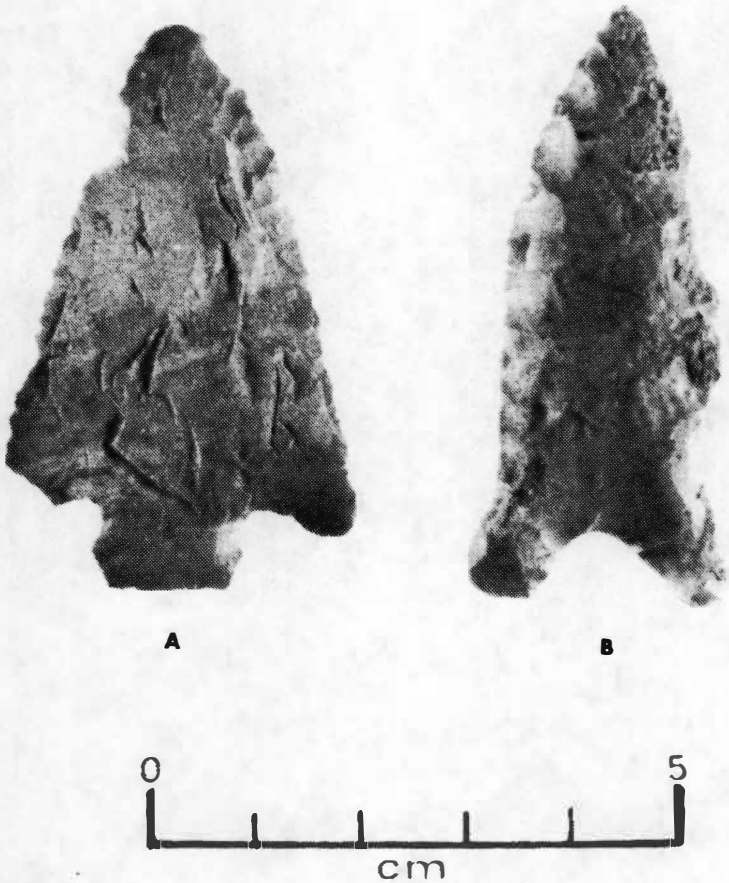


Figure 5.10. Projectile points from Late Archaic contexts. Descriptions and provenience information provided in Appendix B as follows: A, 17; B, 16.

The provenience of the Benton point (a Late Middle Archaic type) in level 5 is also unsettling. Judging from the sedimentary analyses this point would be expected in levels 7 or 8. With so many diagnostics occurring in dubious context within the unit nearest the rear wall, cryoturbation is suspected. Though no evidence of crotavenas was observed in the profiles of this unit, postdepositional disturbances cannot be ruled out.

Aboriginal Ceramics

The aboriginal ceramics from the shelter were very rare. Only eight fragments were recovered by the .64 cm water-screen. Among these were three distinct types. Four very small, badly eroded shell tempered sherds were recovered from the uppermost 30 cm (Figure 5.11, B and D). All appear to be body sherds of a thin walled vessel(s). These are interpreted as associated with the Mississippian Period occupation, and their occurrence in this level fits well with the diagnostic lithics recovered from this context.

Also recovered in the uppermost 20 cm was a single body sherd from a thick walled vessel tempered with chert (Figure 5.11, A). The surface of the vessel was treated by fabric impression and the interior of the vessel was blackened from oxygen reduction. This ceramic type has had no formal description in the literature, but it compares favorably with sherds from the Elk River Series recovered at the Mason Site (40FR8) dating to approximately 1000 B.P. (Faulkner

Figure 5.11. Ceramics from the shelter. A: Elk River Series, chert tempered, fabric impressed; B: Residual shell tempered plain; C: Long Branch Fabric Impressed; D, E, F: Residual limestone tempered plain.

1967, 1968). Similar sherds were also recovered at the Bypass Site (40CN86) (Dickey 1981).

A third type was found in level 2 (10-20 cm) of unit 1019N1002E. This type is represented by a single, small rim sherd from a thin walled vessel (Figure 5.11, C). The rim is flattened to create a slight lip and the exterior is marked with diagonal impressions from a coarse-weave fabric. The fine paste is tempered with quartz grit, and the exterior is blackened while the interior is a buff tan. This sherd compares favorably with the Long Branch Fabric Marked type (Keel 1978:136; McCollough and Duvall 1976:114). This type is associated with a date (in this area) of 2350 B.P.

Faunal Remains

The laboratory methods for the faunal materials have been presented in Chapter II. A list of the vertebrate remains by unit and level are presented in Appendix C. The identification of the vertebrate specimens was undertaken by Jane Horton and Bruce Manzano, who made use of the comparative collection housed in the Department of Anthropology at the University of Tennessee. For each identifiable specimen the element, side, and portion were recorded, along with the weight, evidence of burning, and the taxonomic name. These data are presented in Appendix C.

Before the data for the faunal assemblages recovered from Hayes Shelter are presented, it should be noted that the distinction between elements introduced through human versus nonhuman deposition is

problematical. Rockshelters are recognized as habitation sites for a wide variety of burrowing animals. Because of the attraction of dry denning sites, animal activities may be concentrated at shelters. As mentioned, Hayes Shelter was first recognized as a site on the basis of cultural materials deposited on the surface by a burrowing animal. Figure 5.12 shows the opening of a burrow which was under the bluff overhang some 15 m south of the excavation units. Five coins were placed on the surface where faunal elements were exposed. Among the well preserved (apparently recent) elements were squirrel (*Sciurus* sp.), rabbit (*Sylvilagus floridanus*), and raccoon (*Procyon lotor*).

In addition to these elements were two fragments of cow (*Bos* sp.) cranium. Since the area immediately surrounding the shelter was used as range for cattle, the remains of carcasses were noted on the surface in at least two locations during the excavation period. The closest of these was on top of the bluff over the shelter and is shown on the topographic map (Figure 2.2). Each of these faunal specimens shows evidence of rodent gnawing. This evidence suggests that faunal remains are entering the shelter sediments as rodents bring smaller elements, such as the cow skull fragments, into the shelter from the surrounding area.

Another obvious source of naturally deposited faunal remains is from the death of the burrowing animals themselves. Although this usually cannot be positively identified in the archaeological record, it is strongly suggested at Hayes Shelter by the ubiquitous presence of well-preserved, yet unburned snake vertebrae in even the lowermost

Figure 5.12. Location of faunal elements recovered from the surface of a contemporary animal burrow.

levels of the excavation. This mode of deposition is also suspected of the unburned remains of crayfish (Astacidae sp.) in Late Archaic context.

Vertebrate Remains. Table C.1 presents a complete list of the identified species and unidentifiable fragments and their distribution among the Mississippian and Woodland, Late Archaic and Middle Archaic strata. As illustrated in Table 5.16, 18% of the specimens were recovered in the Mississippian and Woodland strata, 52% in the Late Archaic and 31% in the Middle Archaic. If only the identified elements are compared, these proportions shift with 13% in the upper strata, 41% in the Late Archaic, and 46% in the Middle Archaic. Overall, then, the Late Archaic assemblage has the greater number of faunal specimens, followed by the Middle Archaic and Mississippian/Woodland assemblages. If these three stratigraphic components are compared simply on the basis of volume, however, the Mississippian/Woodland composes 14%, the Late Archaic 50%, and the Middle Archaic 36%. These figures suggest that the proportions of the total number of specimens among the strata are largely a function of the strata volume.

The proportions of identifiable and unidentifiable pieces between the strata indicate that, while the total number of specimens reflects the volume per strata, the number of identifiable specimens present (NISP) shows that the Middle Archaic and earlier strata have the greatest frequency (Table 5.16). Before advancing the hypothesis that this reflects a decrease in the rate of human disposal of faunal

Table 5.16. Distribution of identifiable and unidentifiable faunal specimens among three stratigraphic units.

	Mississippian/Woodland		Late Archaic		Middle Archaic	
	No.	(Row %)	No.	(Row %)	No.	(Row %)
No. Specimens Present	298	(.18)	924	(.52)	550	(.31)
No. of $1x10^5$ cc Levels per Strata	6	(.14)	21	(.50)	15	(.36)
No. Identifiable Specimens Present	90	(.13)	289	(.41)	323	(.46)
	No.	(Col. %)	No.	(Col. %)	No.	(Col. %)
No. Unidentifiable Fragments per Strata	208	(.70)	635	(.69)	227	(.41)

remains through time, it is necessary to investigate alternative hypotheses which may explain the apparent differences as a function of natural depositional factors. Comparisons of the number of unidentifiable pieces within each strata indicate that both the Mississippian/Woodland and Late Archaic strata are each composed of about 70% unidentifiable fragments (Table 5.16). On the other hand, only 41% of the Middle Archaic assemblage is unidentifiable. This suggests the possibility of different modes of deposition operating on these strata, perhaps resulting in less fragmentation during the earlier periods. Some support for this notion is provided by the distribution of burned and unburned specimens in each strata (Table 5.17). In this table it is apparent that very few (6%) of the Middle and Early Archaic specimens are burned. This stands in contrast to the Terminal/Late and Late/Middle Archaic strata in which 36% of the specimens are burned.

The most conclusive evidence regarding the distribution of identifiable specimens is provided by the table illustrating the assemblage composition of each vertebrate group (Table 5.18). It is obvious that snakes are the majority type in the Middle Archaic and account for the over-representation of NISP in this strata. Their high visibility in the strata, however, may indicate nothing more than the presence of a few individuals which died during hibernation in the Middle Archaic sediments.

Further suggestion of warm, dry paleoenvironmental conditions during the Middle Archaic is prompted by the presence of two specimens

Table 5.17. Distribution of burned and nonburned specimens among the identifiable vertebrate fauna from the shelter units.

Stratigraphic Assemblages	Burned			Non-burned			Totals
	No.	Wt. (g)	(%)	No.	Wt. (g)	(%)	
VII Historic/Mississippian	1	.5	(.20)	8	2.04	(.80)	9 (.02)
VI Mississippian/Woodland	8	2.58	(.29)	22	6.21	(.71)	30 (.07)
V Terminal/Late Archaic	50	12.05	(.34)	77	23.82	(.66)	127 (.32)
IV Late/Middle Archaic	43	6.82	(.35)	86	12.64	(.65)	129 (.32)
III Middle/Early Archaic	6	.24	(.004)	89	66.07	(.99)	95 (.24)
II Early Archaic/Paleo?	-	-	-	13	2.83	(1.00)	13 (.03)
Total	108	22.19		295	113.61		N=403
Percent	(.27)	(.16)		(.73)	(.84)		135.84g

Table 5.18. Distribution of identifiable faunal elements for each strata among the vertebrate groups.

Vertebrate Groups	Mississippian-Woodland		Late Archaic		Middle Archaic		Total	
Mammals	40	(.14)	149	(.53)	92	(.33)	281	(.38)
Birds	6	(.22)	20	(.74)	1	(.04)	27	(.04)
Fishes	1	(.02)	37	(.82)	7	(.16)	45	(.06)
Snakes	14	(.05)	19	(.07)	259	(.89)	292	(.40)
Turtles	29	(.32)	61	(.68)	-	-	90	(.12)
Totals	90	(.12)	286	(.39)	359	(.49)	735	

of meadow vole (Microtus pennsylvanicus) in Stratum III and their absence in the more recent strata. Based on sedimentological data, the age of this strata is estimated between 10,000 and 6400 B.P. Meadow vole remains have also been recovered from early Middle Archaic context in Stratum V and below at Cheek Bend Cave (Klippel and Parmalee 1982) and in zone V at Tom's Shelter (Klippel 1986). The current range of this boreal species does not include the Central Duck River Basin, and its absence in post Middle Holocene contexts from these sites suggests that its disappearance may be inferred as a result of the warm, dry conditions associated with the Hypsithermal Interval. The chronological association of meadow vole remains in Holocene sediments in the Central Duck River Basin is further explored by Klippel (1986).

Aquatic Gastropods

Approximately 75,185 aquatic gastropods were recovered from the three shelter units. These are identified to six genera and tabulated in Table 5.19. Since very little is known about the specific environmental conditions preferred by each species, the interpretations drawn from these data are also limited. Perhaps the most important observation that can be made is that the specimens recovered below the Late Archaic strata comprise only 1% of the total sample. Data from Hayes Shelter indicates that gastropod use was much more common among Late than Middle Archaic inhabitants. Evidence from Hayes-Midden (40MU139) indicates that gastropods were collected during Late Middle Archaic times (Klippel and Turner 1983) and earlier

Table 5.19. Bivariate frequency distribution of identifiable freshwater gastropods among the stratigraphic assemblages.

Observed Expected Stratigraphic Assemblages	Pleurocera canaliculatum	Elimia laqueata	Lithasia geniculatum	Lithasia duttoniana	Leptoxis praerosa	Campeloma decisum	Totals
Stratum VII Historic/Mississippian	237 307.1	252 193.0	65 103.6	118 52.8	23 38.2	2 2.2	697 (.009)
Stratum VI Mississippian/Woodland	1054 1323.4	859 831.9	272 446.5	696 227.7	117 164.7	6 9.7	3004 (.04)
Stratum V Terminal/Late Archaic	20804 22293.8	13089 14013.0	9583 7522.8	4080 3836.4	2873 2774.3	175 162.9	50604 (.67)
Stratum IV Late/Middle Archaic	10993 9153.4	6566 5753.8	1252 3088.7	803 1575.2	1105 1139.1	58 66.9	20777 (.28)
Stratum III Middle/Early Archaic	31 41.9	52 26.3	5 14.1	2 7.2	4 5.2	1 0.3	95 (.001)
Stratum II Early Archaic/Paleo	4 3.5	3 2.2	0.0 1.2	1 0.6	0.0 0.4	0.0 0.0	8 (.0001)
Totals	33123 (.44)	20821 (.28)	11177 (.15)	5700 (.08)	4122 (.05)	242 (.003)	75185

in the Middle Archaic at the Ervin Site (Hofman 1984b, 1984c). Mollusk remains are restricted to Late Archaic contexts from Tom's Shelter (Hall 1985) and, as mentioned, are primarily found in the Late Middle and Late Archaic assemblages of Hayes Shelter.

Bone Tools

Approximately 21 bone tools were recovered from the shelter excavations. The majority of these were fragments of long bone splinters which had been ground and polished (Figure 5.13). Their depth distribution among the units is illustrated in Table 5.20. None were recovered below Stratum IV. In addition, a single antler tine tip was recovered from 1019N1002E in Mississippian/Woodland contexts.

Plant Remains

The field recovery and laboratory techniques employed in the analysis of the plant remains from Hayes Shelter are discussed in Chapter II. The sample was obtained through both macroscopic manual sorting of 12.5% of the fine fraction ($.15 < x < .64$ cm) and by flotation of a 4-liter sample from each level. Nuts and seeds were identified to the most discrete taxonomic level possible, while wood charcoal was simply weighed. A summary of the results of this analysis is found in Table 5.21.

In this table it is apparent that hickory (*Carya* sp.) nutshell is the major nut type represented, with fragments identifiable to the family *Juglandaceae* usually present but making up a much smaller proportion. An interesting pattern is demonstrated when the

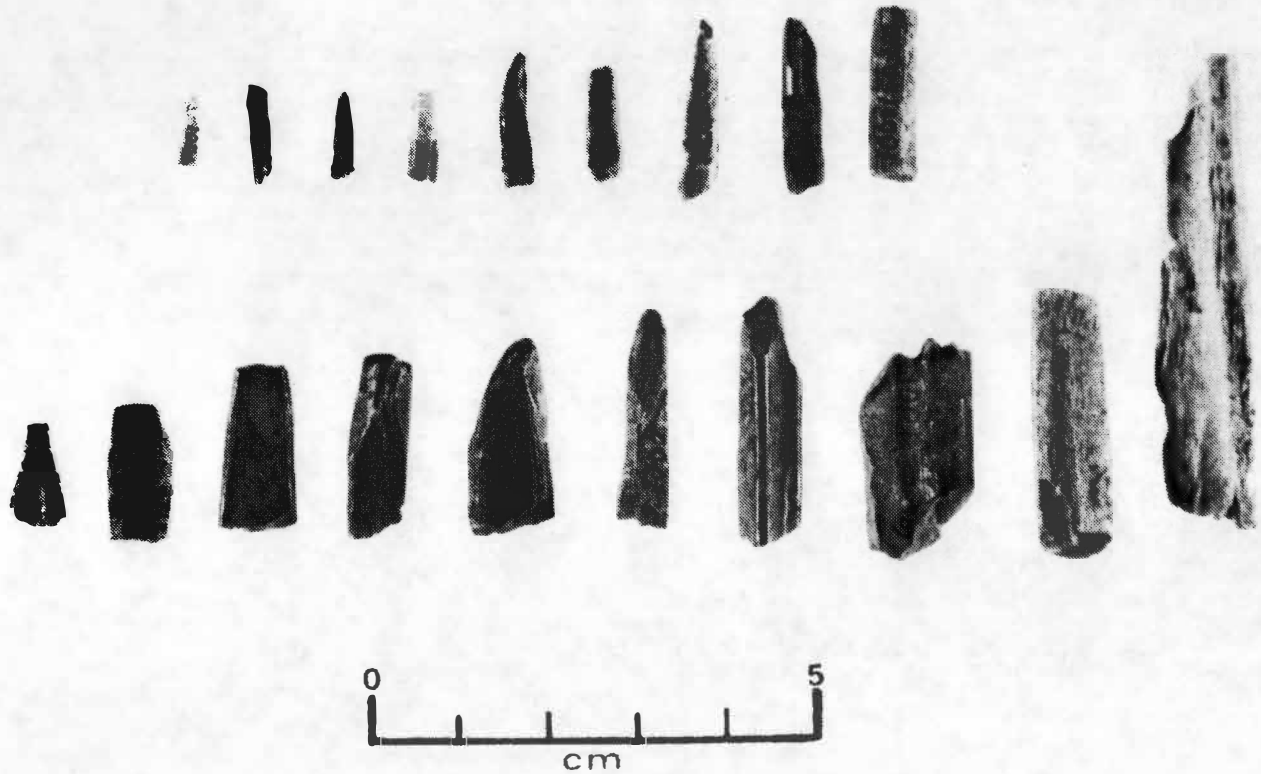


Figure 5.13. A range of bone splinter tools. Provenience information is presented in Table 5.20.

Table 5.20. The distribution of split bone tools.

Depth	1019N1000E	1019N1001E	1019N1002E	Totals
0-10				
10-20		2	2	4 (.20)
20-30		2	2	4 (.20)
30-40	1	3		4 (.20)
40-50				
50-60	1	3	2	6 (.30)
60-70		1		1 (.05)
70-80			1	1 (.05)
Totals	2 (.10)	11 (.55)	7 (.35)	20

Table 5.21. Summary of the distribution of the plant remains from the shelter units.

Depth (cm)	Plant Remains (in grams)					
	Carya spp.	Juglandaceae	Juglans spp.	Total Nuts	Total Wood	Total
0-20	.88	.06	-	.94	15.11	16.05
20-30	5.97	.31	-	6.28	1.27	7.55
30-40	2.60	.12	.08	2.80	.06	2.86
40-50	3.83	.16	-	3.99	.85	4.84
50-60	12.87	.65	.04	13.56	.24	13.80
60-70	9.85	.44	.07	10.36	.53	10.89
70-80	2.59	.18	-	2.77	.06	2.83
80-90	.35	.01	-	.36	*	.36
90-100	.17	.02	-	.19	.01	.20
100-110	-	-	-	-	*	*
Total	39.11 (.66)	1.95 (.03)	.19 (.003)	41.25 (.69)	18.13 (.31)	59.38

frequencies of nutshell and wood charcoal are compared. A much higher percentage of the Mississippian/Woodland sample is composed of wood charcoal than nutshell. This pattern is reversed for the Late Archaic assemblages. Levels 6 and 7 (50-70 cm) have particularly high frequencies of nutshell suggesting, perhaps, variance in the use of the shelter during the Late Archaic.

Historic Artifacts

Four historic artifacts were recovered during the shelter excavations (Figure 5.14). Two small nails were found in the first level of unit 1019N1000E. One of these is a hand-wrought "L" head or finish nail, the other was too rusty for positive identification but appears to be a number four, cut, common. The hand-wrought nail is the earlier of the two and probably dates to the early 19th century.

Two .22 caliber, rimfire, short cartridges were found in level 2, zone B of unit 1019N1002E. One of these casings bore the stamp "U.S." and the other, "P". The suspected age of these artifacts is less than 100 years B.P. Their presence in the level from which a Long Branch Fabric Impressed sherd was found gives some indication of the degree of mixing exhibited in the unit nearest the rear wall.

Conclusion

The results of the analysis of artifacts from Hayes Shelter demonstrate that the site was occupied from Middle Archaic through Mississippian times. Comparisons of the evenness of the distribution

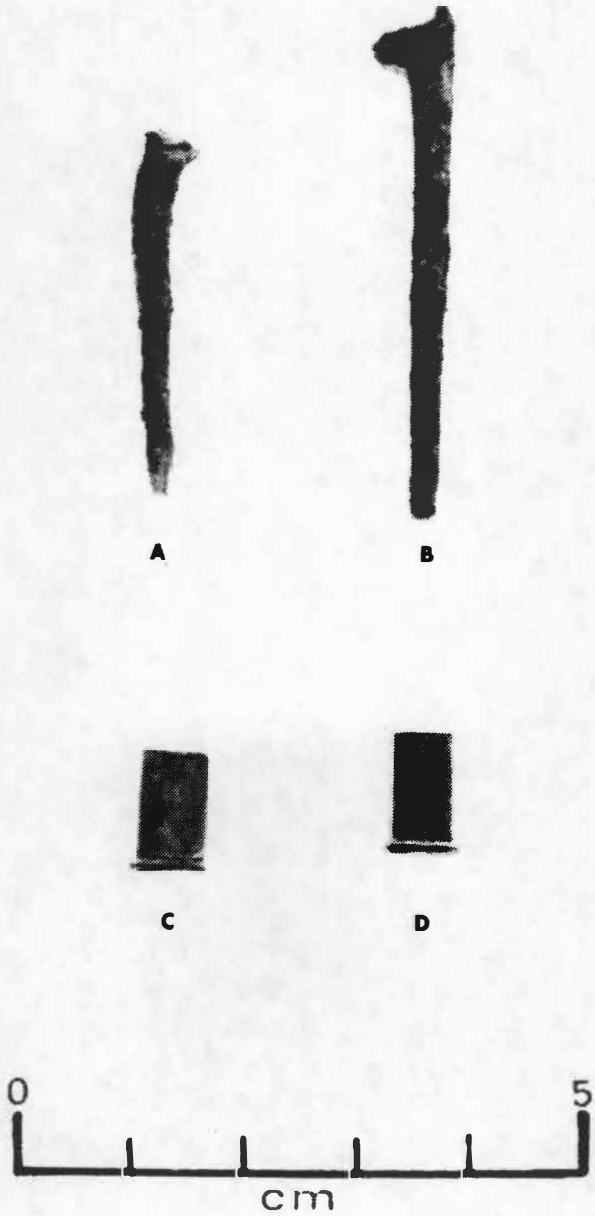


Figure 5.14. Historic artifacts. A: Cut nail; B: Hand-wrought finish nail; C, D: .22 caliber cartridges.

of observations among the lithic artifact and raw material classes for each stratigraphic cultural unit indicate that there is a tendency for distributions to become more even through time. The specific causes for this apparent trend are not known. The possibility that during the later periods the site was reoccupied more often or for longer periods of time is certainly admissible.

The predominant use of immediately available Ordovician chert and its exclusive expression as early-stage debitage in the Middle Archaic assemblage suggests that lithic reduction activities were of an ephemeral and expedient nature. The complete absence of lithic and bone tools and the small percentage of burned bone from the Middle Archaic stratum (III) also suggest limitations in the occupational activities at this time, or a difference in the use of the site.

The Late Middle and Late Archaic assemblages (Strata IV and V) indicate more intensive use of the sheltered area for occupational activities. Ample evidence of middle- and late-stage lithic reduction and tool maintenance, the presence of bone tools, and the common occurrence of burned bone, freshwater mollusks, and nutshell in the Late Archaic strata, may express an increase in the frequency or duration of occupational episodes, but certainly indicates an increase in the range of activities conducted at the site. The inferior Ordovician lithic resources available from the bluffs and valley walls continued to be an important source of material, occasionally employed in the manufacture of late-stage bifacial tools, although Fort Payne

chert procured from gravel bars was the most common material among the bifaces.

Substantial evidence for repeated occupation of the shelter through Mississippian times is provided by the frequency of debitage, bifaces, ceramics, and diagnostic lithic tool types in the upper strata. Ridley chert continued to be the most commonly exploited lithic material, but bifaces were more frequently made of Fort Payne material. The distributions of the stratigraphic lithic assemblages shows a pattern of increasing evenness through time, suggesting that the range of reductive activities broadened perhaps due to frequency or intensity of site occupation. The presence of ceramics associable with Woodland and Mississippian culture periods were so sparse that they merely attest to the occupation of the site during these times.

CHAPTER VI

INTERSITE COMPARISONS

Diversity analysis of materials from Hayes Shelter shows that the distribution of debitage among reduction stages is more even in later lithic assemblages. In part, this pattern may be explained as a function of variability in the selection of raw materials; the distribution of chert types is also more even in the later assemblages, and the percentage of Ridley chert seems to be correlated with percentages of early-stage debris. This suggests that the evenness of the lithic assemblages at Hayes Shelter, to some extent, is dependent on the raw material types employed. If changes in the distribution among debitage classes are a function of changing patterns of resource exploitation, then one appropriate question is "why do the patterns of raw material selection change?"

The following section compares the results of the analyses of 25 lithic assemblages from eight sheltered (including Hayes) and eight open sites in or near the Central Duck River Basin in an attempt to explore some of the questions raised by the data from Hayes Shelter. These comparisons attempt to determine if the patterns noted for the Hayes Shelter assemblages are expressed on a regional basis. These investigations are concerned primarily with three sources of variability: the distribution of raw materials and how it reflects the use of local resources, the effect that resource selection may

have had on the reduction trajectory pattern, and the ways in which these patterns change through time.

Sixteen Site Sample

The selection of sites used in these comparisons is based on the availability of similarly-coded data, i.e. the analysis of lithic data from each site employs the Columbia Archaeological Project Cultural Material Inventory Coding Format (Hofman and Turner 1979) or a format which can be accurately crossreferenced to the Columbia format. Excavation and analysis of materials from each of the sites (except Topsy (40WY204) and Fattybread Branch (40MU408)) were conducted under contract with the Tennessee Valley Authority as part of the Columbia Archaeological Project. The Topsy Site was excavated under contract with the Tennessee Department of Transportation and the data used here are derived from the report of investigations (Amick 1982) and from Amick's thesis (1984b). Fattybread Branch was excavated under contract with the National Park Service and these data are presented in the report of investigations currently in press (Amick et al. 1986). Data for the six other open sites (Bench, Cave Spring, Clay Mine I and II, Cedar Creek, and Leftwich) are taken from tables presented by Amick (1984b). Tom's Shelter data are derived from Hall's (1985) thesis and from raw data generously provided by him. The Fountain Creek sheltered sites (Pilkington, Baker, McCollum, Goatcliff, Height, and Hardison) are reported on by Entorf (1985) and the data presented here are derived from this source or from raw data

on file at the University of Tennessee. The information necessary to order these raw data by stratigraphic assemblage was not made available to the author and, therefore, temporal considerations of raw material distributions from the Fountain Creek sites do not appear in the comparative tables.

Highland Rim/Outer Basin, Open-air Sites

The Topsy Site is located on the Buffalo River in the Southwestern Highland Rim physiographic section (Figure 3.3; Amick 1982). In this locale, large-sized Mississippian Fort Payne chert cobbles are abundant in the gravel bars. Mean cobble weight from a sample taken near the Topsy site is 159.56 g. The mean weight from a comparable sample from the inner basin is 60.81 g (Amick 1982:Table 1).

Diagnostic lithic tools recovered from the site are predominantly associable with the Late Archaic Ledbetter Phase (Amick 1982:29, Figure 23 and 24; Amick et al. 1986:26, Figure 4.11; Faulkner and McCollough 1973:151-152). The data used in these analyses are restricted to materials recovered from excavated context (Stratum I) and are considered to represent a Late Archaic assemblage. The Topsy assemblage indicates that the industry focused on the rich source of Fort Payne chert available in the gravel bars nearby (Amick 1982:30). The reduction trajectory suggested by the total stratum I assemblage is long, but predominated by late-stage by-products. The lack of early-stage evidence compelled Amick to suggest that this step in the

reduction process was conducted at the source location where debris was lost by fluvial processes (Amick 1982:35).

The Fattybread Branch Site is located on the Duck River within the Shelby Bend Archaeological District on the perimeter of the western outer basin (Figure 3.3; Amick et al. 1986:290-415). Although chert cobbles are available in the Duck River lag and point bars near the site, the dissected uplands of the Western Highland Rim, a few kilometers away, are a very rich source for fresh, fine-grained Fort Payne. Late Archaic industries of the Fattybread Branch site relied heavily on these Highland Rim sources.

Data employed in this sample are from a block excavation (A1) which concentrated on the recovery of materials from Late Archaic contexts within the T1b paleosol. Diagnostic artifacts and radiocarbon dates confirm this cultural association. Variation among the biface thinning values for specimens from this assemblage suggest a short-segment, late-stage reduction trajectory (Amick et al. 1986:366, 416).

Inner Basin Open-air Sites

The Bench Site (40MU433) is located on an alluvial terrace of the Duck River on the western end of Cannon Bend at river mile 141. The underlaying bedrock in this bend is Ordovician Lebanon limestone which occurs below the Carters Formation as part of the Stones River Group. The site location and all of Cannon Bend are within the inner Nashville Basin as defined by the contact between the Carters and Hermitage Formations which occurs a few kilometers north of Cannon

Bend (see Geologic Map of Tennessee, West Central Sheet:1966). The interpretation of Cannon Bend as representative of an outer basin location, with its deep soils and homogeneous mature forest vegetation, has been emphasized by researchers whose goal was to establish this environmental dichotomy for comparative purposes (Amick 1984b:147; 1985c:147; Klippel and Turner 1983:6). Actually, the resources of the inner and outer basin areas are equally accessible from the Cannon Bend locality.

Excavations at the Bench focused on the recovery of Middle Archaic deposits in the T1b paleosol. Although the radiocarbon date for the deposit was questionable, diagnostic artifacts recovered from manual excavations support the Middle Archaic interpretation of the assemblage (Amick 1984b:151-154). A gravel sample collected from a Duck River bar about 10 km upstream was composed of 91% Fort Payne, 7% Carters, and 1% Ridley cherts, although most of these were desilicified (Amick 1984b:336, Tables C.5 and C.12). As Carters chert was the predominant chert type represented in the debitage from this assemblage (Table 6.1), it is likely that the sources for this material were the nearby residual upland soils and valley walls.

The Cave Spring Site (40MU141) is located in Cheek Bend at Duck River mile 154. The alluvial terraces in the bend are underlain by Ridley Formation limestones and shallow upland soils cover the Lebanon limestone substrate. Excavation methods and artifact analyses of the Middle Archaic assemblage from the site are reported in more detail by Hofman (1981, 1982, 1984a). The sample employed here follows Amick

Table 6.1. Debitage by raw material types from sheltered and open sites in the Central Duck River Basin. Assemblages are arranged by major chronological period.

Site Assemblages	Ridley	Carters	Bigby-Cannon	Brassfield	Fort Payne	St. Louis	Other	Total	Evenness
Tom's	12 (.01)	475 (.39)	-	-	696 (.57)	4 (.003)	40 (.03)	1227	.4443
Mississippian Subtotal	12 (.01)	475 (.39)	-	-	696 (.57)	4 (.003)	49 (.03)	1227	.4443
Tom's	122 (.02)	1874 (.40)	-	3 (.0006)	2037 (.44)	3 (.0006)	598 (.13)	4627	.5608
Hayes	611 (.79)	7 (.009)	23 (.03)	1 (.001)	126 (.16)	-	1 (.001)	769	.3310
Woodland Subtotal	723 (.13)	1881 (.35)	23 (.004)	4 (.0007)	2163 (.40)	3 (.0006)	599 (.11)	5396	
Topsy	-	-	-	-	2518 (1.00)	-	1 (.0001)	2519	.0018
Fattybread	-	8 (.001)	7 (.0009)	31 (.004)	7968 (.99)	32 (.004)	-	8046	.0339
Tom's	86 (.009)	6213 (.64)	-	13 (.001)	3216 (.33)	1 (.0001)	139 (.01)	9668	.3922
Clay Mine II	142 (.18)	3 (.004)	23 (.03)	-	633 (.79)	1 (.001)	2 (.002)	804	.3290
Leftwich	1022 (.53)	2 (.001)	93 (.05)	2 (.001)	783 (.41)	3 (.002)	10 (.005)	1915	.4623
Hayes	2792 (.70)	-	82 (.02)	-	1052 (.26)	-	88 (.02)	4014	.3940
Late Archaic Subtotal	4042 (.15)	6226 (.23)	205 (.008)	46 (.002)	16170 (.60)	37 (.001)	240 (.009)	26966	
Bench	2 (.002)	887 (.69)	16 (.01)	-	375 (.29)	-	-	1280	.3488
Cave Spring	4003 (.70)	-	122 (.02)	-	1568 (.27)	7 (.001)	25 (.004)	5725	.2636
Clay Mine I	124 (.34)	1 (.003)	15 (.04)	-	216 (.60)	-	6 (.02)	362	.4580
Cedar Creek	500 (.54)	5 (.005)	43 (.05)	-	371 (.40)	4 (.004)	5 (.005)	928	.4737
Hayes	621 (.93)	-	2 (.003)	-	33 (.05)	-	10 (.02)	666	.1514
Middle Archaic Subtotal	5250 (.59)	893 (.10)	198 (.02)		2563 (.29)	11 (.001)	46 (.005)	8961	
Total	10027 (.24)	9475 (.22)	426 (.01)	50 (.001)	21592 (.51)	55 (.001)	925 (.02)	42550	

(1984b:134-136) and consists of the assemblage recovered from two 2 x 3 m excavations. Diagnostic lithics and radiocarbon dates indicate a Middle Archaic Eva/Morrow Mountain Phase association for the assemblage (Hofman 1982, 1984a).

The Clay Mine Site (40MU347) is located within Cheek Bend about 1.6 km upstream from Cave Spring. Two buried components were present at the site; one Late Archaic (II) and the other Middle Archaic (I). The results of the analysis of material excavated from two 5 m^2 units indicate that the lower component is associable with the Sykes/White Springs Cluster and the upper component with the Ledbetter. These associations are supported by radiocarbon dates (Amick 1983, 1984b:105).

The chert resources for all of the inner basin open sites in the Cheek Bend vicinity are similar. Ridley or Carters cherts are available both as river and stream transported gravel and as residuum in upland areas. Fort Payne is the majority type in the gravel bars of this area, but the cobble size and weight range are considerably smaller than for gravel occurring in tributaries of the Highland Rim Province (Amick 1984b:Appendix A). Fort Payne chert occurring as active lag gravels in the inner basin has two contemporary sources. One is through long-range transport from the Eastern Highland Rim as bedload, and the other as a reintroduction of gravels deposited in strath terraces through the erosive action of streams or the lateral migration of the Duck itself (Delcourt 1986, personal communication). In both cases, the age of the gravel is likely much greater than the

active bedload in the Highland Rim where more recently exposed blocks of Fort Payne are introduced. The older gravel is subject to a greater degree of desilicification and rounding, and the size of the gravels are restricted by the dynamics of the river, which have varied greatly through prehistory.

In general, there is no significant downstream decrease in the size of Fort Payne gravel samples from inner basin Duck River point bars (Amick 1984b:34). In this area, gravel size is affected primarily by tributary discharge which slows the Duck's current and causes larger gravels to drop out just upstream of confluences. A much more pronounced pattern of downstream size decrease is noted within the tributaries themselves. At the mouth of Fountain Creek, for example, the mean cobble weight is 48.4 g and 18 km upstream the mean weight is 93 g (Amick 1984b:Tables C.2 and C.3). It is also notable that in the sample collected at mile 11 on Fountain Creek, Carters chert comprises 5.7% and Fort Payne 94.3% of the total, while at the confluence, Carters comprises 7.4% and Fort Payne 91.4% (Amick 1984b:Tables C.5 and C.6). This suggests that although gravel size is greater up the tributaries, the incidence of the local Carters chert is greater in the Duck River bars downstream. Although generalizations from these data would be premature, similar factors may have exercised some influence on the prehistoric selection of raw materials.

The Cedar Creek Site (40MU432) is located on the left bank of the Duck, 1.6 km upstream from the Clay Mine Site and immediately above

the confluence of Cedar Creek (Figure 2.3). Specific information regarding the excavations at the site are presented by Amick (1984b:139-147, 1985a:27-30). The sample used here includes all of the materials recovered from area B and the upper strata in area A. Diagnostics and radiocarbon dates suggest a Middle Archaic association for this assemblage.

The Leftwich Site (40MU262) is about 1.5 km upstream of the Cedar Creek Site on the left bank of the Duck. A more detailed account of the site is presented by Amick (1984b:136-139, 1985a:25-27). The sample employed in this analysis includes all materials from levels 8-15 which were greater than .64 cm. Diagnostic projectile points from these contexts are classifiable to the Ledbetter Cluster, hence, the Leftwich sample used in these comparisons represents a Late Archaic assemblage.

Inner Basin Sheltered Sites

All of the sheltered sites employed in these comparisons are, strictly speaking, inner basin sites, though this designation perhaps fits Hayes and Tom's Shelters better than the Fountain Creek sites. Tom's Shelter is located on the right bank of the Duck at river mile 147, about 300 m downstream of the confluence of Negro Creek (Figure 2.3). This location is about 2 km upstream of the confluence of Fountain Creek and roughly halfway between the Bench and Cave Spring sites. The shelter was presumably formed by the erosive action of the lateral migration of the Duck into the Lebanon and Carters limestone

on the outside of this bend. Details of the archaeological investigations of the site are presented by Hall (1985).

Six 1 m^2 units were excavated under the shelter overhang and five zones were identified. Zone II primarily includes Mississippian-age deposits, Zone III contains artifacts associated with the Woodland Period and, Zone IV represents the Archaic Period. Where comparisons in this study make use of data not presented in Hall's (1985) manuscript, the temporal (stratigraphic) divisions follow those illustrated in Hall (1985:190, Figure 33).

The six Fountain Creek sites are located on both sides of the creek from mile 5 to mile 11. Each of the shelters was formed through the erosion of the Lebanon and Carters limestone into which Fountain Creek has cut. Geologically, then, these sites are technically classifiable as within the inner basin. This is misleading, however, as the highlands immediately surrounding the creek are underlain by Upper Ordovician Bigby-Cannon/Hermitage limestones characteristic of the outer basin region. As previously mentioned, the gravel samples from Fountain Creek show that Mississippian Fort Payne is the predominant type (more than 90%), with Carters chert composing somewhat less than 10% of the samples. Many of the tributaries which feed Fountain Creek find their headwaters on Elk Ridge (about 8 km south). Elk Ridge is capped by the Mississippian Fort Payne Formation and forms a finger of the Highland Rim drained northward to the Duck River and southward to the Elk River. Fort Payne chert may be available on Elk Ridge, but this is not specifically known.

The site closest to the Highland Rim is the Pilkington Site. Two adjacent 1 m^2 units were excavated at the site and four strata were identified. The sample employed in this study is identified as Middle Woodland in the tables presented by Entorf (1985:54-61). Affiliation of the artifacts with this cultural period is based on the stratigraphic association of limestone tempered ceramics in Stratum III.

Proceeding downstream, the Baker Site (40MU435) is the next site encountered. Three 1 m^2 units were excavated under the overhang at this shelter and three natural strata were recognized. Stratum I is the lowermost and is identified as Middle Archaic in age on the basis of its relation to stratum II (Entorf 1985:229). Stratum II is identified as dating to the Middle Archaic based on the inclusion of an Eva/Morrow Mountain point (Entorf 1985:229). Stratum III is the uppermost stratum and is identified as Mississippian/Late Woodland in age based on the presence of a small triangular projectile of the Hamilton/Madison type (Entorf 1985:230).

The tabular presentation of the lithic data from the site divide the assemblage into the two cultural components mentioned. Apparently a bimodal distribution of debitage further aided in the separation of these components (Entorf 1985:245), but the results of this analysis are not presented.

McCollum Rockshelter (40MU390) is located about 5 km downstream (Fountain Creek mile 8) of the Baker Shelter. McCollum is the largest of the Fountain Creek shelters, and four 1 m^2 units were excavated

exposing 13 strata (Entorf 1985:39-51). Strata I-III are identified as Middle Archaic by association with two Eva/Morrow Mountain projectile points. Strata IV is apparently transitional from Middle to Late Archaic, while Strata V is identified as Late Archaic on basis of the presence of a projectile point of the Ledbetter Cluster. Stratum VI is transitional as Stratum VII contains limestone tempered and Long Branch Fabric Impressed ceramics, providing an Early Woodland affiliation. Stratum VIII contains shell tempered sherds and is interpreted as dating to the Mississippian Period. The tabulated data from McCollum are divided into three components: Middle Archaic, Late Archaic and Mississippian/Woodland (Entorf 1985:Tables 4.2, 4.3, 4.4, 4.6 and 4.7). The data employed in the present study follow these divisions.

Excavations at the Height Rockshelter included six 1 m^2 units which exposed two strata. Stratum I, the basal unit, was devoid of cultural material. Stratum II included a single stemmed point classified as a Ledbetter, and limestone tempered ceramics classified as Mulberry Creek Plain (Entorf 1985:189, 192-193). The artifacts recovered from Stratum II are associated with one of two components; Late Archaic or Middle Woodland. The cultural contexts of these components were reportedly derived, in part, from an analysis of the vertical distribution of debitage. The tabular data presented by Entorf (1985: Tables 6.1, 6.2 and 6.3) are used in this study.

The Goatcliff Shelter excavations involved 18 1 m^2 units exposing two natural strata. No artifacts were found in the lowermost stratum

(I), and Stratum II produced a variety of ceramics including limestone, clay, chert, sand, and shell tempered sherds representing Early, Middle and Late Woodland, and Mississippian culture periods. Lithic artifacts which could be associated with these periods were also encountered in Stratum II. The vertical distribution of debitage aided in the spatial separation of two components; Middle and Late Woodland/Mississippian, and these are employed in the following analysis.

Hardison Rockshelter was investigated through the excavation of four 1 m^2 units from which three natural stratigraphic zones were defined. Strata I and II are both assigned to the Terminal Archaic/Early Woodland periods on the basis of Mulberry Creek Plain and Long Branch Fabric Impressed sherds and a projectile point associated with the Wade Cluster, which were incorporated in the fill (Entorf 1985:209-218). All of the artifacts in the Hardison sample are associated with these temporal periods.

Raw Material Variability

Table 6.1 shows the distribution of the debitage in seven raw material categories from each of the 16 sites. The evenness value for each site is plotted with the mean and 95% confidence intervals in Figure 6.1. Results show that the calculated evenness for each site is well below the 95% confidence interval. Each site demonstrates a distribution among the seven categories that is far less even than the model which is based on the distribution when the values in each

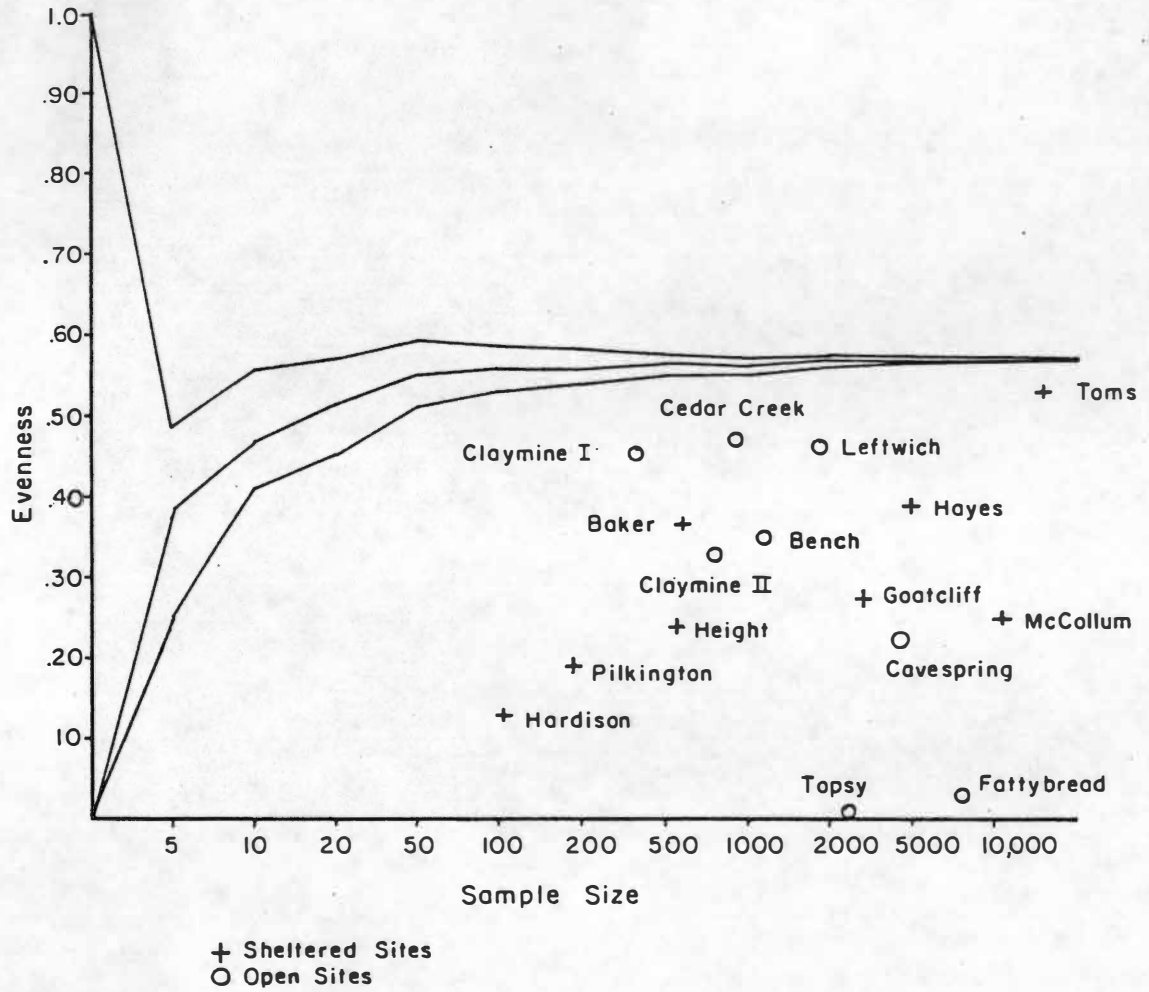


Figure 6.1. Evenness values for debitage among the raw material categories for the 16 site sample.

material category are totaled. This suggests that there is enough difference between each site that the individual distributions do not mirror the distribution of their totals. These results suggest that resource selection is distinct at each site.

A broad pattern emerges, however, when we consider the sites' spatial relationship to the material sources. Table 6.2 shows the frequency of Middle and Upper Ordovician and Mississippian cherts in the debitage assemblages from each site. The sites are listed in order of their decreasing proximity to the Highland Rim (the source location for the superior Fort Payne chert). The sites are also grouped by the physiographic region in which they occur. One general pattern in these data is an inverse relationship between the frequency of Fort Payne chert and the distance to the Highland Rim. This reflects the fact that in the inner and outer basin areas where Fort Payne resources are poor, the assemblages become increasingly dominated by local chert types.

It is also interesting to note the more common occurrence of Upper Ordovician chert types in the assemblages of the sites located in the inner basin area. This pattern would be expected for sites situated in the outer basin area but is unexpected for the inner basin sites. It is unusual that no Upper Ordovician cherts occur in the debitage assemblages of any of the Fountain Creek shelters as these sites are adjacent to potential Bigby-Cannon and Brassfield source areas.

Table 6.2. Raw material variability among the 16 site sample.

Sites	Middle Ordovician	Upper Ordovician and Silurian	Mississippian	Totals
Topsy			2518 (1.0)	2518
Fattybread	8 (.001)	38 (.005)	8000 (.99)	8046
Highland Rim Totals	8 (.0008)	38 (.004)	10518 (.99)	10564
Pilkington	17 (.09)		173 (.91)	190
Baker	352 (.58)		251 (.42)	603
McCollum	1075 (.11)		9008 (.89)	10083
Goatcliff	597 (.02)		2777 (.82)	3374
Height	159 (.27)		427 (.73)	586
Hardison	4 (.04)		100 (.96)	104
Tom's	8772 (.57)	613 (.04)	5957 (.39)	15342
Bench	889 (.69)	16 (.01)	375 (.29)	1280
Outer Basin Totals	11865 (.38)	629 (.02)	19068 (.60)	31562
Cave Spring	4003 (.70)	122 (.02)	1575 (.28)	5700
Clay Mine I	125 (.35)	15 (.04)	216 (.61)	356
Clay Mine II	145 (.18)	23 (.03)	634 (.79)	802
Cedar Creek	505 (.55)	43 (.05)	375 (.41)	923
Leftwich	1024 (.54)	95 (.05)	786 (.41)	1905
Hayes	3335 (.68)	199 (.04)	1381 (.28)	4915
Inner Basin Totals	9137 (.63)	497 (.03)	4967 (.34)	14601

Evidence for increased dependence on a wider variety of chert types in the resource poor areas is also reflected in the evenness values. Figure 6.2 illustrates a plot of the evenness values for each assemblage against site distance from the Highland Rim. The pattern shows that the evenness values are quite low for sites within a few kilometers of the Highland Rim and that the values for sites located in the inner basin are somewhat higher than for sites in the outer basin.

Assemblage Patterning

Major Lithic Classes

Table 6.3 shows the distribution of the lithic types from each of the 16 sites. The most significant difference between the sites from each physiographic region is the percentage of blocky debris. As previously suggested, the increased use of Ordovician cherts in the basin areas may have influenced the frequency of blocky debris in the assemblages.

A plot of the evenness of the distribution of lithic types from each site indicates that most are more even than the model (Figure 6.3). Four sites (Topsy, Fattybread, McCollum and the Bench) have distributions far less even than expected. The distribution at Topsy and Fattybread suggest that reduction activities at these sites apparently favored the production of flake debris. It is notable that their frequencies of blocky debris are extremely low. This

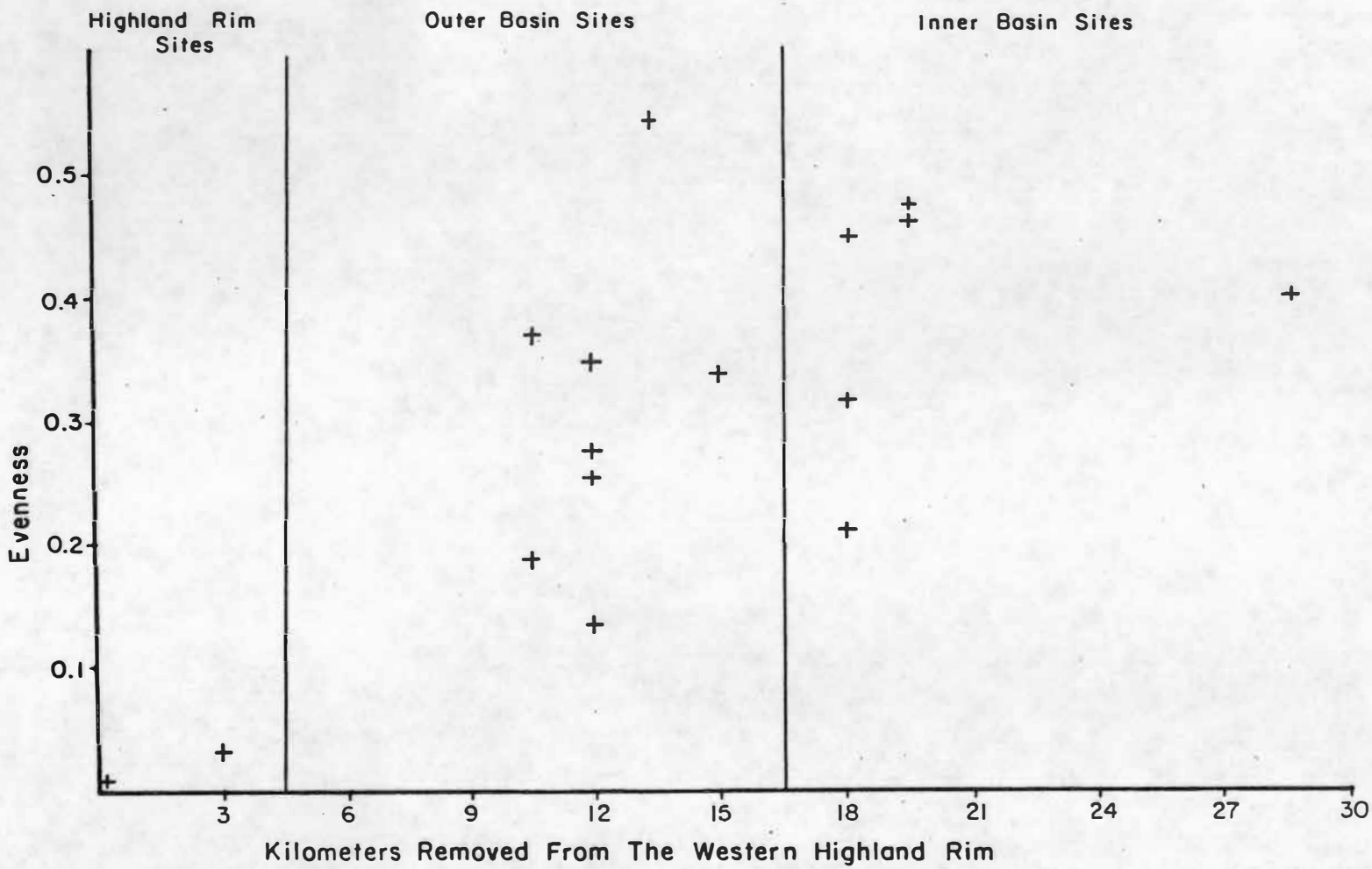
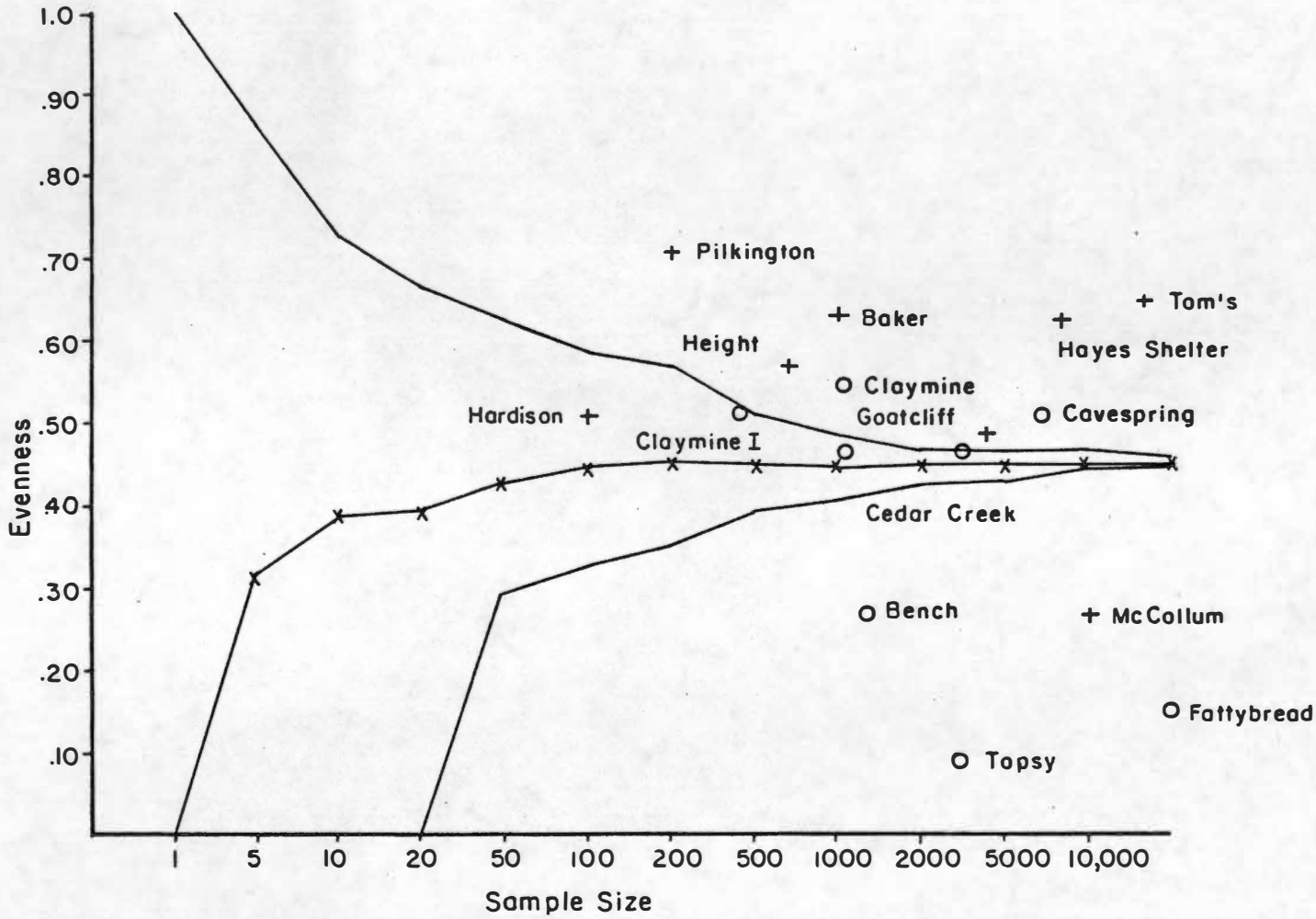


Figure 6.2. Plot of the evenness of the distribution of debitage among the raw material classes against the distance of the site to the Western Highland Rim.

Table 6.3. Distribution of lithic types for the 16 site sample.

Site	Cores	Tested Cobbles	Blocky Debris	Debitage	Hammer-stones	Core Tools	Flake Tools	Bifaces	Total	Evenness
Topsy	4 (.002)	1 (.0004)	15 (.006)	2519 (.98)	-	-	2 (.0008)	27 (.01)	2568	.0977
Fattybread	151 (.005)	74 (.002)	436 (.01)	30707 (.97)	25 (.0008)	-	68 (.002)	332 (.01)	31793	.1534
Highland Rim Totals	155 (.005)	75 (.002)	451 (.01)	33226 (.97)	25 (.0007)		70 (.002)	359 (.01)	34361	
Pilkington	5 (.03)	7 (.04)	41 (.21)	131 (.67)	-	-	9 (.05)	2 (.01)	195	.7132
Baker	9 (.009)	9 (.009)	347 (.35)	629 (.63)	-	-	3 (.003)	5 (.005)	1002	.6360
McCollum	23 (.002)	36 (.003)	675 (.07)	9491 (.93)	2 (.0002)	3 (.0003)	28 (.002)	36 (.003)	10294	.2680
Goatcliff	16 (.004)	10 (.002)	649 (.16)	3265 (.81)	1 (.0002)	10 (.002)	18 (.004)	44 (.01)	4013	.4382
Height	5 (.007)	4 (.006)	149 (.21)	538 (.75)	-	2 (.003)	8 (.01)	7 (.01)	713	.5704
Hardison	-	-	17 (.15)	89 (.81)	1	-	-	3 (.03)	110	.5045
Tom's	69 (.004)	264 (.01)	5630 (.32)	11365 (.65)	-	-	234 (.01)	41 (.002)	17603	.6500
Bench	5 (.0003)	11 (.0006)	59 (.04)	1278 (.93)	-	-	12 (.0007)	10 (.0006)	1375	.2665
Outer Basin Totals	132 (.004)	341 (.01)	7567 (.21)	26786 (.76)	4 (.0001)	15 (.0004)	312 (.009)	148 (.004)	35305	
Cave Spring	50 (.007)	29 (.004)	1331 (.18)	5721 (.79)	-	-	29 (.004)	78 (.01)	7238	.5160
Clay Mine II	16 (.01)	6 (.006)	110 (.11)	834 (.81)	4 (.004)	-	17 (.01)	46 (.04)	1033	.5505
Clay Mine I	12 (.03)	7 (.02)	26 (.06)	362 (.83)	-	-	11 (.03)	18 (.04)	436	.5180
Cedar Creek	8 (.007)	5 (.005)	107 (.10)	928 (.85)	-	2 (.002)	27 (.02)	16 (.01)	1093	.4623
Leftwich	20 (.009)	9 (.04)	274 (.12)	1915 (.84)	2 (.0009)	-	8 (.004)	50 (.02)	2278	.4167
Hayes	1 (.0001)	-	2908 (.37)	4933 (.63)	-	-	7 (.0009)	27 (.003)	7876	.6230
Inner Basin Totals	107 (.006)	56 (.003)	4756 (.25)	14693 (.77)	6 (.0003)	2 (.0001)	99 (.005)	235 (.01)	18964	



+ Sheltered Sites
O Open-Air Sites

Figure 6.3. Plot of the evenness of the lithic debitage and tool types for each site.

pattern is also indicated at McCollum and the Bench, though the percentages of blocky debris in the assemblages are slightly higher.

There also appears to be a pattern among the evenness scores which suggests that the sheltered site assemblages are generally more even than expected. Seventy-five percent of the sheltered site assemblages are more even than expected and only 12% are less even. For the open sites, 25% are less even and 38% are more even. The overall pattern suggests that there is a greater range of assemblage evenness among the open sites than the sheltered sites.

Plotted against the distance of the sites' location from the Highland Rim, a somewhat more ambiguous pattern emerges (Figure 6.4). Topsy and Fattybread Branch again show very low values and are very close to excellent Fort Payne resources. The outer basin sites have the most diversity among them, with the Bench and McCollum scoring low and with Pilkington, Baker and Tom's shelters having high evenness values. The latter three have higher than average percentages of blocky debris in their assemblages which are composed primarily of local Ordovician cherts.

The inner basin site evenness values seem to cluster more tightly. Plotted against their sample sizes (Figure 6.4), 50% of the inner basin assemblage evenness scores are within the 95% confidence interval. Hayes Shelter stands out, again with a high percentage of blocky debris and local Ridley chert. These results suggest that assemblage patterning is strongly influenced by the raw material type which is exploited, and this, in turn, is dependent on the nature of

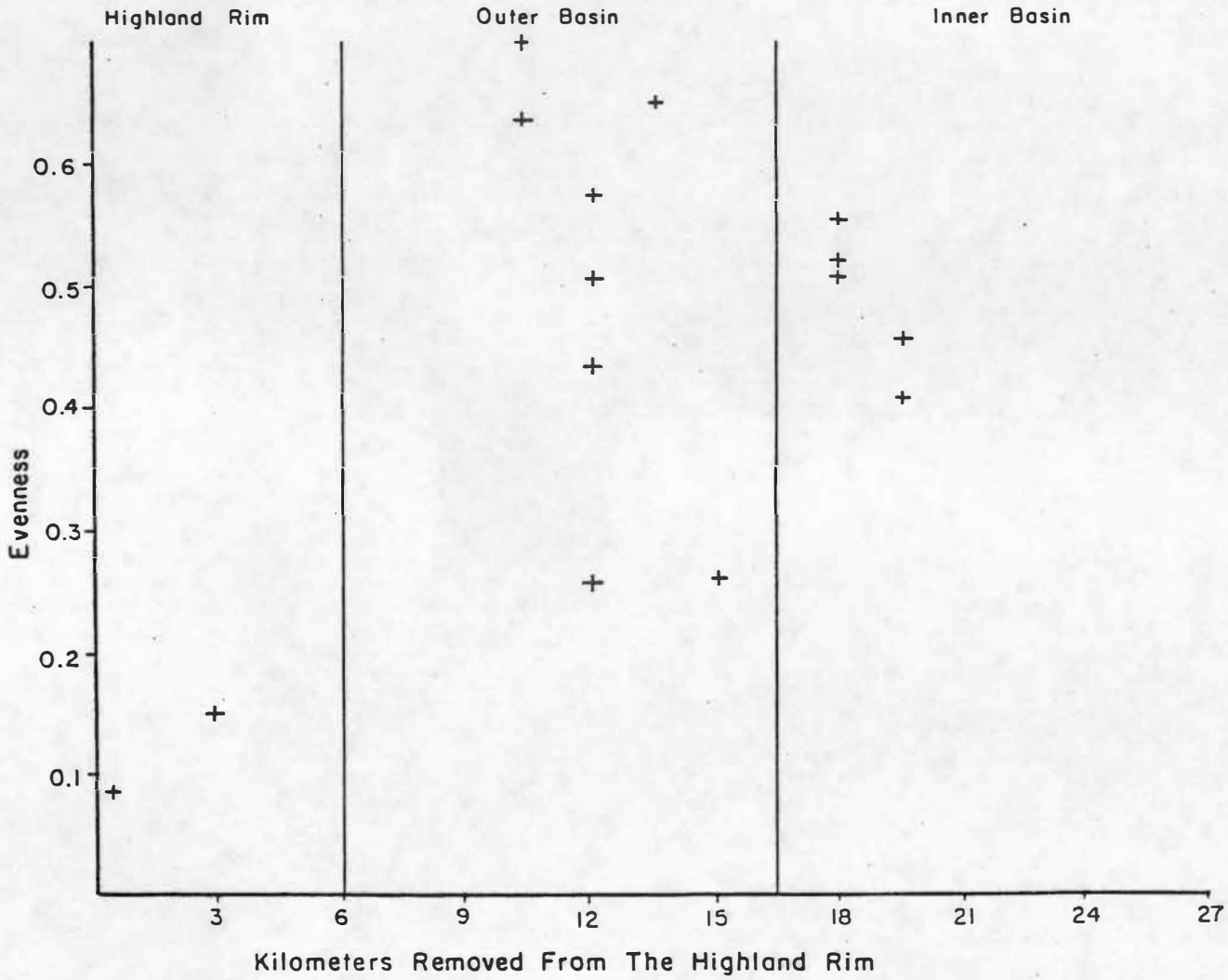


Figure 6.4. Plot of the evenness of the lithic types against the distance of the site from the Highland Rim.

the locally available resources. In addition to this broad pattern of association of assemblages with locally available material types, there is more diversity among open site assemblages than sheltered sites.

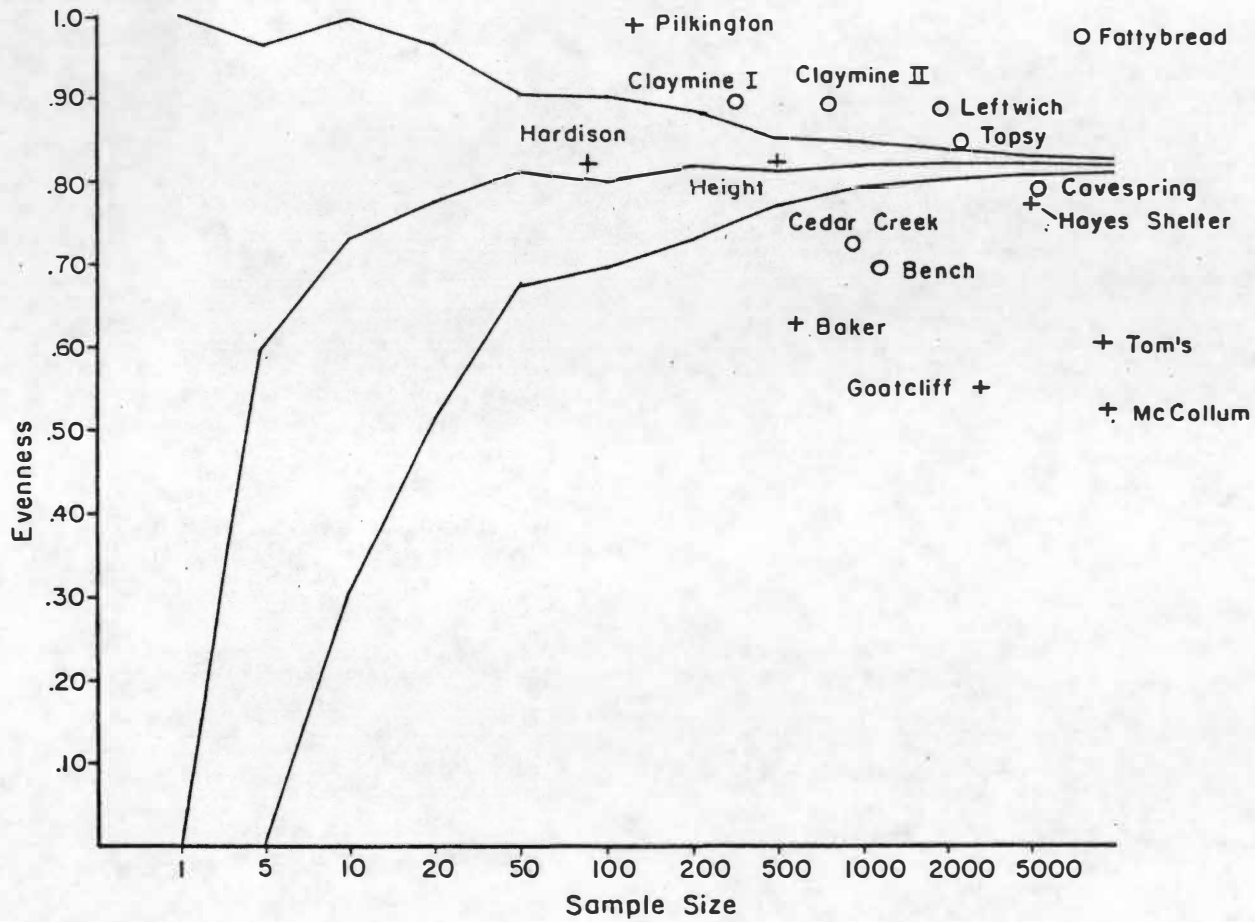
Debitage Reduction Stages

The distribution of debitage among the reduction stages for the 16 site sample also shows a difference between sites in the three physiographic regions (Table 6.4). The distribution is much more even among Highland Rim sites than those from the other areas. The difference is less pronounced between sites from the two basin areas.

When debitage evenness is plotted against the sites' sample size, the pattern of sheltered versus open-air sites is the reverse of that exhibited by the total assemblage (Figure 6.5). This sample does not include blocky debris, and thus reflects a slightly later segment of the reduction trajectory. The plot shows 63% of the debitage assemblages from the sheltered sites distributed less evenly than expected. The same percentage of assemblages from open-air sites are distributed more evenly than the model predicts. Totaling the values of the sheltered sites, the distribution among the classes suggests a predominantly middle-stage trajectory segment with 16% decortication, 71% interior, and 13% biface thinning flakes. The open-air distribution indicates a greater frequency of early- and late-stage debitage with 33% decortication, 49% interior, and 18% biface thinning flakes. Variability in distribution among sites, whether sheltered or open, is high. The overall indication is that the variability

Table 6.4. Distribution of reduction stage debitage for the 16 site sample.

Sites	Decortication	Interior	Thinning	Total
Topsy	346 (.14)	1513 (.60)	660 (.26)	2519
Fattybread	3488 (.43)	2582 (.32)	2097 (.26)	8167
Highland Rim Total	3834 (.36)	4095 (.38)	2757 (.26)	10686
Pilkington	53 (.40)	36 (.27)	42 (.32)	131
Baker	137 (.22)	27 (.04)	465 (.74)	629
McCollum	740 (.08)	7860 (.83)	891 (.09)	9491
Goatcliff	293 (.09)	2655 (.81)	371 (.10)	3319
Height	126 (.23)	346 (.64)	66 (.12)	538
Hardison	29 (.33)	52 (.58)	8 (.09)	89
Tom's	2720 (.26)	6427 (.63)	1122 (.11)	10269
Bench	288 (.18)	927 (.72)	123 (.10)	1338
Outer Basin Total	4386 (.17)	18330 (.71)	3088 (.12)	25804
Cave Spring	2082 (.36)	3249 (.57)	390 (.07)	5721
Clay Mine I	181 (.50)	144 (.40)	37 (.10)	362
Clay Mine II	140 (.17)	461 (.55)	233 (.28)	834
Cedar Creek	256 (.28)	617 (.66)	55 (.06)	928
Leftwich	445 (.23)	1133 (.59)	337 (.18)	1915
Hayes	733 (.15)	3335 (.68)	872 (.18)	4940
Inner Basin Total	3837 (.26)	8939 (.61)	1924 (.13)	14700
Total	12057 (.24)	31364 (.61)	7769 (.15)	51190



O Open-Air Sites
+ Sheltered Sites

Figure 6.5. Plot of the evenness of debitage among 3-way reduction classes for the sites.

among debitage reduction stages is greater for sheltered sites than for open sites.

Temporal Considerations

Raw Material Selection

Results thus far indicated that raw material distributions tend to reflect the locally available chert types or the distance of the site from high quality Fort Payne resources, that the assemblage composition is affected by resource selection, and that these patterns differ somewhat between sheltered and open-air sites. Table 6.1 presents the distribution of material types from assemblages in four broad temporal groups. The evenness scores for these assemblages are plotted against the sample size in Figure 6.6. All of the distributions are less even than the model based on the total. Each of the assemblages differs from the next enough that the global model fails to reflect the distribution in any single assemblage. This suggests that resource selection is assemblage-specific. Widely divergent evenness scores among the assemblages of multicomponent sites such as Hayes and Tom's shelters indicate that resource selection varies considerably through time.

Table 6.5 illustrates the total scores for Middle Ordovician, Upper Ordovician and Silurian, and Mississippian materials from each major temporal period. The proportions are quite different for each period. The shift from Middle to Late Archaic is especially pronounced as inner basin Ordovician resources drop from 69% to 38%

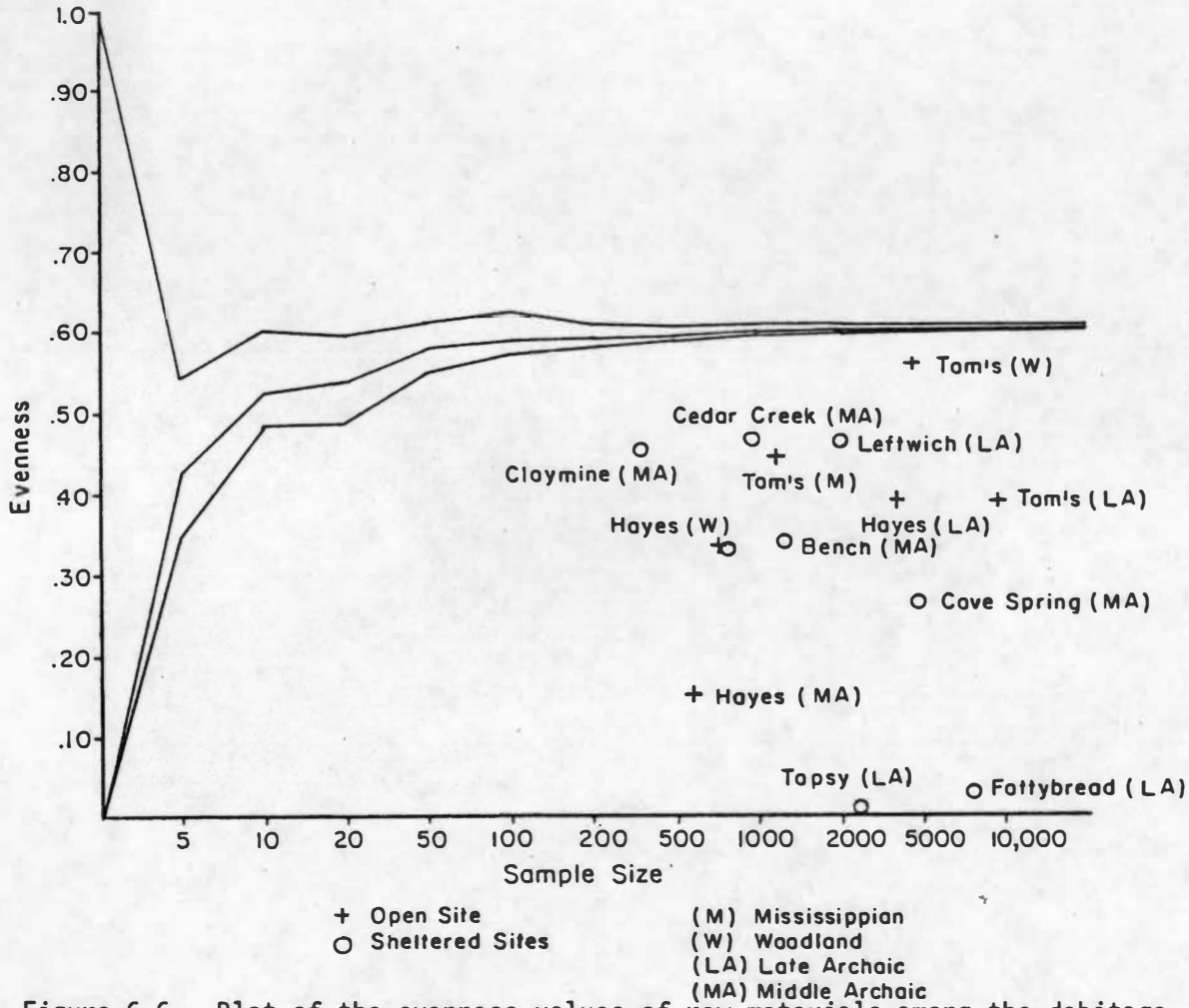


Figure 6.6. Plot of the evenness values of raw materials among the debitage for site assemblages.

Table 6.5. Raw material totals from each major geological type and chronological period.

Temporal Period	Middle Ordovician	Upper Ordovician and Silurian	Mississippian	Totals
Mississippian	487 (.41)	-	700 (.59)	1187
Woodland	2640 (.55)	27 (.006)	2166 (.45)	4833
Late Archaic	10268 (.38)	251 (.009)	16207 (.61)	26726
Middle Archaic	6143 (.69)	198 (.02)	2574 (.29)	8915
Total	19538 (.47)	476 (.01)	21647 (.52)	41661

and Fort Payne materials jump from 29% to 61%. Material selection in the Woodland assemblages again demonstrates higher frequencies of Middle Ordovician resources and lower Fort Payne proportions. These figures, however, are derived from only two shelter sites (Hayes and Tom's) and both of these sites show higher proportions of local raw materials at all times.

Assemblage Patterning

Table 6.6 presents the distribution among the lithic categories for each major chronological period. The evenness values for these assemblages are plotted against the sample size in Figure 6.7. The plot indicates that very little temporal patterning exists. The fact that no assemblage was distributed such that it fell within the 95% confidence interval also points to overall variability. A plot of the evenness scores against a chronological scale shows very little linear patterning or clustering (Figure 6.8). This further demonstrates the broad range of variability in distributions across the temporal periods. The pattern detected for material type distributions is not observable among the lithic classes of the temporally distinct assemblages.

Debitage Reduction Stages

The results of the comparison of the three-way debitage reduction stages by major chronological period also show little evidence of temporal patterning. Table 6.7 indicates that the overall proportions of decortication flakes decrease slightly from the Middle to Late

Table 6.6. The distribution of artifacts among the lithic classes for each site assemblage.

Site Assemblages	Cores	Tested Cobbles	Blocky Debris	Debitage	Hammer-stones	Core Tools	Flake Tools	Bifaces	Total	Evenness
Tom's	5 (.003)	25 (.01)	437 (.22)	1440 (.73)	-	-	43 (.02)	24 (.01)	1974	.4107
Baker	1 (.08)	-	40 (.40)	59 (.58)	-	-	-	1 (.01)	101	.4112
McCollum	1 (.0002)	16 (.004)	229 (.06)	3684 (.93)	-	-	23 (.006)	5 (.001)	3958	.1568
Goatcliff	9 (.006)	8 (.006)	362 (.25)	1015 (.70)	1 (.0007)	3 (.002)	13 (.009)	35 (.02)	1446	.4291
Hayes	1 (.0009)	-	314 (.29)	766 (.70)	-	-	3 (.003)	13 (.01)	1097	.3642
Mississippian/ Woodland Subtotal	17 (.002)	49 (.006)	1382 (.16)	6964 (.81)	1 (.0001)	3 (.0003)	82 (.01)	78 (.009)	8576	
Pilkington	5 (.05)	5 (.05)	19 (.18)	67 (.64)	-	-	6 (.06)	2 (.02)	104	.5997
Goatcliff	7 (.003)	2 (.0008)	287 (.11)	2250 (.88)	-	1 (.0004)	11 (.004)	9 (.004)	2567	.2281
Height	4 (.008)	-	97 (.19)	405 (.79)	-	2 (.004)	4 (.008)	3 (.006)	515	.3357
Hardison	-	-	17 (.15)	89 (.81)	1 (.009)	-	-	3 (.03)	110	.3200
Tom's	13 (.003)	42 (.009)	1201 (.26)	3305 (.70)	-	-	108 (.02)	35 (.007)	4704	.4143
Woodland Subtotal	29 (.004)	49 (.006)	1621 (.20)	6116 (.76)	1 (.0001)	3 (.0004)	129 (.02)	52 (.006)	8000	
McCollum	11 (.003)	5 (.001)	277 (.07)	3772 (.92)	1 (.0002)	-	17 (.004)	7 (.002)	4090	.1687
Height	1 (.005)	4 (.02)	52 (.27)	133 (.68)	-	-	2 (.02)	4 (.02)	196	.4514
Tom's	47 (.005)	180 (.02)	3559 (.38)	5524 (.59)	-	-	83 (.009)	48 (.005)	9441	.4535
Hayes	-	-	1546 (.27)	4080 (.72)	-	-	3 (.0005)	18 (.003)	5647	.3258
Topsy	4 (.002)	1 (.0004)	15 (.006)	2519 (.98)	-	-	2 (.0008)	27 (.01)	2568	.0615
Fattybread	151 (.005)	74 (.002)	436 (.01)	30707 (.97)	25 (.0008)	-	68 (.002)	332 (.01)	31793	.1056
Clay Mine II	16 (.02)	6 (.006)	110 (.11)	834 (.81)	4 (.004)	-	17 (.02)	46 (.04)	1033	.3905
Leftwich	20 (.009)	9 (.004)	274 (.12)	1915 (.84)	2 (.0009)	-	8 (.004)	50 (.02)	2278	.3130
Late Archaic Subtotal	250 (.004)	279 (.005)	6269 (.11)	49484 (.87)	32 (.0006)	-	200 (.004)	532 (.009)	57046	
Baker	8 (.009)	9 (.01)	307 (.34)	570 (.63)	-	-	3 (.003)	4 (.004)	901	.4194
McCollum	9 (.004)	8 (.004)	169 (.08)	2035 (.90)	1 (.0004)	-	7 (.003)	21 (.009)	2250	.2090
Hayes	-	1 (.0009)	1048 (.92)	84 (.07)	-	-	1 (.0009)	-	1134	.1481
Bench	5 (.004)	11 (.008)	59 (.04)	1278 (.92)	-	-	12 (.009)	10 (.007)	1375	.1087
Cave Spring	50 (.007)	29 (.004)	1331 (.18)	5721 (.79)	-	-	29 (.004)	78 (.01)	7238	.3327
Clay Mine I	12 (.03)	7 (.02)	26 (.06)	362 (.83)	-	-	11 (.03)	18 (.04)	436	.3793
Cedar Creek	8 (.007)	5 (.005)	107 (.10)	928 (.85)	-	2 (.002)	27 (.02)	16 (.01)	1093	.3152
Middle Archaic Subtotal	92 (.006)	70 (.005)	3047 (.21)	10978 (.76)	1 (.00007)	2 (.0001)	90 (.006)	147 (.01)	14427	
Total	388 (.004)	447 (.005)	12319 (.14)	73542 (.84)	35 (.0004)	8 (.00009)	501 (.006)	809 (.009)	88049	

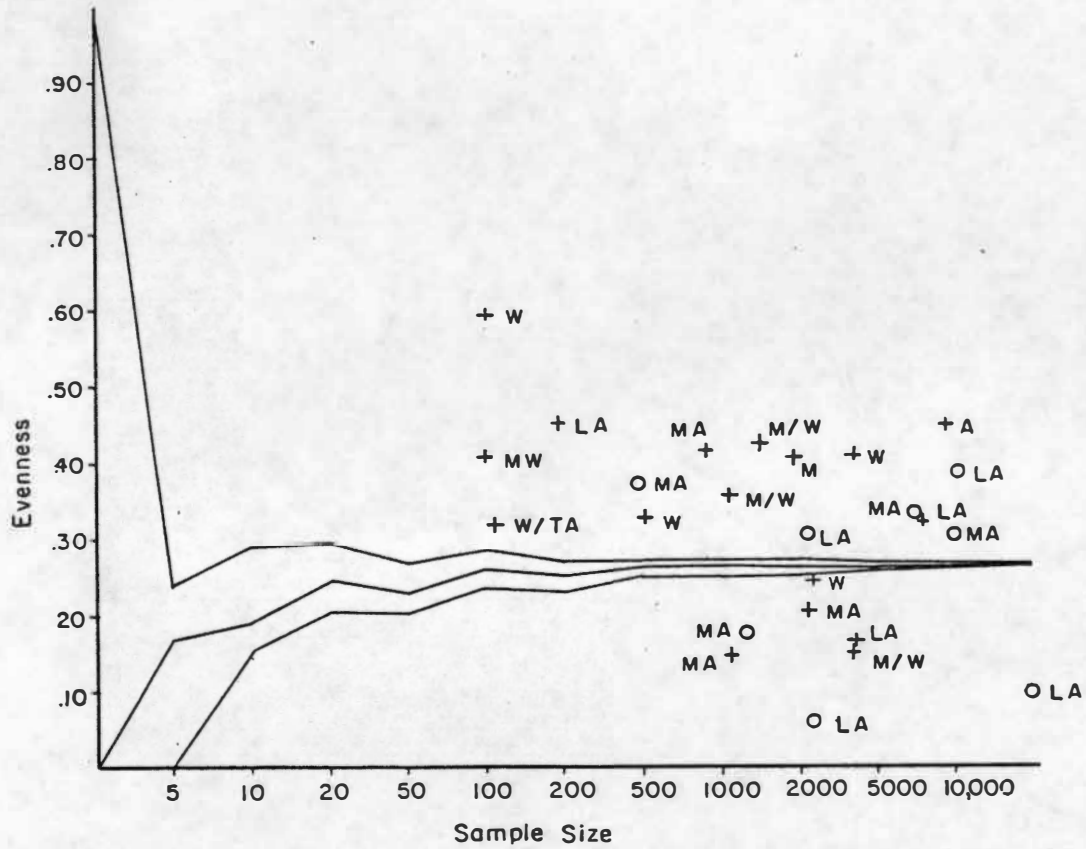


Figure 6.7. Plot of the evenness of lithic classes for each site assemblages.

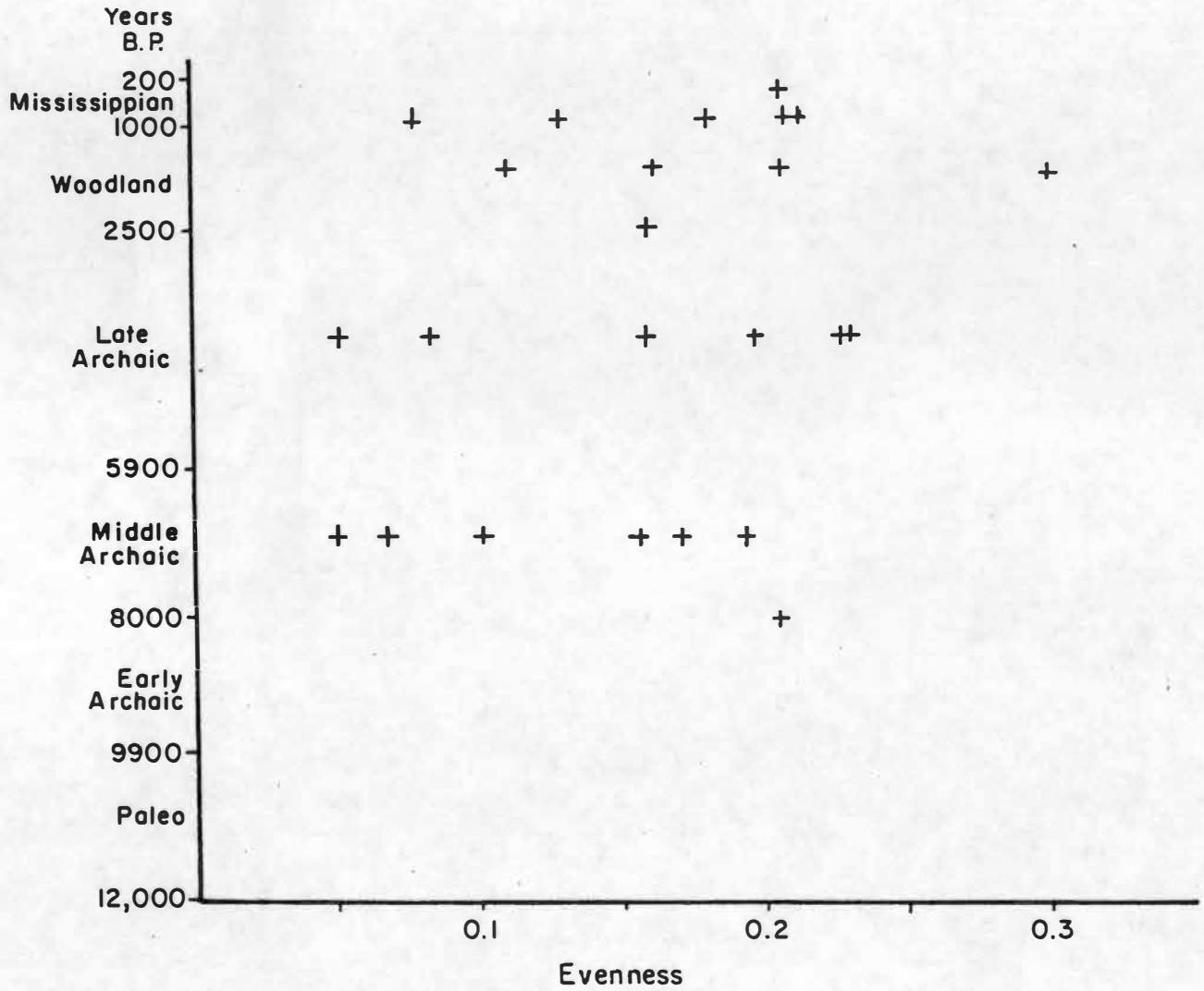


Figure 6.8. Plot of evenness of lithic classes, scaled against time.

Table 6.7. Frequency distribution of reduction stages by condensed chronological period. Sheltered and open sites are grouped and arranged in descending order from resource rich to resource poor areas.

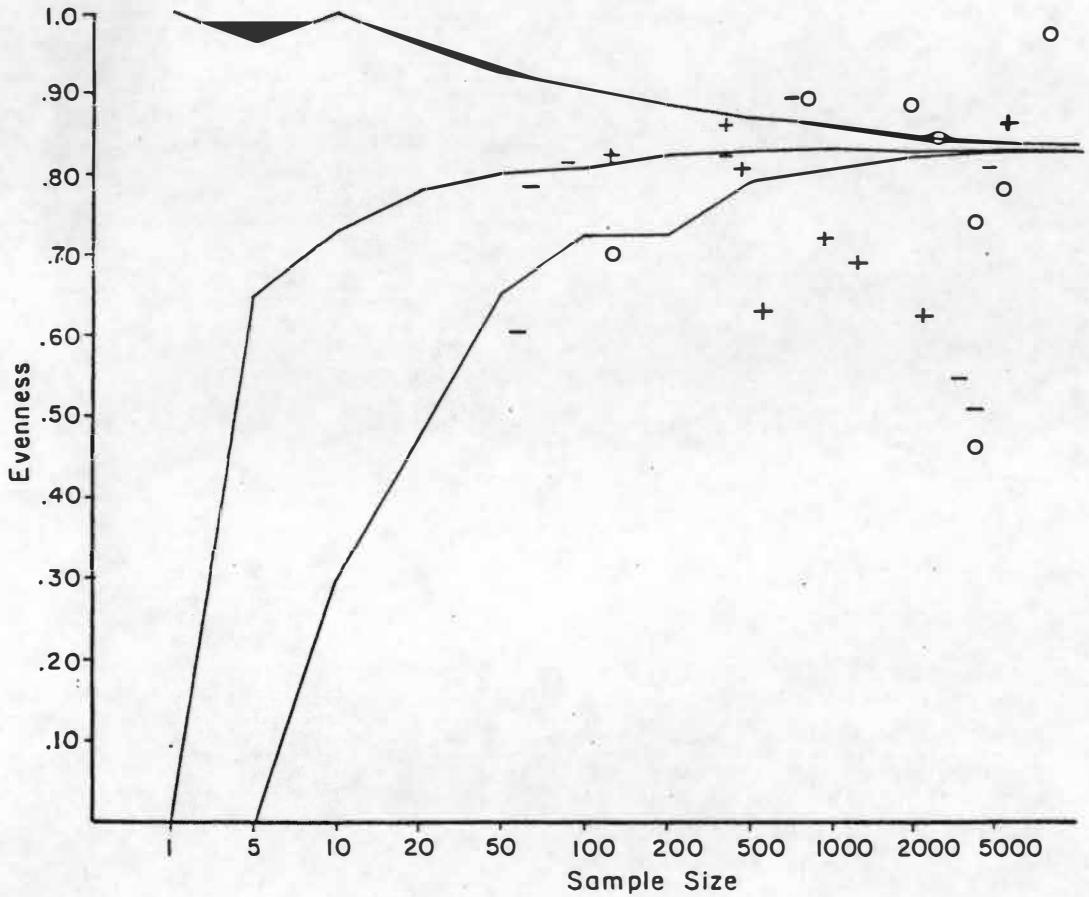
	Debitage Reduction Stages by Chronological Period								
	Mississippian-Early Woodland			Terminal Archaic-Late Archaic			Middle Archaic-Early Archaic		
Sites	Decortication	Interior	Thinning	Decortication	Interior	Thinning	Decortication	Interior	Thinning
Pilkington	19 (.28)	6 (.09)	42 (.63)						
Baker	13 (.22)	2 (.03)	44 (.75)				124 (.22)	25 (.04)	421 (.74)
McCollum	221 (.06)	3053 (.83)	410 (.11)	295 (.08)	3235 (.86)	242 (.06)	224 (.11)	1572 (.77)	239 (.12)
Goatcliff	293 (.09)	2655 (.81)	317 (.10)						
Height	90 (.22)	256 (.63)	59 (.15)	36 (.27)	90 (.68)	7 (.05)			
Hardison	29 (.33)	52 (.58)	8 (.09)						
Tom's	1313 (.28)	2858 (.61)	484 (.10)	1407 (.25)	3569 (.65)	548 (.10)			
Hayes Shelter	161 (.21)	427 (.56)	178 (.23)	545 (.14)	2816 (.70)	669 (.17)	27 (.20)	85 (.63)	22 (.16)
Topsy				356 (.14)	1513 (.60)	660 (.26)			
Fattybread				3488 (.43)	2582 (.32)	2097 (.03)			
Bench							228 (.18)	927 (.73)	123 (.10)
Cave Spring							2082 (.36)	3249 (.57)	390 (.07)
Clay Mine II				140 (.17)	461 (.55)	223 (.28)			
Clay Mine I							181 (.50)	144 (.40)	37 (.10)
Cedar Creek							256 (.28)	617 (.66)	55 (.06)
Leftwich				445 (.23)	1133 (.60)	337 (.18)			
Total	2139 (.16)	9309 (.72)	1542 (.12)	6702 (.25)	15,399 (.57)	4793 (.18)	3122 (.28)	6619 (.60)	1287 (.12)

Archaic and the proportion of thinning flakes increases. The trend is again reversed in the Mississippian/Woodland as both decortication and thinning flake proportions decrease. The plot of evenness values for these distributions shows a similar lack of linear patterning as sites from each period are distributed above, below, and within the 95% range of confidence (Figure 6.9).

Summary and Discussion

In the foregoing sections it was demonstrated that although raw material selection seems to be specific to each site, variability in the types of chert employed increases as the sites become farther away from the Highland Rim and its high quality Fort Payne. This is interpreted to mean that there is, quite naturally, a higher incidence of the use of local Ordovician cherts in the areas where these chert types occur. In other words, in the samples studied individual site lithic industries were produced primarily of locally available chert. In areas where Fort Payne is only available in small waterworn cobbles, this entailed the use of the broader spectrum of resources which were locally available.

It was also demonstrated that the characteristics of the raw material exploited affect the nature of the manufacturing process, as early-stage by-products (blocky debris) are more common in assemblages based on Ordovician cherts. Again, this is an obvious observation, but with important implications. If inner basin resources are likely to shatter more easily in the manufacturing process, then they are apt



— Mississippian/Woodland Assemblages
o Late Archaic Assemblages
+ Middle Archaic Assemblages

Figure 6.9. Plot of the evenness of 3-way debitage categories among eight Mississippian/Woodland, eight Late Archaic and seven Middle Archaic assemblages.

to be a poor material for biface manufacture. It follows that the use of this material in prehistory may reflect either expedient use of a nonessential resource or necessary use of a primary essential resource, possibly indicating conditions of population and environmental stress. The evidence from multicomponent sites in the inner basin area (eg. Hayes and Tom's Shelters) suggests the former, i.e., that the use of the local Ordovician materials was a common practice throughout all temporal periods and coexisted with or supplemented the use of Fort Payne materials.

The data from sites in the Central Duck River Basin also indicate that the lithic reduction activities conducted at sheltered sites were, in a broad sense, different from activities conducted at open-air sites, although the difference often reflects the flaking ability of the chert available in the immediate area. The evenness of artifact distributions is greater from sheltered sites than from their open-air counterparts. The reverse is true of debitage reduction stages; sheltered sites more commonly show less even distributions. Although this appears contradictory, the analyses are actually measuring two different things. Based on the model derived from the total scores, the increased incidence of blocky debris in the shelter assemblages is largely responsible for their apparently more even distributions among all the lithic classes. As Ridley and Carters cherts are commonly incorporated in the shelter fill, this result is not unexpected. When blocky debris is eliminated and only flake waste is analyzed, the shelter assemblages are seen to be more specialized.

These results seem to confirm, to a limited degree, the common expectation that the suite of activities performed at rockshelters is perhaps more limited than at open-air sites (Adovasio et al. 1978:649; DeJarnette et al. 1962:87; Fitzgibbons et al. 1977:46; Hall 1985:217; Klippel 1971a:15; Vento et al. 1980:187; Wood 1968:170).

In general, the debitage from sheltered and open-air sites are dominated by interior flakes, but decortication flakes are more frequent in the open site assemblages, and are the majority type at some sites (e.g., Fattybread and Clay Mine I). Among the sheltered sites are examples with more biface thinning than interior flakes (e.g., the Pilkington and Baker sites). It should be noted, however, that there is a great deal of variability among the debitage assemblages from both sheltered and open sites which suggests that conditions such as those dictating the nature and availability of lithic resources may be influencial in shaping assemblage composition.

The consideration of temporal variability among the lithic assemblages from the sites suggests a shift in raw material selection from the Middle to Late Archaic Periods. The Middle Archaic assemblages are predominated by Ridley and Carters chert, and Late Archaic assemblages are composed primarily of Fort Payne.

The data presented in the foregoing discussion indicate that although temporal patterns among the broad lithic and debitage assemblage classes have been difficult to recognize, the shift in raw material use is apparent. It is proposed that the lithic industries of both the Middle and Late Archaic Periods in the basin areas relied

on a mix of local and extralocal cherts. At any one time, variability in the proportions of Fort Payne chert in the inner basin assemblages may be a function of the distance of the site to the Highland Rim source area, the nature and availability of local Fort Payne resources, or the specific procurement strategies of the group in question. It is proposed here that the difference which is noted between the proportions of Fort Payne chert in the Middle and Late Archaic assemblages is most likely the result of variance in the local availability of these chert resources.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

The archaeological record at Hayes Shelter suggests occupation of the site from Middle Archaic through Mississippian times. Evidence suggests that the Middle Archaic occupational episodes might have been quite limited in duration or frequency or both. Faunal and floral remains from this period show little evidence of food processing activities; calcined bone and carbonized plant remains are scarce. Lithic debris suggests that reduction activities focused on the Ridley chert available at or near the shelter. The largest proportion of the assemblage is composed of blocky debris or shatter. This is predetermined to some extent by the nature of the raw material selected. Excluding blocky debris, flake frequencies suggest an intermediate segment in the biface reduction process.

The shelter was occupied more intensively during the Late Archaic Period. Carbonized plant remains, including walnut and hickory shell, increase proportionally along with calcined bones. The presence of bifaces, bone tools, and mollusk shells attests to the intensification of subsistence activities. Lithic debris in these levels is predominantly Ridley chert. Proportions of blocky debris are smaller than those observed for the Middle Archaic levels, but still compose a significant part of the assemblage. The majority of flake debris is composed of secondary decortication and tertiary flakes, although

proportions of primary decortication and biface thinning flakes are higher than in the earlier levels. This pattern suggests a longer segment of the reduction trajectory including early- and late-stage by-products.

Ceramic bearing strata indicate that subsistence activities continued at the shelter through the Woodland and Mississippian Periods. Carbonized plant remains are well represented, though some of the wood charcoal may be the result of recent historic activities. Bone specimens are less commonly burned than in the Archaic levels, and bone tools are well represented. The proportion of lithic tools increases in these levels as the flake debris is reduced. Secondary decortication and biface thinning flakes increase and primary and tertiary flakes reduce in frequency. As with the Archaic assemblages, the reduction trajectory segment is intermediate with a slight increase in the importance of late-stage bifacial thinning.

Though there is no apparent linear temporal trend in the evenness of the distribution of raw material types, there is a distinct shift from Middle to Late Archaic times. The reduced proportion of Ridley chert in the Late/Middle Archaic and Terminal/Late Archaic strata suggest that the chert resources available in and around the shelter became less important during these periods.

The evenness of the distribution of artifacts among the lithic classes shows that the later assemblages tend to be more even. This may indicate that the shelter was more intensively used during the later periods. This intensification of activity may be expressed as a

function of more frequent occupation, longer occupational episodes, or changing patterns of subsistence.

Comparing the lithic data from Hayes Shelter to other sheltered and open sites in the Central Duck River Basin suggests that the Middle to Late Archaic shift in raw material selection is generally observable. Fort Payne chert use is restricted in the Nashville Basin area during the Middle Archaic when the reliance on local Ordovician cherts is greater. By Late Archaic times, the use of the local materials is reduced while Fort Payne exploitation increases. Though the specific source location for the Fort Payne which appears in the Nashville Basin assemblages is not known, it is expected that a portion of this was procured from gravel bars within the basin. Possible changes in the size and frequency of Fort Payne gravel in these bars may have affected the apparent selective patterning.

Temporal differences in the distribution of artifacts among the lithic classes for the 16 Duck River sites analyzed do not exhibit any patterning suggestive of a linear trends or temporal clustering. Apparently the nature of patterning measured for this sample is assemblage specific. Interassemblage variability was noted in each of the major prehistoric cultural periods. It was also noted that sheltered site assemblages tend to be distributed differently from open site assemblages. The implication is that, on a regional basis, assemblage variability is more strongly influenced by whether the site is open or sheltered than by the sociocultural changes which may have occurred through time. The specific difference between open-air and

sheltered sites was measured in terms of lithic class evenness, which was shown to be effected by resource selection. As each of the sheltered sites is located within a chert-bearing limestone formation and these materials were often the predominant resource used, the distinctiveness of sheltered site assemblages may also be a function of local resource availability.

Conclusions

In attempting to identify extant variability in lithic raw material and reduction assemblages recovered from the Central Duck River Basin sites, the foregoing discussions have focused on descriptive techniques which characterize the data by the recognition of patterns among raw material and technological classes. Although the interpretive potential of these results is limited, the data offer an opportunity to assess certain aspects of subsistence and settlement models which have been previously advanced for the region.

A preliminary model of Archaic hunter-gatherer adaptations in the Central Duck River region was presented by Hofman (1984b). In this formulation, population pressure and environmental stress, exacerbated by the warm, dry conditions of the Hypsithermal Interval, resulted in a more intensive, localized pattern of resource exploitation. Though presumably not suffering from the same stressful environmental conditions, the trend toward more intensive exploitation of localized resources during the Middle Archaic Period has been noted in many

areas across the Southeast (Blanton 1984; Claggett and Cable 1982; Coe 1964; Gardner 1974). Under Hofman's model, population increase encouraged sedentism. He suggests that Middle Archaic groups "could no longer move indiscriminately to new areas any time the resources waned, other groups were likely using the places they might move to" (Hofman 1984b:173). This pattern is expected to have been self-perpetuating such that:

> The less groups moved, the harder it probably became to move because more permanent site fixtures (grinding stones, roasting and storage pits, structures) would increase with longer stays and intensified use of secondary resources, whereas familiarity with the distant resources would decrease (Hofman 1984:173).

Another interpretation is offered by Amick (1984b, 1985c). Amick's (1984b:253-262) settlement model for the Middle Archaic in the Duck River Basin also rests on the environmental conditions concomitant with the Hypsithermal Interval, but his interpretations differ slightly from Hofman's. Amick's model suggests that the arid conditions of the Hypsithermal Interval resulted in a dessication of the upland environment which "undoubtedly led to oak mast crop production decline in the Highland Rim and Outer Nashville Basin physiographic sections" (Amick 1984b:239). This interpretation prompts further speculation that deer populations were reduced in the Highland Rim section because of the purported mast shortage, and increased in the Nashville Basin as a result of ample herbacious browse.

The model suggests that increasing human population and environmental deterioration resulted in population "packing" in the

inner basin area during the Middle Archaic. These conditions ostensibly circumscribed both the territory and the resources and necessitated the implementation of a highly mobile settlement strategy which intensively exploited a broad range of resources through a system of minimized tactical logistics. The lithic industry suggested for this time was characterized by "long trajectory length and procurement of local materials with little evidence of staged manufacture" (Amick 1984b:233).

With the ameliorating climatic conditions of the Late Archaic Period, the settlement system purportedly shifted to a less mobile one characterized by "structured procurement patterns conducted by specialized task groups" (Amick 1984b:225). For the lithic industry of groups in the Nashville Basin, this presumably meant the routine procurement of raw materials from the Highland Rim which were then reduced in stages at various sites, resulting (archaeologically) in a wider range of interassemblage variability. The research presented in this study does not support these models in certain important aspect.

It has been suggested previously in this study that although the character of the vegetation must have changed significantly under the prolonged warm, dry conditions during much of the Middle Holocene, there is no evidence to indicate that arid conditions led to a "deterioration" of the Highland Rim which rendered this area less desirable as habitat for white-tailed deer or their human predators. Independent evidence for increased human population in the inner Nashville Basin area during the Middle Archaic has been suggested by

the parameter count of time-sensitive diagnostics from Cheek (inner basin) and Cannon (outer basin) Bends (Klippel and Turner 1983). Although these assemblages are undoubtedly well controlled and probably quite comparable, the bends themselves are less than 8 km apart (a comfortable three hour walk) and represent microenvironmental differences which most likely would have been recognized as resource patches by highly mobile hunter-gatherer groups.

Analyses presented here have indicated that although temporal patterns among the broad lithic and debitage assemblage classes have been difficult to recognize, the shift in raw material use is apparent. It is proposed that the lithic industries of both the Middle and Late Archaic Periods in the basin areas relied on a mix of local and extralocal cherts. At any one time, variability in the proportions of Fort Payne chert in the inner basin assemblages may be a function of the distance of the site to the Highland Rim source area, the nature and availability of local Fort Payne resources, or the specific procurement strategies of the group in question. It is proposed here that the difference which is noted between the proportions of Fort Payne chert in the Middle and Late Archaic assemblages from this area likely reflect the local availability of the resource.

Palynological and geomorphological evidence suggests that a period of floodplain stabilization and soil formation was experienced during the early Middle Archaic (Brakenridge 1982, 1984; H. Delcourt 1979; P. Delcourt 1985). Brakenridge (1982:64) has indicated that

river discharge during this period may have been reduced by as much as 56%. Under such circumstances the larger gravels would be the first to drop out of the hydrodynamic system. This could have had a pronounced effect on the size and amount of Fort Payne gravel being introduced and transported as bedload (Delcourt, personal communication 1986). In addition, the zonal climatic pattern which prevailed during the Mid-Holocene reduced the number and intensity of storms which would otherwise encourage the exposure of strath gravels through sheet and tributary erosion (P. Delcourt 1985). This may have had a greater effect on the abundance and variety of cherts introduced into the system than the variability of the rate of river discharge (Brakenridge, personal communication, 1986). A marked reduction in fluvial activity may have resulted in a significant reduction of Fort Payne gravel in the point bars on the Central Duck River during much of the Middle Archaic Period. As a result, procurement strategies may have shifted from a focus on gravel bars to the Ordovician cherts available along the valley walls and within the residual upland soils. With the re-establishment of a meridional climatic pattern in Late Archaic times, the annual rate of precipitation and the frequency and intensity of storms and overbank flooding increased. This may have resulted in an increase in the amount of Fort Payne gravel introduced into the Central Duck from the Eastern Highland Rim and from Nashville Basin strath terraces.

Although the hypothesized shift in the availability of larger Fort Payne gravels in the Nashville Basin during the Middle Holocene

has not been independently demonstrated, it is considered a possible source of temporal variability in the frequency of this material type in the prehistoric lithic assemblages of the basin area. Independent tests of this hypothesis might include the study of the nature of the distribution of gravels which occur in the buried strath terraces along the Central Duck. The ability to specify precise source locations for the material types included in the archaeological assemblages through such means as trace element analysis or x-ray defraction might also clarify the question of the use of extralocal chert types. Certainly, a more detailed study of the lithic assemblages themselves with a rigorous analysis of the characteristics of the debitage and biface components would do much to resolve the ambiguities identified.

The original analyses of the lithics from the various sites compared in this study were undertaken by several different researchers over a period of several years and employ slightly different systems of classification. Under these circumstances the level of comparison employed here has been quite general. The patterns which are evident among these data are certainly influenced by these factors. It is felt, however, that the coarseness of the classificatory system has imparted a robust quality to these comparisons, making them quite appropriate for the identification of general patterns among the data. Certainly, the interpretation of these patterns will evolve with the growth of our knowledge of the paleoenvironment and the specific nature of archaeological records in the Central Duck River Basin.

REFERENCES CITED

REFERENCES CITED

Adovasio, J.M., J.D. Gunn, J. Donahue, and R. Stuckernath
1978 Meadowcraft Rockshelter, 1977: An Overview. American Antiquity 43:632-651.

Ahler, Stanley A.
1971 Projectile Point Form and Function at Rodgers Shelter, Missouri. Research Series No. 8. Missouri Archaeology Society, Columbia.

1973 Post-Pleistocene Depositional Change at Rodgers Shelter, Missouri. Plains Anthropologist 18(59):1-26.

1976 Sedimentary Processes at Rodgers Shelter. In Prehistoric Man and His Environments, A Case Study in the Ozark Highland, edited by W.R. Wood and R.B. McMillan, pp. 125-139. Academic Press, New York.

Amick Daniel S.
1981 A Preliminary Assessment of Chert Resources in the Columbia Reservoir, Maury and Marshall Counties, Tennessee. Southeastern Archaeological Conference Bulletin 24:48-51.

1982 Topsy: Late Archaic Biface Manufacture on the Buffalo River, Southwestern Highland Rim, Tennessee. Department of Anthropology, University of Tennessee. Submitted to TDOT, Contract No. BRZ-9100(2)-031-0303-94. Copies available from Tennessee Department of Transportation, Nashville.

1983 Buried Component Testing at the Clay Mine Site (40MU347). Tennessee Anthropological Association Newsletter 8(2):1-11.

1984a Designing and Testing a Model of Raw Material Variability for the Central Duck River Basin, Tennessee. In Prehistoric Chert Exploitation-Studies from the Midcontinent, edited by B. Butler and E. May, pp. 167-184. Occasional Paper No. 2. Center for Archaeological Investigations, Southern Illinois University, Carbondale.

1984b Lithic Raw Material Variability in the Central Duck River Basin: Reflections of Middle and Late Archaic Organizational Strategies. Unpublished Master's thesis, Department of Anthropology, University of Tennessee, Knoxville.

Amick, Daniel S.
1985a Buried Late Holocene Buried Site Testing in the Central Duck River Basin. In Exploring Tennessee Prehistory: A Dedication to Alfred K. Guthe, edited by T. Whyte, C. Boyd and B. Riggs, pp. 23-38. Report of Investigations No. 42 Department of Anthropology, University of Tennessee, Knoxville.

1985b Excavations at the Fattybread Branch Site (40MU408): Late Archaic Floodplain Adaptations. In Cultural Adaptations in the Shelby Bend Archaeological District, edited by D.S. Amick, J.M. Herbert and M.E. Fogarty, pp. 290-415. Submitted to the National Park Service, Contract No. NPS CX-5000-4-0624.

1985c Late Archaic Fort Payne Biface Manufacture of the Topsy Site (40WY204). Buffalo River Basin, Tennessee. Southeastern Archaeology 4(2):134-151.

Amick, Daniel S. and George M. Crothers
1984 A Preliminary Columbia Archaeological Project Bibliography: 1972-1984. Ms. on file, Department of Anthropology, University of Tennessee, Knoxville.

Amick, Daniel S., Joseph M. Herbert, and Mary Ellen Fogarty
1986 Cultural Adaptations in the Shelby Bend Archaeological District. Submitted to National Park Service, Contract No. NPS CX-5000-4-0624.

Baker, Charles M.
1978 The Size Effect: An Explanation in Surface Artifact Assemblage Content. American Antiquity 43(2):288-293.

Bamforth, Douglas B.
1986 Technological Efficiency and Tool Curation. American Antiquity 51(1):38-50.

Basanta, K. Sahu
1964 Depositional Mechanics from the Size Analysis of Clastic Sediments. Journal of Sedimentary Petrology 34(1):73-83.

Baskin, Carol C. and Jerry M. Baskin
1975 Additions to the Herbaceous Flora of the Middle Tennessee Cedar Glades. Journal of the Tennessee Academy of Science 50(1):25-26.

Berger, A.
1978 Long-term Variations of Caloric Insolation Resulting from the Earth's Orbital Elements. Quaternary Research 9:139-167.

Bernabo, J.C.
1981 Quantitative Estimates of Temperature Changes Over the Last 2700 Years in Michigan Based on Pollen Data. Quaternary Research 15:126-142.

Bernabo, J.C. and T. Webb, III
1977 Changing Patterns in the Holocene Pollen Record of Northeastern North America: A Mapped Summary. Quaternary Research 8:64-98.

Binford, Lewis R.
1979 Organization and Formation Processes, Looking at Curated Technologies. Journal of Anthropological Research 35(3):255-273.

Binford, Lewis R. and Mark L. Papworth
1963 The Eastport Site, Antrim County, Michigan. In Miscellaneous Studies in Typology and Classification, edited by A.M. White, L.R. Binford and M.L. Papworth, pp. 71-123. Museum of Anthropology, University of Michigan, Anthropological Papers 19.

Binford, Lewis R. and George I. Quimby
1963 Indian Sites and Chipped Stone Materials in the Northern Lake Michigan Area. Fieldiana-Anthropology 37:277-307.

Blanton, Dennis
1984 Lithic Raw Material Procurement and Use During the Morrow Mountain Phase in South Carolina. In Lithic Resource Procurement: Proceedings from the Second Conference on Prehistoric Chert Exploitation, edited by S.C. Vehik, pp. 115-132. Center for Archaeological Investigations Occasional Paper 4.

Bradley, Bruce A.
1975 Lithic Reduction Sequences: A Glossary and Discussion. In Lithic Technology, edited by E. Swanson, pp. 5-14. Mouton Publishers, The Hague.

Brakenridge, G. Robert
1982 Alluvial Stratigraphy and Geochronology along the Duck River, Central Tennessee: A History of Changing Floodplain Regimes. Unpublished Ph.D. dissertation, Department of Geosciences, University of Arizona, Tucson. University Microfilms, Ann Arbor.

1984 Alluvial Stratigraphy and Radiocarbon Dating along the Duck River, Tennessee: Implications Regarding Flood-plain Origin. Geological Society of America Bulletin 95:9-25.

Braun, E. Lucy
1950 Deciduous Forests of Eastern North America. Blakiston Co., Inc. Philadelphia.

Brose, David A.
1978 A Model of Changing Subsistence Technology in the Late Woodland of Northeastern Ohio. In Lithics and Subsistence, edited by D.D. Davis, pp. 87-116. Vanderbilt University Publication in Anthropology 20.

Bryson, R.A., D.A. Baerreis, and W.M. Wendland
1970 The Character of Late- and Post-glacial Climatic Changes. In Pleistocene and Recent Environments of the Central Great Plains, edited by W. Dort and J.K. Jones. University of Kansas Press, Lawrence.

Bryson, R. and W. Wendland
1977 Tentative Climatic Patterns for Some Late Glacial and Postglacial Episodes in Central North America. In Life, Land, and Water, Proceedings of the 1966 Conference on Environmental Studies of the Glacial Late Agassiz Region, edited by W.J. Mayer-Oakes, pp. 271-298. University of Manitoba Press, Winnipeg.

Burgess, Robin L. and Leon Jacobson
1984 Cultural Sediment Formation in Open-Air Sites and Rock Shelters on the Brandberg, Namibia. Journal of Field Archaeology 11:233-240.

Butzer, Karl W.
1964 Environment and Archaeology: An Introduction to Pleistocene Geography. Aldine, Chicago.

1971 Environment and Archaeology: An Ecological Approach to Prehistory. Aldine, Chicago.

1978 Toward an Integrated Contextual Approach in Archaeology. Journal of Archaeological Science 5:191-193.

1981 Cave Sediments, Upper Pleistocene Stratigraphy, and Mousterian Facies in Cantabrian Spain. Journal of Archaeological Science 8:133-183.

1982 Archaeology as Human Ecology: Method and Theory for Contextual Approach. Cambridge University Press, Cambridge.

Callahan, Evrett
1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flintknappers and Lithic Analysts. Archaeology of Eastern North America 7(1):1-180.

Cambron, James W. and David C. Hulse
1960 The Transitional Paleo-Indian in North Alabama and South Tennessee. Journal of Alabama Archaeology 6(1):7-33.

1964 Handbook of Alabama Archaeology, Part I: Point Types. Archaeological Research Association of Alabama Inc., University, Alabama.

Claggett S. and J.S. Cable
1983 The Haw River Sites. Commonwealth Associates, Jackson, Michigan.

Coe, Joffre L.
1964 The Formative Cultures of the Carolina Piedmont. Transactions of the American Philosophical Society new series 54(5). Philadelphia.

Collins, Michael B.
1974 A Functional Analysis of Lithic Technology Among Prehistoric Hunter-Gatherers of Southwestern France and Western Texas. Ph.D. dissertation, University of Arizona, University Microfilms, Ann Arbor.

1975 Lithic Technology as a Means of Processual Inference. In Lithic Technology, edited by Swanson, pp. 15-34. Mouton Publishers, The Hague.

Cornwall, I.W.
1958 Soils for the Archaeologist. Phoenix House, London.

Crabtree, Don
1966 A Stoneworker's Approach to Analyzing and Replicating the Lindemeier Folsom. Tebiwa 9(1):3-39.

1972 An Introduction to Flintworking. Occasional Paper No. 28. Idaho State University Museum, Pocatello.

Crabtree, Don E. and B. Robert Butler
1964 Notes on Experiments in Flintknapping, I: Heat Treatments of Silica Minerals. Tebiwa 7:1-6.

Crites, Gary D.
1983 Woody Vegetation in the Inner Nashville Basin: An Example from the Cheek Bend Area of the Central Duck River Valley. Report submitted to the Tennessee Valley Authority, Norris.

DeJarnette, D.L., E.B. Kurjack, and J.W. Cambron
1962 Stanfield-Worley Bluff Shelter Excavations. Journal of Alabama Archaeology 8(1-2):1-24.

Delcourt, Paul A.
1985 The Influence of Late-quaternary Climatic and Vegetational Change on Paleohydrology in Unglaciated Eastern North America. Ecologia Mediterranea Tome XI (Fasicule 1).

Delcourt, Paul A. and Hazel R. Delcourt
1984 Late Quaternary Paleoclimates and Biotic Responses in Eastern North America and the Western North Atlantic Ocean. Paleogeography, Paleoclimatology, Paleoecology 48:263-284.

Delcourt, Hazel R.
1979 Late Quaternary Vegetation History of the Eastern Highland Rim and Adjacent Cumberland Plateau of Tennessee. Ecological Monographs 49(3):255-280.

DeSelm, Hal R.
1959 A New Map of the Central Basin of Tennessee. Journal of the Tennessee Academy of Science 34(1):66-72.

Dickey, Jerry
1981 Salvage Excavations at the Bypass Site, 40LN86. Ms. on file, Department of Anthropology. University of Tennessee, Knoxville.

Dye, David H.
1980 Primary Forest Efficiency in the Western Middle Tennessee River Valley. Ph.D. dissertation, Department of Anthropology, Washington University, St. Louis. University Microfilms, Ann Arbor.

Edwards, Max J., Joe A. Elder, and M.E. Springer
1974 The Soils of the Nashville Basin. U.S. Department of Agriculture, Soil Conservation Service. Bulletin 499.

Entorf, Robert F.
1985 The Archaeology of Rockshelters on Fountain Creek Maury County, Tennessee. Unpublished Master's thesis, Department of Anthropology, University of Tennessee, Knoxville.

Farrand, William E.
1975a Sediment Analysis of a Prehistoric Rockshelter: The Abri Pataud. Quaternary Research 5:1-26.

Farrand, William
1975b Analysis of the Abri Pataud Sediments. In Excavation of the Abri Pataud, Les Eyzies (Dordogne), edited by H.L. Movias, pp. 27-68. Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge.

Faulkner, Charles H.
1967 Tennessee Radiocarbon Dates. Tennessee Archaeologist 23(1):12-30.

1968 The Mason Site (40Fr8). In Archaeological Investigations in the Tims Ford Reservoir, Tennessee, 1966, edited by Charles H. Faulkner, pp. 12-140. Report of Investigations No. 6. Department of Anthropology, University of Tennessee, Knoxville.

Faulkner, Charles H. and Major C.R. McCollough
1973 Introductory Report of the Normandy Reservoir Salvage Project: Environmental Setting, Typology, and Survey. Report of Investigations No. 11, Department of Anthropology, University of Tennessee, Knoxville.

1974 Excavations and Testing, Normandy Reservoir Salvage Project: 1972 Seasons. Report of Investigations No. 12. Department of Anthropology, University of Tennessee, Knoxville.

Fenneman, Nevin M.
1938 Physiography of the Eastern United States. MacGraw Hill, New York.

Fitzgibbons, P.T., J.M. Adovasio, and J. Donahue
1977 Excavations at Sparks Rockshelter (15J019), Johnson County, Kentucky. Pennsylvania Archaeologist 47(5):1-58.

Flenniken, J. Jeffrey
1985 Stone Tool Reduction Techniques as Cultural Markers. In Stone Tool Analysis, edited by M.G. Plew, J.C. Woods, and M.G. Pavesic, pp. 265-276. University of New Mexico Press, Albuquerque.

Folk, Robert L.
1974 Petrology of Sedimentary Rocks. Hemphill Publishing Co., Austin.

Folk, Robert L. and William C. Ward
1957 Brazos River Bar: A Study in the Significance of Grain Size Parameters. Journal of Sedimentary Petrology 27(1):3-26.

Futato, Eugene M.
1977 The Bellefonte Site; 1Ja300. Research Series No. 2. Office of Archaeological Research, University of Alabama, University.

1980 Chipped Stone Biface Manufacture in the Bear Creek Watershed. Southeastern Archaeological Conference Bulletin 22:77-83.

Futato, Eugene M.
1983 Archaeological Investigations in the Cedar Creek and Upper Bear Creek Reservoirs. Report of Investigations 13. Office of Archaeological Research, University of Alabama.

Gardner, William M.
1974 The Flint Run Complex: Pattern and Process during the Paleo-Indian to Early Archaic. In The Flint Run Paleo-Indian Complex: A Preliminary Report 1971-1973 Season, edited by W.M. Gardner, pp. 5-47. Catholic University of America, Archaeology Laboratory, Department of Anthropology, Occasional Publications 1. Washington, D.C.

Gladfelter, B.G.
1981 Developments and Directions in Geoarchaeology. In Advances in Archaeological Method and Theory. Vol. 4, edited by M.J. Schiffer, pp. 343-344. Academic Press, Chicago.

Goodyear, Albert C.
1974 The Brand Site: A Technofunctional Study of a Dalton Site in Northeast Arkansas. Arkansas Archaeological Survey, Research Series 7.

Graham, Russel W.
1976 Late Wisconsin Mammalian Faunas and Environmental Gradients of the Eastern United States. Paleobiology 4:343-350.

1979 Paleoclimates and Late Pleistocene Faunal Provinces in North America. In Pre-Llano Cultures in the Americas: Paradoxes and Possibilities, edited by R.L. Humphrey and D. Stafford, pp. 49-68. The Anthropological Society of Washington.

Greiser, Sally T.
1977 Micro-Analysis of Wear Patterns on Projectile Points and Knives from the Jurgens Site, Kersey, Colorado. Plains Anthropologist 22:107-116.

Guillien, Y. and J.P. Lautridou
1970 Recherches de gelifraction experimentale du Centre de Geomophologie. I-Calcaires des Charentes. Centre de Geomorphologie, Bulletin No. 5:1-45. CNRS, Caen.

Hall, Charles L.
1985 The Role of Rockshelter Sites in Prehistoric Settlement Systems: An Example from Middle Tennessee. Unpublished Master's thesis, Department of Anthropology, University of Tennessee, Knoxville.

Hall, Charles L., Daniel S. Amick, William B. Turner, and Jack L. Hofman
1985 Columbia Archaeological Project Archaic Period Radiocarbon Dates. In Exploring Tennessee Prehistory: A Dedication to Alfred K. Guthe, edited by T. Whyte, C. Boyd, and B. Riggs, in press. Report of Investigations No. 42. Department of Anthropology, University of Tennessee, Knoxville.

Harmon, A.B., E. Lusk, J. Overton, J. Elder, and L. Williams
1959 Soil Survey of Maury County, Tennessee. Soil Survey Series 1952, No. 7. U.S. Department of Agriculture, Washington, D.C.

Hassan, Fekri A.
1978 Sediments in Archaeology: Methods and Implications for Paleoenvironmental and Cultural Analysis. Journal of Field Archaeology 5:197-213.

Hofman, Jack L.
1981 Test Excavation at a Buried Middle Archaic Component on the Duck River, Middle Tennessee. Southeastern Archaeological Conference Bulletin 24:44-48.

1982 Radiocarbon Dates from the Eva-Morrow Mountain Component at the Cave Spring Site, 40MU141, Middle Tennessee. Tennessee Anthropological Association Newsletter 7(2):1-5.

1983 Ervin: A Mid-Holocene Shell Midden on the Duck River. Submitted to the Tennessee Valley Authority, Norris, Tennessee.

1984a Contextual Studies of the Middle Archaic Component at Cave Spring in Middle Tennessee. Unpublished Master's thesis, Department of Anthropology, University of Tennessee, Knoxville.

1984b Hunter-Gatherers in the Nashville Basin of Tennessee 8000-5000 B.P. Tennessee Anthropologist 9(2):130-192.

1984c Radiocarbon Dates from Ervin: A Mid-Holocene Shell Midden on the Duck River in Middle Tennessee. Tennessee Anthropological Association Newsletter 9(2):2-8.

1986 Vertical Movement of Artifacts in Alluvial and Stratified Deposits. Current Anthropology 27(2):163-171.

Hofman, Jack L. and William B. Turner
1979 Columbia Archaeological Project Cultural Material Inventory Coding Format. Submitted to TVA, Contract No. TV-60066A. Copies available from Tennessee Valley Authority, Norris.

Holmes, W. Henry
1919 Handbook of Aboriginal American Antiquities. Part I. Introductory. The Lithic Industries. Bureau of American Ethnology, Bulletin 60.

Hood, Victor P. and Major C.R. McCollough
1976 The Effects of Heat Treatment on Significant Silica Minerals of the Middle Tennessee Region. In Third Report of the Normandy Reservoir Salvage Project, edited by M.C.R. McCollough and C.H. Faulkner. Report of Investigations No. 16, Department of Anthropology, University of Tennessee, Knoxville.

House, John H. and James W. Smith
1975 Experiments in Replication of Fire-cracked Rock. In The Cache River Archaeological Project, An Experiment in Contract Archaeology, edited by M.B. Schiffer and J.H. House, pp. 75-80. Arkansas Archaeological Survey Research Series No. 8.

Jeffries, Richard W.
1982 Debitage as an Indicator of Intraregional Activity Diversity in Northwest Georgia. Midcontinental Journal of Archaeology 7(1):99-132.

Jelinek, Arthur J.
1965 Lithic Technology Conference, Les Eyzies, France. American Antiquity 31(2):277-278.

1976 Form, Function, and Style in Lithic Analysis. In Cultural Change and Continuity, Essays in Honor of James Bennett Griffin, edited by E. Cleland, pp. 19-33. Academic Press, New York.

Johnson, Jay K.
1979 Archaic Biface Manufacture: Production Failures, A Chronicle of the Misbegotten. Lithic Technology 8(2):25-35.

1981a Further Additional Biface Production Failures. Lithic Technology 10(2-3):26-28.

1981b Lithic Procurement and Utilization Trajectories: Analysis, Yellow Creek Nuclear Power Plant Site, Tishomingo County, Mississippi, Vol. II. Anthropological Papers No. 1, Center for Archaeological Research, University of Mississippi, University.

1982 Archaic Period Settlement Systems in Northeastern Mississippi. Tennessee Anthropologist 6(2):172-179.

Johnson, Jay K.
1984 Measuring Prehistoric Quarry Site Activity in Northeast Mississippi. In Prehistoric Chert Exploitation: Studies from the Midcontinent, edited by B.M. Butler and E.E. May, pp. 225-236. Center for Archaeological Investigations Occasional Paper No. 2. Center for Archaeological Investigations, Southern Illinois University, Carbondale.

1985 Patterns of Prehistoric Chert Procurement in Colbert Ferry Park, Northwest Alabama. In Lithic Resource Procurement: Proceedings from the Second Conference on Prehistoric Chert Exploitation, edited by S.C. Vehik, pp. 153-164, Occasional Paper No. 4. Center for Archaeological Investigations, Southern Illinois University, Carbondale.

Johnson, Jay K. and Carol A. Morrow
1981 Thermal Alteration and Fort Payne Chert. Journal of Alabama Archaeology 27(2):141-149.

Keel, Bennie C.
1978 1974 Excavations at the Nowlin II Site (40CF35). In Sixth Report of the Normandy Archaeological Project, edited by M.C.R. McCollough and C.H. Faulkner, pp. 1-290. Report of Investigations No. 21. Department of Anthropology, University of Tennessee, Knoxville.

King, J.E.
1981 Late Quaternary Vegetational History of Illinois. Ecological Monographs 51:43-62.

King, Francis B. and Russel W. Graham
1981 Effects of Ecological and Paleo Ecological Patterns on Subsistence and Paleoenvironmental Reconstructions. American Antiquity 46:128-142.

King, J.E. and W.H. Allen, Jr.
1977 A Holocene Vegetational Record from the Mississippi River Valley, Southeastern Missouri. Quaternary Research 8:307-323.

Kintigh, Keith W.
1984 Measuring Archaeological Diversity by Comparison with Simulated Assemblages. American Antiquity 49(1):44-54.

Kline, Gerald W.
1978 The Duck's Nest Site: A Small Mississippian Site in Warren County, Tennessee. Unpublished Master's thesis, Department of Anthropology, University of Tennessee, Knoxville.

Klippel, Walter E.
1971a Graham Cave Revisited. A Reevaluation of its Cultural Position During the Archaic Period. Missouri Archaeological Society Memoir No. 9.

1971b Prehistory and Environmental Change Along the Southern Border of the Prairie Peninsula During the Archaic Period. Ph.D. dissertation, Department of Anthropology, University of Missouri, Columbia.

1986 Microtus Pennsylvanicus in Southern Holocene Contexts. American Midland Naturalist, in press.

Klippel, W.E. and P.W. Parmalee
1982 The Paleontology of Cheek Bend Cave, Maury County, Tennessee: Phase II. Submitted to the Tennessee Valley Authority, Norris, Tennessee. TVA TV-49244A Fieldwork, TVA TV-53013A, Laboratory analyses.

Klippel, Walter E. and William B. Turner
1983 Prehistory and Holocene Land Surface Changes in the Nashville Basin. Paper presented at the 48th Annual Meeting at the Society for American Archaeology, Pittsburgh, Pennsylvania.

Klippel, Walter E. and Darcy F. Morey
1986 Freshwater Gastropods as a Food Resource among Hunter-gatherers in the Midsouth. American Antiquity, in press.

Knox, J.C.
1983 Responses of River Systems to Holocene Climates. In Late Quaternary Environments of the United States, Vol. 2, The Holocene, edited by H.E. Wright, Jr., pp. 26-41. University of Minnesota Press, Minneapolis.

Laville, H.
1976 Deposits in Calcareous Rock Shelters: Analytical Methods and Climatic Interpretation. In Geoarchaeology, Earth Science and the Past, edited by D.A. Davidson and M.L. Shackley, pp. 137-158. Duckworth, Gloucester.

Laville, H., J. Rigaud, and J. Sackett

1980 Rock Shelters of the Perigord. Academic Press, New York.

Lloyd, Monte, Jerrold H. Zar, and James R. Karr
1968 On the Calculation of Information-theoretical Measures of Diversity. The American Midland Naturalist 79(2):257-272.

McCollough, Major C.R. and Glyn D. DuVall
1976 Results of 1973 Testing. In Third Report of the Normandy Reservoir Salvage Project, edited by Major C.R. McCollough and Charles H. Faulkner, pp. 27-140. Report of Investigations No. 16. Department of Anthropology, University of Tennessee, Knoxville.

McCluskey, George H.
1976 Raw Material Types Utilized in the Manufacture of Lithic Implements in the Columbia Reservoir, Tennessee. In Final Report on the 1972-1973 Archaeological Site Reconnaissance in the Proposed Columbia Reservoir Maury and Marshall Counties Tennessee, by D.B. Dickson, Appendix D, pp. 709-726. Submitted to the Tennessee Valley Authority, Norris, Tennessee.

Mahaffey, John J.
1983 Geoarchaeology of the Holocene and Late Pleistocene Alluvial Deposits along the Middle Duck River, Tennessee. Submitted to TVA, Contract No. TV-60066A. Copies availabe from Tennessee Valley Authority, Norris.

Malaurie, J.
1968 Themes de recherches geomorphologiques dans le Nord-Quest du Gorenland. Centre de Tech. Docum. Cartogr. Geogr. CNRS, Paris.

Mason, Curtis C. and Robert L. Folk
1958 Differentiation of Beach Dune and Aeolian Flat Environments by Size Analysis, Mustang Island, Texas. Journal of Sedimentary Petrology 28(2):211-226.

Monet-White, Anta
1968 The Lithic Industries of the Illinois Valley in the Early and Middle Woodland Periods. Museum of Anthropology, University of Michigan, Anthropological Papers 35.

Morrow, Carol A.
1981 Thermal Alteration Testing of Ft. Payne Chert. In Lithic Procurement and Utilization Trajectories: Analysis, Yellow Creek Nuclear Power Plant Site, Tishomingo County, Mississippi Vol. II, pp. 205-222. Archaeological Papers of the Center for Archaeological Research-Number 1, University of Mississippi, University.

Morse, Dan F.
1967 The Robinson Site and Shell Mound Archaic Culture in the Middle South. Ph.D. dissertation, University of Michigan. University Microfilms, Ann Arbor.

Muto, Guy R.
1971 A Technological Analysis of Early Stages in the Manufacture of Lithic Implements. Unpublished Master's thesis, Idaho State University, Pocetello.

Nance, Jack D.
1971 Functional Interpretations from Microscopic Analysis. American Antiquity 36:361-366.

Newcomer, Mark H.
1971 Experiments in Handaxe Manufacture. World Archaeology 3(1):81-94.

Odell, George H.
1981 The Morphological Express at Function Junction: Searching for Meaning in Lithic Tool Types. Journal of Anthropological Research 37(4):319-342.

Penny, James S. and Major C.R. McCollough
1976 The Normandy Lithic Resource Survey. In Third Report of the Normandy Reservoir Salvage Project, edited by M.C.R. McCollough and C.H. Faulkner, pp. 141-194. Report of Investigations No. 16. Department of Anthropology, University of Tennessee, Knoxville.

Pielou, E.C.
1966 The Measurement of Diversity in Different Types of Biological Collections. Journal of Theoretical Biology 13:131-144.

1969 An Introduction to Mathematical Ecology. Wiley-Interscience, New York.

1975 Ecological Diversity. Wiley-Interscience, New York.

Pitts, M.W. and R.M. Jacobi
1979 Some Aspects of Change in Flaked Stone Industries of the Mesolithic and Neolithic in Southern Britain. Journal of Archaeological Science 6:163-177.

Purdy, Barbara A.
1971 Investigations Concerning the Thermal Alteration of Silica Minerals: An Archaeological Approach. Ph.D. dissertation, University of Florida, University Microfilms, Ann Arbor.

1975 Fractures for the Archaeologist. In Lithic Technology: Making and Using Stone Tools, edited by E. Swanson, pp. 133-141. Mouton, Paris.

Quarterman, Elsie
1950a Ecology of Cedar Glades: I. Distribution of Glade Flora in Tennessee. Bulletin of the Torrey Botanical Club 77:1-9.

1950b Major Plant Communities of Tennessee Cedar Glades. Ecology 31(2):234-254.

Raab, L.M., R.F. Cande, and D.W. Stahle
1979 Debitage Graphs and Archaic Settlement Patterns in the Arkansas Ozarks. Midcontinental Journal of Archaeology 4:167-182.

Raspet, Carol A.
1979 A Production Stage Analysis of Lithic Artifacts from the Lightline Lake Site, LeFlore County, Mississippi. Unpublished Master's thesis, University of Mississippi, University.

Royce, Chester F.
1968 Recognition of Fluvial Environments by Particle-size Characteristics. Journal of Sedimentary Petrology 38(4):1171-1178.

Shackley, M.L.
1972 The Use of Textural Parameters in the Analysis of Cave Sediments. Archaeometry 14:133-145.

1975 Archaeological Sediments: A Survey of Analytical Methods. Halstead, New York.

Shannon, C.E.
1948 A Mathematical Theory of Communication. Bell Systems Technology Journal 27:379-423, 623-656.

Sheets, Payson D.
1975 The Structure of a Prehistoric Industry in Mesoamerica. Current Anthropology 16(3):336-392.

Smalley, G.W.
1980 Classification and Evaluation of Forest Sites on the Western Highland Rim and Pennyroyal. In General Technical Report 50-30. USDA Forest Service, Albuquerque, New Mexico.

Solomon, A.M., H.R. Delcourt, D.C. West, and T.J. Blasing
1980 Testing a Simulation Model for Reconstruction of Pre-historic Forest Stand Dynamics. Quaternary Research 14:275-293.

Stahle, David W. and James E. Dunn
1982 An Analysis and Application of the Size Distribution of Waste Flakes from the Manufacture of Bifacial Stone Tools. World Archaeology 14(1):84-97.

Tennessee Valley Authority
1972 Final Environmental Statement, Duck River Project, TVA, Office of Health and Environmental Sciences, Norris, Tennessee.

Torrence, Robin
1983 Time Budgeting and Hunter-gatherer Technology. In Pleistocene Hunters and Gatherers in Europe, edited by G. Bailey, pp. 11-22. Cambridge University Press, New York.

Tricart, J.
1967 Le Modele des regions periglaciares, in Traite de Geomorphologie edited by J. Tricart and A. Cailleux. S.E.D.E.S., Paris.

Vento, F.J., J.M. Adovasio, and J. Donahue
1980 Excavations at Dameron Rockshelter (15J023A). Johnson County, Kentucky. Ethnology Monographs No. 4, Department of Anthropology, University of Pittsburgh.

Watson, P.J.
1976 In Pursuit of Prehistoric Subsistence: A Comparative Account of Some Contemporary Flotation Techniques. Midcontinental Journal of Archaeology 1(1):77-100.

Wilson, Charles W., Jr.
1949 Pre-Chattanooga Stratigraphy in Central Tennessee, Bulletin 56. Tennessee Division of Geology, Nashville.

Wood, Raymond
1968 Mississippian Hunting and Butchering Patterns: Bone from the Vista Shelter, 23SR20, Missouri. American Antiquity 33(2):170-179.

Wylie, H.G.
1975 Tool Microwear and Functional Types from Hogup Cave, Utah. Tebiwa 17:1-31.

Wynn, Jack T. and James R. Atkinson
1976 Archaeology of the Okashua and Self Sites, Mississippi. Submitted to the U.S. Army Corps of Engineers, Mobile District.

Yerkes, Richard W.
1984 Site Activities and Subsistence at Labras Lake: A Microwear Study and Contextual Investigation of the Late Archaic, Late Woodland and Mississippian Components of a Bluff Phase Site in St. Clair County, Illinois. Unpublished Ph.D. dissertation, University of Wisconsin, Madison.

Young, George H. and Payson D. Sheets
1975 A Test of Village Socioeconomic Ranking Using Lithic Debitage. Newsletter of Lithic Technology 1(3):30-66.

Zar, Jerrold H.
1984 Biostatistical Analysis. Originally published 1974, Prentice-Hall, Inc., Englewood Cliffs.

APPENDICES

APPENDIX A

HAYES SHELTER CODING FORMAT

The classificatory system employs the variables and values outlined by Amick (1982) and by Hofman and Turner (1979). The card column numbers used in coding are parenthetically included after each variable or value. An abbreviated schema of the format is presented in Table A1.

County (5-6). An alphanumeric variable denoting the state site number, county designation (ML for Marshal).

Site Number (7-9). State site number (143).

Sample Number (11). Denoting cases where more than one fine fraction sample was sorted (1, 12, . . .).

North Coordinate (12-13). The last two digits of the north grid coordinate (19, as all units were excavated on the 1919N grid line).

Zone (14). Denotes cases where arbitrary levels were split when excavating by natural strata (A, B, etc.).

East Coordinate (15-16). The last two digits of the east grid coordinate.

Value = 95 1019N995.5 E

Value = 00 1019N1000 E

Value = 01 1019N1001 E

Value = 02 1019N1002 E

Value = 21 1019N1021.5 E

Size Grade (17). Denotes fraction grades.

Value = 1 >2.45 cm

Value = 2 2.45 > x >1.27 cm

Value = 3 1.27 > x >.16 cm

Value = 4 .64 > x >.16 cm

Cortex Type (21). Denotes the attributes of the outer surfaces of lithic specimens.

Value = 1 No observable cortex.

Value = 2 Incipient Fracture Planes: identified as flat smooth surfaces usually veneered with thin mineral deposits resembling patination, initially occurring internally and exposed by thermoclastic or percussivespalling. This attribute is considered noncortical in the analysis.

Value = 3 Residual Cortex: noted as a soft white to buff-colored chalk rind. Characteristic of nodular Ordovician cherts found in the Ridley and Carters formations, this attribute is usually associated with residual cherts weathered from local limestone outcrops.

Value = 4 Waterworn: observed as a smooth, hard rind of brown to red color. Usually associated with gravels derived from Mississippian and Ordovician formations (Amick 1984:52-64), this attribute set reflects hydric transport and indicates alluvial sources both local and non-local.

Value = 5 Smooth White: identified as a hard, thin rind of white or cream color, this type is associated with nodular chert derived from the Mississippian St. Louis/Warsaw formation (Amick 1984:65).

Value = 6 Residual/Incipient Fracture Plane: denotes the combination of these attribute sets and represents residual chert.

Value = 7 Waterworn/Incipient Fracture Plane: combines the attributes of these variables and represents gravels derived from alluvial sources.

Raw Material (22-23). The lithic material types employed follow descriptions previously advanced (Amick 1982:19-20, 1984:41-68; Kline 1978; Penny and McCollough 1976).

Values:	02	Ridley (Ordovician)
	04	Carters (Ordovician)
	06	Bigby-Cannon Fine (Ordovician)
	07	Bigby-Cannon Coarse (Ordovician)
	08	Brassfield (Silurian)
	09	Fort Payne (Mississippian)
	10	Saint Louis (Mississippian St. Louis/Warsaw)
	13	Chalcedony (Mississippian Ft. Payne)
	14	Indeterminate
	15	Ridley/Carters Indeterminate (Ordovician)
	16	Quartzite (Cretaceous Tuscaloosa)
	17	Limestone (Ordovician Ridley)

Texture (24). Five textural classes were employed.

Values:	1	Vitreous-homogeneous (glassy)
	2	Fine (smooth)
	3	Medium (sandy)
	4	Coarse (rough)
	5	Desilicified (soft, friable)

Thermal Alteration (25-26). Attribute sets reflecting states of thermal alteration follow from replication experiments and descriptions presented by Amick (1982:22).

Values: 01 No evidence of thermal alteration.

10 Partial heating: usually indicated by partially reddened cortex, suggesting unintentional heating.

30 Heated: as reflected by pot-lidding on dorsal flake surface or color change.

50 Heated after final modification: noted as pot-lidding, crenation, or any positive indicator of thermal failure on the ventral surface of flakes or on finished pp/ks.

70 Heated before final modification: greater luster, rippling, or color change on the ventral than on the dorsal surface of flakes, and differential luster among flake scars on bifaces, indicating heating prior to the final step in the reduction process.

Level I (28-29). This variable was used to indicate major classes or categories of artifacts.

Values 01 Flaked stone artifacts

02 Flaking debris (debitage)

03 Pecked and ground stone artifacts

04 Shell and bone artifacts

05 Ceramics (aboriginal)

06 Historic artifacts

07 Unmodified bone, shell and plant remains

Level II (31-32). This level more narrowly defines types of artifacts. As very few diagnostic pp/ks, ceramic, shell and bone, or historic artifacts were recovered from Hayes Shelter, these were simply described and illustrated in this study. The Columbia Archaeological Survey Cultural Material Coding Format (Hofman and Turner 1979) should be consulted for further detailing of types. Categories include flaked stone tool types, non-tool flaked stone types, pecked and ground stone tool types, and types for modified shell and bone, aboriginal ceramics, historic debris, and unmodified objects possibly incorporated in the fill as artifacts. Values were coded for the following flaked stone tools (Level 1, value = 01):

Values 14 Bifaces: exhibiting two flaked faces originating at a single margin. This group was further subdivided by the amount and location of cortex and by the development of haft modification.

29 Hammerstones: or percussors used in the lithic production process.

32 Cores: exhibiting multiple flake scars not originating at a single margin.

Categories for the non-tool flaked stone types (Level 1 = 02) include the following:

Values 01 Flakes: exhibiting a positive flake scar and, unless fragmentary, a striking platform.

02 Non-flake debris.

Level III (34-35). This level identifies classes for flakes, and non-flake debitage. Level III values for flakes (Level 1 = 01, Level 2 = 02) follow Amick (1982:16).

Values	01	Unbroken; full dorsal cortex; platform not lipped.
	02	Unbroken; partial dorsal cortex; platform not lipped.
	03	Unbroken; no dorsal cortex, but platform may retain cortex; platform not lipped.
	04	Unbroken; lipped platform; greater than or equal to 2 cm and less than 5 cm in maximum dimension.
	05	Unbroken; lipped platform; less than 2 cm in maximum dimension.
	06	Broken (platform); lipped platform; greater than or equal to 2 cm and less than 5 cm in maximum dimension.
	07	Core rejuvenation flake; remnants of core attributes including a platform and a series of flake removals.
	12	Broken (platform); lipped platform; less than 2 cm in maximum dimension.
	15	Broken (platform); full dorsal cortex; platform not lipped.
	16	Broken (platform); partial dorsal cortex; platform not lipped.
	17	Broken (platform); no dorsal cortex, but platform may retain cortex; platform not lipped.
	18	Broken (no platform); full dorsal cortex.
	19	Broken (no platform); partial dorsal cortex.

20 Broken (no platform); no dorsal cortex.

21 Retouch flakes are typically small (.64> x >.16 cm), thin, and ovoid in shape. Platforms are usually small (ca. 1 mm), round, or concave in planview. Slight lipping is occasionally observed, as well as slight platform crushing.

25 Broken (platform); lipped platform; greater than or equal to 5 cm in maximum dimension.

Level III values for non-flake debris (Level 1 = 02, Level 2 = 02) are as follows:

Values 01 Fire-cracked rock: displaying evidence of thermal failure such as pot-lidding, crenation, and spalling, but no evidence of flaking.

02 Blocky debris: exhibiting negative flake scars, but no platforms; characteristically cubical and often having exposed incipient fracture or bedding planes.

03 Tested cobbles or incipient cores: exhibiting at least one but no more than three negative flake scars.

08 Natural spalls: splintered or shattered thermoclasts of Ridley chert, showing no evidence of percussive reduction.

Flake Tools (37). This category was designed to identify retouched and utilized flakes. The distinction between these types of modification is based on an intuitive judgment of the size, depth, and regularity of spacing of flake scars along the margin. Larger,

deeper, more regularly spaced flake scars were registered as retouches and smaller, less regular ones as use damage. All observations were macroscopic, and no attempt was made to distinguish use damage from incidental edge damage due to trampling, etc. Rather than rely on functionally interpreted morphological types, the location of the retouch or damage on the face and the margin of the flake is recorded.

Values 1 Unifacial retouch

2 Bifacial retouch

3 Unifacial utilization

4 Bifacial utilization

Location of Modification (38). This refers to the location of retouch or damage along the margin of the flake. The flake platform is oriented proximally and the dorsal faceup if damage or retouch occurs on both faces.

Values 0 No orientation: where use damage was suspected on non-flake artifacts.

1 Distal

2 Lateral

4 Lateral/distal

5 All margins

Haft Modification (70). Identifiable haft elements on biface tools were opposing notches or the development of a stem. The possibility of flake retouch as indicative of hafting (Odell 1981:232-333, Figures 2a and 2b) was not considered here.

Values 1 Present

2 Absent

Bifacial Cortex (71). This variable denotes the amount and location of cortex present on bifaces.

Values 1 Absent

2 One face only

3 Both faces

4 Only on margin

5 One face and margin

6 Both faces and margin

Biface Fragment (74-78). This variable records which portion of the biface a given specimen represents.

Values 01 Complete

02 Proximal: base

03 Distal: tip

04 Medial: blade segment with two margins

05 Lateral: blade edge fragment

06 Stem: no shoulders or blade

07 Indeterminate: employed when early-stage specimens could not be oriented

Biface Failure Type (77-78). Each failure type is indicative of some stage in the manufacture and use trajectory. Descriptions of the types have been advanced in numerous publications (see Chapter V) and this format follows Amick (1982:19-21).

Values 01 Hinge

02 Reverse (outrepasse)

04	Perverse
05	Transverse hinge
06	Lateral snap
07	Incipient fracture
08	Crenated
09	Pot-lidding
10	Expansion
11	Haft snap
12	Edge collapse
16	Impact/use
17	Lateral snap/expansion
18	Haft snap/perverse
19	Haft snap/transverse hinge
20	Hinge/perverse
21	Edge collapse/lateral snap
22	Incipient fracture/lateral snap
23	Incipient fracture/pot-lidding
24	Hinge/lateral snap
25	Lateral snap/lateral snap
26	Edge collapse/perverse
27	Lateral snap/perverse
28	Lateral snap/pot-lidding
29	Haft snap/pot-lidding
30	Lateral snap/haft snap
31	Haft snap/transverse hinge/pot-lidding

32 Lateral snap/incipient fracture/pot-lidding

33 Perverse/lateral snap/pot-lidding

34 Hinge/lateral snap/lateral snap

35 Edge collapse/lateral snap/crenated

36 Hinge/lateral snap/pot-lidding

40 Expansion/pot-lidding

41 Lateral snap/reverse

42 Incipient fracture/reverse

43 Hinge/expansion

Table A1. An abbreviated schematic illustration of the Columbia Archaeological Project artifact coding format (Hofman and Turner 1979).

VARIABLES		
LEVEL 1	LEVEL 2	LEVEL 3
Lithic Tools (01)	Tool Types (01-56)	PP/K Types (01-99)
Lithic Non-Tools (02)	Flakes (01) Non Flakes (02)	Flake Types (01-29)
Lithic Pecked and Ground Tools (03)	Pecked and Ground Types	Non-Flake Types (01-08)
Shell and Bone Artifacts (04)	Shell and Bone Types	
Aboriginal Ceramics (05)	Aboriginal Ceramic Types	
Historic Artifacts (06)	Historic Types	
Unmodified Bone, Shell and Plant Remains (07)	Unmodified Artifact Types	

APPENDIX B

DIAGNOSTIC ARTIFACT DESCRIPTIONS

The following descriptions are presented for each late-stage bifacial implement which is associated with a traditional culture/morphological type. The number of specimens was so small that many of the measurements necessary for statistical summation of larger samples were omitted here. Each artifact described is referenced to an illustration. Descriptions include provenience, culture/morphological type, haft element, blade shape, failure type, raw material type, and evidence of thermal alteration.

1019N 995.5 E

1. Level 3 (20-30 cm): Early Woodland; shallow side notched; slightly incurvate base; lanceolate blade shape; slight grinding in notches; rhomboidal sharpening; tranverse hinge (impact) failure; Ft. Payne chert; no evidence of thermal alteration.

2. Level 3 (20-30 cm): Late Woodland; small triangular; slightly excurvate base; straight blade margins; lateral snap failure; Bigby Cannon chert; no evidence of thermal alteration.

3. Level 4 (30-40 cm): Late Woodland/Mississippian; small triangular; strongly incurvate base; very narrow, straight blade; blade margins reworked (possibly for use as a drill); lateral snap failure; Ft. Payne chert; definitely heated.

4. Level 4 (30-40 cm): Middle/Late Woodland; medium triangular; slightly incurvate base; slightly incurvate base; slightly incurvate blade margins; expansion failure; Ft. Payne chert; heated after final modification.

5. Level 5 (40-50 cm): Indeterminate; large triangular retouched flake; straight base; slightly excurvate blade margins; lateral snap failure; Ft. Payne chert; no evidence of thermal alteration.

6. Level 8 (70-80 cm): Late Archaic (Ledbetter?); small, inversely tapered shoulders; narrow, slightly contracting stem; very thick, narrow blade with slightly excurvate margins; crushing on blade margin, possibly caused by attempted thinning; pot-lidding failure removed one shoulder and most of one blade margin; Ft. Payne chert; heated after final modification.

7. Level 11 (100-110 cm): Middle Archaic (Eva/Morrow Mountain); short contracting stone with rounded base; inversely tapered shoulders; indeterminate (amputated) blade margins; lateral snap/lateral snap failure; Ft. Payne chert; definitely heated.

1019N 1000 E

8. Level 2 (20-30 cm): Late Woodland; small triangular; incurvate base; straight blade margins; lateral snap failure; Ft. Payne chert; no evidence of heating.

9. Level 2 (20-30 cm): Terminal Late Archaic; Little Bear Creek (Futato 1983:215-220, 225-228); large, slightly expanding stem; slightly excurvate base; narrow, inversely tapered shoulders; long, slightly excurvate blade margins; multiple hinge failures during thinning; pot-lidding failure; Ft. Payne chert; heated after final modification.

1010N 1001 E

10. Level 1 (0-20 cm): Mississippian/Late Woodland; small triangular; incurvate base; lateral margins show extensive reworking, forming pronounced basal tangs or ears; perverse failure with edge damage suggest use as drill; Ft. Payne chert; no evidence of heat.

11. Level 1 (0-20 cm): Indeterminate stem; medium straight stem; straight base; haft snap failure; Ft. Payne chert; heated after final modification.

1019N 1002 E

12. Level 2 (10-20 cm): Late Woodland/Mississippian; small triangular; slightly incurvate blade; slightly incurvate base; thick, median ridge knot; multiple hinge failures; lateral snap tip; Ft. Payne chert; possibly heated.

13. Level 2 (10-20 cm): Early Woodland; round base cluster; narrow, slightly tapered shoulders; narrow contracting stem; rounded base; haft snap (tranverse hinge) failure; Ft. Payne chert; heated after final modification.

14. Level 5 (40-50 cm): Late Archaic; Ledbetter; medium triangular blade with slightly excurvate margins; narrow, straight to slight inversely tapered shoulders; straight stem; haft snap; clear impression of black mastic compound on haft element; Ridley chert; no evidence of heating.

15. Level 5 (40-50 cm): Late, Middle Archaic; Benton; medium, straight blade; straight wide stem; slightly incurvate base; narrow, slightly tapered shoulders; perverse failure at fossil inclusion;

secondary impact burination and possible retouch to form burin; Ft. Payne chert; no evidence of heating.

16. Level 7 (60-70 cm): Paleo; Quad; lanceolate blade with recurvate margins; deeply incurvate base, well ground; grinding along basal blade margins; retouch along one lateral margin indicates reworking (patination difference); Fort Payne chert; no evidence of thermal alteration.

17. Level 8 (70-80 cm): Early Archaic?; Kirk?; medium, triangular blade with straight margins; deep corner notches forming steeply inversely tapered shoulders and expanding stem; slight grinding in notches; stem ears, and shoulder "barbs" broken off; Fort Payne chert; heated after final modification.

APPENDIX C

FAUNAL REMAINS

Table C.1. Identifiable faunal elements by chronological period.

	Shelter Units 1019N, 1000, 1001 and 1002E						Test Unit 1019N995.5E	
	Mississippian/Woodland		Late Archaic		Middle Archaic		All Levels	
	Fragment	Wt(g)	Fragment	Wt(g)	Fragment	Wt(g)	Fragment	Wt(g)
MAMMALS								
Unidentified Large Mammal	5	1.87	9	4.51			23	38.3
Unidentified Small Mammal	13	.78	50	4.36	15	.33	18	1.15
Beaver, *Castor canadensis*			1	.3			2	1.46
Muskrat, *Ondatra zibethicus*			6	1.28	1	.2		
Striped skunk, *Mephitis mephitis*			1	.4				
River otter, *Lutra canadensis*, cf.							1	1.05
Eastern cottontail, *Sylvilagus floridanus*	3	.75	14	3.38	11	1.71	5	.12
Gray/fox squirrel *Sciurus* sp.	11	.85	40	3.17	5	.12	13	.25
Eastern chipmunk, *Tamias striatus*			9	.43	2	.05		
Southeastern flying squirrel, *Glaucomys volans*			2	.02				
Red fox, *Vulpes vulpes*			1	.3				
Raccoon, *Procyon lotor*			6	2.26			2	1.1
White-tailed deer *Odocoileus virginianus*	5	6.07	6	10.06	3	2.35	20	51.0
Deer mouse, *Peromyscus maniculatus*							1	.01
Peromyscus cf.	2	.06	1	.03				
Eastern woodrat, *Neotoma floridana*			1	.05				
Meadow vole, *Microtus pennsylvanicus*					3	.11		
Pine vole, *Microtus pinetorum*			1	.01			2	.01
Prairie vole, *Microtus ochrogaster*			1	.01			2	.03
Microtus sp.					7	.05	2	.01
Short-tailed shrew, *Blarina brevicauda*					7	.23	1	.04
Family Canidae	1	.2	2	.7				
Family Felidae					2	1.31		
FISH								
Unidentified fish, Class Ostichthyes	1	.01	31	.83	4	.04	1	.03
Longnose Gar, *Lepisosteus osseus*			5	.06			3	.1
Freshwater Drum, *Aplodinotus grunniens*					3	.08		
Catfish, *Pylodictus olivaris*			1	.5				
AMPHIBIANS								
Unidentified frog, Family Ranidae			1	.2				
Hellbender, *Cryptobranchus alleganiensis*			1	.3				
TURTLES								
Unidentified turtle	25	2.44	56	4.98			70	8.69
Musk turtle, *Sternotherus odoratus*	4	.85	3	.84			1	.06
Softshell turtle, *Trionyx* sp.							1	.04
Map turtle, *Graptemys* sp.							2	.68
Sliders/Cooters, *Chrysemys* sp.							1	.25
Box turtle, *Terrapene carolina*							2	.07
Mud and Musk turtles, Family Kinosternidae							2	.3
SNAKES								
Unidentified snake, Family Colubridae	8	.61	11	2.26	173	40.02	11	1.12
Nonvenemous snakes, Family Viperidae	1	.01	2	.20	24	3.82	3	.86
Rattlesnakes, Family Viperidae	5	.8	6	1.75	62	18.81		
BIRDS								
Unidentified bird	6	.31	19	.86	1	.06	2	.21
Turkey, *Meleagris gallopavo*			1	2.2				
INVERTEBRATES								
Crayfish, Family Astacidae			2	.15				
Unidentified bone fragments 1" and 1"	208	74.0	635	231.3	227	53.0	380	134.3
Unidentified bone fragments 1/16" wt. only		10.18		49.79		15.73		53.2
Totals	298	99.79	924	325.29	550	138.02		
Percentages	(.18)	(.18)	(.52)	(.58)	(.31)	(.25)		

Table C.2. Identifiable freshwater gastropods from 1019N1000E.

Level (Depth)	Pleurocera canaliculatum	Elimia laqueata	Lithasia geniculatum	Lithasia duttoniana	Leptoxis praerosa	Campeloma decisum	Totals
Surface		1	2				3
1 (0-20)	434	593	113	59	70	1	1270
2 (20-30)	948	597	255	210	144	9	2163
3 (30-40)	1690	1084	488	223	246	10	3741
4 (40-50)	1704	1104	429	246	301	10	3794
5 (50-60)	1547	1387	420	174	272	20	3820
6 (60-70)	1435	1465	332	210	236	45	3723
7 (70-80)	1204	494	100	64	122	13	1997
8 (80-90)	248	43	10	13	23	1	338
9 (90-100)	32	9	2		3		46
10 (100-110)	3	4			1		8
11 (110-120)	7	1			1		9
12 (120-130)	2	1					3
13 (130-140)	1	1		1			3
14 (140-150)	2						2
Totals	9257	6784	2151	1200	1419	109	20920

Table C.3. Identifiable freshwater gastropods from 1019N1001E.

Level (Depth)	Pleurocera canaliculatum	Elimia laqueata	Lithasia geniculatum	Lithasia duttoniana	Leptoxis praerosa	Campeloma decisum	Totals
Surface			1	79			80
1 (0-20)	487	2	121	82	85	4	781
2 (20-30)	1197	597	356	148	170	6	2474
3 (30-40)	3922	747	1275	503	412	15	6874
4 (40-50)	2892	1335	501	308	343	18	5397
5 (50-60)	1855	1356	446	224	273	14	4168
6 (60-70)	4399	1293	241	184	238	9	6364
7 (70-80)	820	1075	141	66	123	6	2231
8 (80-90)		357	20	4	14	1	396
9 (90-100)	2	41					43
10 (100-110)		1					1
11 (110-120)	2	1					3
12 (120-130)	1	2					3
13 (130-140)							
14 (140-150)							
Totals	15577	6807	3102	1598	1658	73	28815

Table C.4. Identifiable freshwater gastropods from 1019N1002E.

Level (Depth)	Pleurocera canaliculatum	Elimia laqueata	Lithasia geniculatum	Lithasia duttoniana	Leptoxis praerosa	Campeloma decisum	Totals
Surface	6	17	1	1	1		26
1 (0-10)	231	235	64	38	22	2	592
2 (10-20)	133	263	35	15	22	1	469
3 (20-30)	424	594	118	75	54	4	1269
4 (30-40)	925	875	353	140	140	7	2440
5 (40-50)	2265	1948	554	224	282	17	5290
6 (50-60)	2943	2222	434	312	389	22	6322
7 (60-70)	1198	962	269	137	155	4	2725
8 (70-80)	146	107	35	23	37	2	350
9 (80-90)	13	4	5	2	2	1	27
10 (90-100)	5						5
11 (100-110)		2			1		3
Totals	8289	7229	1868	967	1105	60	19518

Table C.5. Identifiable freshwater gastropods from 1019N995.5E.

Level (Depth)	Pleurocera canaliculatum	Elimia laqueata	Lithasia geniculatum	Lithasia duttoniana	Leptoxis praerosa	Campeloma decisum	Totals
1 (0-10)							
2 (10-20)			1				1
3 (20-30)	8	4	21	13	2		48
4 (30-40)	38	10	140	188	3		379
5 (40-50)	32	13	158	135	6		344
6 (50-60)	32	14	69	63	15		193
7 (60-70)		1	7	11	4		23
8 (70-80)	6	5	25	21	13		70
9 (80-90)	15	5	67	48	20		155
10 (90-100)	26	8	127	76	42		279
11 (100-110)	26	6	141	65	37	2	277
12 (110-120)	2	1	1		1		5
13 (120-130)							
14 (130-140)							
15 (140-150)							
16 (150-160)							
17 (160-170)			1				1
Totals	185	67	758	620	143	2	1775

VITA

Joseph M. Herbert was born in Auburn, Alabama on January 4, 1953 and graduated from Auburn High School in 1971. After working several years in the residential construction industry, Mr. Herbert enrolled at Auburn University and was awarded the Bachelor of Arts degree in 1980, with a major in Philosophy and minors in Anthropology and Biology. While enrolled at Auburn University, he assumed an archaeological research position in the Department of Sociology and Anthropology under the direction of John W. Cottier.

In September, 1981, Mr. Herbert enrolled in the graduate program in Anthropology at the University of Tennessee. He was awarded the Master of Arts degree in June, 1986 with a major in Anthropology. During his enrollment at the University of Tennessee, Mr. Herbert served as a Research Technician for the Columbia Archaeological Project and as a Supervisor for the Shelby Bend Archaeological Project, under the direction of Walter E. Klippel.

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