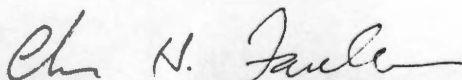


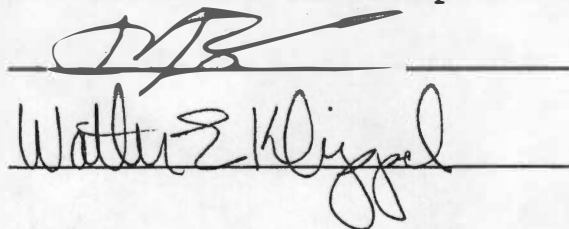
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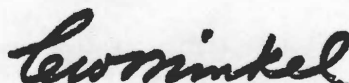


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**Evolutionary Perspectives For The Analysis
Of Prehistoric Lithic Artifacts: An
Example From The Western Highland
Rim of Tennessee**

A Thesis
Presented for the
Master of Arts
Degree
The University of Tennessee

Andrew P. Bradbury

May 1994

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ABSTRACT

The goal of this thesis is to develop an evolutionary framework for the analysis of prehistoric lithic artifacts. The principles of evolutionary theory are presented and then extended to the lithic artifact analysis. Methods are developed based on the theoretical framework. Lithic artifacts recovered from two Terminal Archaic Wells Creek phase sites in Houston County, Tennessee are used as a case study to demonstrate the utility of such an approach. Variability can be demonstrated with respect to morphology, technology, and function of lithic implements. Elements that may represent attributes under selective pressure are examined.

The lithic material recovered from the two sites is shown to be quite distinct from other contemporary groups in the area. It is suggested here, based on similarities in both morphological forms and technology, that Wells Creek is related to the Riverton Culture and similar entities known from archaeological remains recovered from sites north of the study area. Radiocarbon dates for Wells Creek overlap those of Riverton and other similar groups.

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Chapter I

Introduction

In the past decade, a growing number of archaeologists (e.g. Dunnell 1980, 1989, 1992; Leonard and Jones 1987; O'Brien and Holland 1990, 1992; Rindos 1984) have proposed the use of Darwinian evolutionary theory for archaeological explanation. Much of this research has dealt with the theoretical aspects of evolutionary theory as applied to archaeological data. However, some research has tested archaeological data using Darwinian evolutionary theory (e.g. Boyd 1986; Leonard and Reed 1993; Rindos 1984). The Darwinian perspective emphasizes that evolution is a two part process; the production of variability and selection acting on this variability. Evolution is seen as an ongoing, gradual change in attribute frequency across temporal and geographical dimensions.

This thesis examines the use of an evolutionary framework for the analysis of prehistoric lithic artifacts. The use of evolutionary explanation in lithic analysis has a sound basis due to several factors: 1) humans have utilized lithic technology for approximately 2.5 million years so in some respects stone tools have co-evolved with humans; 2) the majority of human prehistory must be documented through lithic technology because perishable materials do not preserve at most sites; 3) changes in lithic technology can be observed over time; and 4) the principal evolutionary concepts of

variation, selection, and function can be demonstrated with data derived from lithic analysis.

The goals of this thesis are: 1) develop an evolutionary framework for the analysis of prehistoric lithic artifacts; 2) based on this theoretical perspective, develop appropriate methods for analysis; and 3) demonstrate the utility of such an approach using archaeological material.

The examination of archaeological material recovered from the Pitts (40HO12) and Lockarts Chapel (40HO15) sites in Houston County, Tennessee is used to demonstrate the utility of an evolutionary framework for the analysis of lithic artifacts. The sites were originally excavated and analyzed as part of contract archaeological excavations undertaken in conjunction with highway construction activities. The initial results documented the presence of a previously undefined cultural manifestation in Tennessee. Using Willey and Phillips' (1958) definition of a phase, this Terminal Archaic manifestation was termed the Wells Creek phase (Bradbury 1992a). Dunnell (1989:45) has argued the use of evolutionary theory demands that we abandon typological terms such as cultures, phases, and stages. I agree with Dunnell on this point; however, I also recognize that these terms have some utility for general descriptive and communication purposes as they are well established in the archaeological literature. This point is discussed more fully in Chapter 3. For the present, it will suffice to note that terms such as culture,

phase, or stage, in this thesis, are used only to provide a general point of reference (i.e. temporal placement or for general description) and are not a substitute for explanation of the data.

Rindos (1984:74) has stated that "we should adopt a case study approach to the understanding of selective components of cultural variation and change." This perspective is utilized in this thesis. Due to the distinctive lithic implements, the Wells Creek material presents a unique case study.

Background information regarding the original excavations, environmental setting, and an overview of the Late Archaic is presented in Chapter 2. Much of the discussion is descriptive in nature. An emphasis is placed on a discussion of lithic technology of groups that inhabited the Interior Low Plateau Physiographic Province and that are roughly contemporaneous with Wells Creek or that exhibit similar assemblages. This background will allow for comparisons to be made between Wells Creek and other groups based on lithic artifacts.

The theoretical basis for this thesis is divided into two sections. First, in Chapter 3, the principles of evolutionary theory as applied to biological organisms are examined. This discussion is then extended to archaeological data, and more specifically, the analysis of lithic artifacts. Chapter 4 examines the use of material culture as a medium of information exchange, and what role this may have in

evolutionary studies.

Based on the theoretical framework presented in chapters 3 and 4, methods have been developed for the analysis of the Wells Creek lithic material. These methods are outlined in Chapter 5.

Results of the analysis are presented in Chapter 6. Emphasis is placed on the examination of variability, selection, and function as they pertain to the Wells Creek lithic artifacts. The discussion is then extended to comparisons with other contemporary groups in the area.

The demonstration of evolutionary phenomena requires an examination that has considerable temporal dimensions. Unfortunately, this is not possible at the present time. As Dunnell (1989:45) has noted, the use of evolutionary explanation requires that data be collected in a manner different than is common in contemporary archaeology. The development of an evolutionary archaeology is still in its infancy. Much work is still needed on both the theoretical and methodological aspects of the application of evolutionary principles to archaeological data. The continued development in archaeological evolutionary theory and the application of this theory to archaeological data will further define the approach.

In using the 'case study' approach, such as presented here, it is recognized that the demonstration of long term evolutionary phenomena is not possible. However, the

continued examination of these case studies is an important step in the development of a larger data base that will eventually allow for the examination of larger scale evolutionary phenomena. For the present, the demonstration of variability and an examination of elements that appear to be under selective pressure are possible. Only when a sufficiently large number of sites have been described in evolutionary terms can we develop evolutionary explanations for the archaeological record that can account for the development of the human condition. This thesis represents one small step in that direction.

Chapter II

Background Information

The analysis of archaeological material recovered from the Pitts (40HO12) and Lockarts Chapel (40HO15) sites in Houston County, Tennessee documented the presence of a previously undefined cultural manifestation in the Cumberland Valley of Tennessee. Based on the artifactual remains recovered at the two sites, this archaeological entity appeared to be very different from other contemporaneous assemblages in the area. Using Willey and Phillips (1958) definition of a phase, this Terminal Archaic manifestation was termed the Wells Creek phase (Bradbury 1992a). Artifacts recovered from the Wells Creek sites resembled those associated with the Riverton Culture of Illinois and Indiana. This chapter will present a brief overview of the site excavations and background. The main focus of this chapter is to provide a general description of the excavations and artifact assemblage.

Environmental Background

Geological Resources

The Wells Creek area is located within the Western Highland Rim section of the Interior Low Plateau Physiographic Province as defined by Fenneman (1938). The Highland Rim is a level-bedded cherty plateau of Mississippian age. Erosional elements of Devonian Age shale are exposed at the lowest elevations. The Highland Rim is the largest section of the

Interior Low Plateau Province and covers approximately 24,087 km² of Tennessee, Alabama, and Kentucky. Much of the Highland Rim is plateau-like, although there is marked dissection along major streams of the area. The Highland Rim section is divided into the Eastern and Western sections (Fenneman 1938; Luther 1977; Thornbury 1977).

The Western portion of the Highland Rim is a broad, tilted plateau with an area of 19,425km². Average elevation for this area is 274m AMSL. This area is characterized by a dissected, rolling terrain with numerous streams and rivers. In Stewart and Sumner counties a karst topography is extensive. The main drainages of this region are the Cumberland and Duck rivers (Luther 1977; Miller 1974).

Erosion of the Pennsylvanian sandstones exposed the more resistant cherty Mississippian limestone that now characterizes the Highland Rim. Exposed formations in this area are mostly Early-Middle Mississippian age and are primarily limestone formations. The down-cutting of rivers across the Highland Rim has exposed several geological formations that were of economic importance to prehistoric people of the area. In the Wells Creek area, these formations are the Fort Payne, St. Louis/Warsaw, and Ste. Genevieve limestone formations. All three of these formations contain high quality chert.

The Fort Payne Formation is the lowest formation exposed in the Wells Creek area. Bassler (1982:155) has described the

Fort Payne Formation of the Nashville Basin as a massive argillaceous limestone which weathers into a solid brittle blocky chert and siliceous shale. This Mississippian age formation contains beds and nodules of dense cryptocrystalline chert. The chert is dense and flint-like in appearance (Hulme 1968). Chert from the Fort Payne Formation occurs in a variety of colors and was of great economic importance to prehistoric people throughout the Southeast (Amick 1984; Ensor 1981; Faulkner and McCollough 1973; Futato 1983; Johnson 1981). Quartz geodes also occur within this formation (Marcher 1962; Theis 1936). The Fort Payne Formation is exposed at various locations around the Wells Creek area (Stearns et al. 1968).

The St. Louis Formation generally consists of a fine-grained to compact gray limestone containing nodules of blue to bluish-gray chert (Lusk 1935; Theis 1936). Spherical "cannonballs" consisting of dense chert are found at most extensive outcrops of this formation (Hulme 1968). These chert nodules are somewhat smaller in size in comparison to the Fort Payne chert; however, its very dense and fine-grained characteristics make it an optimal raw material for stone tool manufacture. Quartz geodes are also present in the Warsaw Formation. The St. Louis Formation caps many of the hills on the Highland Rim and is exposed at various locations in the Wells Creek area (Hulme 1968; Stearns et al. 1968).

The Ste. Genevieve Formation consists of calcareous,

dolomitic, and argillaceous limestones, shale, and chert. Bedding in the limestone is massive and chert occurs as lenses and nodules that vary greatly in size. The formation weathers to chert rubble containing cannonball and ovoid masses of chert. Cherts of this formation are similar to those of the Upper St. Louis Formation. The Ste. Genevieve Formation is exposed at a few locations around the Wells Creek area and northward into Kentucky (Hulme 1968; Stearns et al. 1968).

Floral and Faunal Resources

The Western Highland Rim section of the Interior Low Plateau Province is located in the Western Mesophytic Forest Region (Braun 1974). This region is a transition zone which is not characterized by a single climax type, although oaks are dominant.

Braun (1974:35) describes the Western Mesophytic Forest Region as "a mosaic of unlike climaxes and subclimaxes, and thus may be thought of as an ecotone. Representative examples of the Mixed Mesophytic association occur frequently in its eastern part, and more locally westward. Oak-hickory and prairie communities resembling the climaxes to the west and several intermediate types, as oak-tuliptree and beech-chestnut, take part in the mosaic."

Many species of trees can be found within the Western Highland Rim. These species vary from place to place, although an oak forest was once widespread. In the Wells Creek Valley "the main forest species are white, post, black,

scarlet, and Eastern red oaks, pignut and white hickories, and black walnut, white ash, yellow-popular, blackgum, sugar maple, beech and red cedar. There are occasional stands of blackjack oak, persimmon, sourwood, and redbud. Among the smaller species are dogwood, privet, sassafras, chestnut oak, basswood, Southern red oak, and hophornbeam" (Wildermuth 1958:41).

Other plant resources such as herbaceous species were also available in this area. These plants include maygrass (Phalaris caroliniana), goosefoot (Chenopodium sp.), wild rice (Zizania aquatica), sunflower (Helianthus annus), marsh elder (Iva funtescens), sumpweed (Iva annua v. macrocopa), and ragweed (Ambrosia trificla). Fruits such as blackberry (Rubus sp.) and grape (Vitis sp.) would also have been available to prehistoric groups in the area (Wildermuth 1958).

Many species of terrestrial and avian animals inhabit the Interior Low Plateau province. Aquatic animals and fish are also abundant in the rivers and streams of this region. Small game populations are large; however, only scattered deer and turkey occur in the Highland Rim (Shultz et al. 1954).

Animal species that may have been important for prehistoric groups in the area include white-tailed deer (Odocoileus virginianus), black bear (Ursus americanus), opossum (Didelphis virginiana), raccoon (Procyon lotor varius), gray fox (Urocyon cinereoargenteus), woodchuck (Marmota monax), gray squirrel (Sciurus carolinensis), beaver

(Castor canadensis), eastern cottontail (Sylvilagus floridanus mallurus), and swamp rabbit (Sylvilagus aquaticus) (Kellogg 1939). In addition to these species, buffalo (Bison bison pennsylvanicus), elk (Cervus canadensis), wolf (Canis lupus lycaon), and panther (Felis concolor couguar) were observed by early settlers in the Nashville area (Haywood 1823:108). These animals were probably in the Western Highland Rim during prehistoric times, but are no longer present in the area.

Many species of fish, aquatic turtles, and mollusks inhabit the streams and rivers of the Highland Rim. Native fish species on the Highland Rim include catfishes (Ictalurus punctatus, I. furcatus, I. melas, and I. natalis), largemouth bass (Micropterus salmoides), rock bass (Ambloplites rupestris), smallmouth bass (Micropterus dolomieu), white crappie (Pomoxis annularis), bluegill (Lepomis macrochirus), sunfishes (Lepomis cyanellus, L. humilis, L. macrochirus, L. cyanellus, and L. microlophus), smallmouth buffalo (Ictibus bulbalus), gars (Lepisosteus oculatus and L. osseus), and carp suckers (Carpiodes carpio and C. velifer) (Shultz et al. 1954). Fish such as suckers and buffalo spawn in the spring in large numbers. At this time of the year these species would have been easily obtainable. Many of the fish species that are native to the Highland Rim are available in Wells Creek. Mollusks would have been available in the Tennessee and Cumberland rivers. Although small aquatic gastropods, are found in Wells Creek, bivalves appear to be absent; therefore,

mollusks probably were not utilized to any extent by prehistoric groups in the Wells Creek area.

Summary of Excavations

The two sites were situated in the Wells Creek Valley approximately 2.5-3 km south of the confluence of Wells Creek and the Cumberland River (Figure 1). Excavation of the Pitts (40HO12) and Lockarts Chapel (40HO15) sites was conducted by the Transportation Center at the University of Tennessee-Knoxville as part of Phase II testing and Phase III data recovery on sites to be adversely affected by the relocation of State Route 149 in Houston County, Tennessee. Elsewhere, I have discussed the excavation of these sites (Bradbury 1992), thus only a summary is presented here.

Pitts Site

The Pitts site was situated on a large knoll on the west bank of Wells Creek. Phase II testing at the site documented the presence of prehistoric pit features intruding into sterile subsoil directly below the plowzone. Phase III excavations consisted of the removal of the plowzone in a block area to expose pit features and post holes. Forty pit features and eighteen post holes were exposed and excavated. Diagnostic cultural material dating to the Late and Terminal Archaic, Early Woodland, and Mississippian periods was recovered. Based on the presence of diagnostic artifacts, eleven of the features were determined to be associated with the Wells Creek phase occupation (Figure 2). No post holes

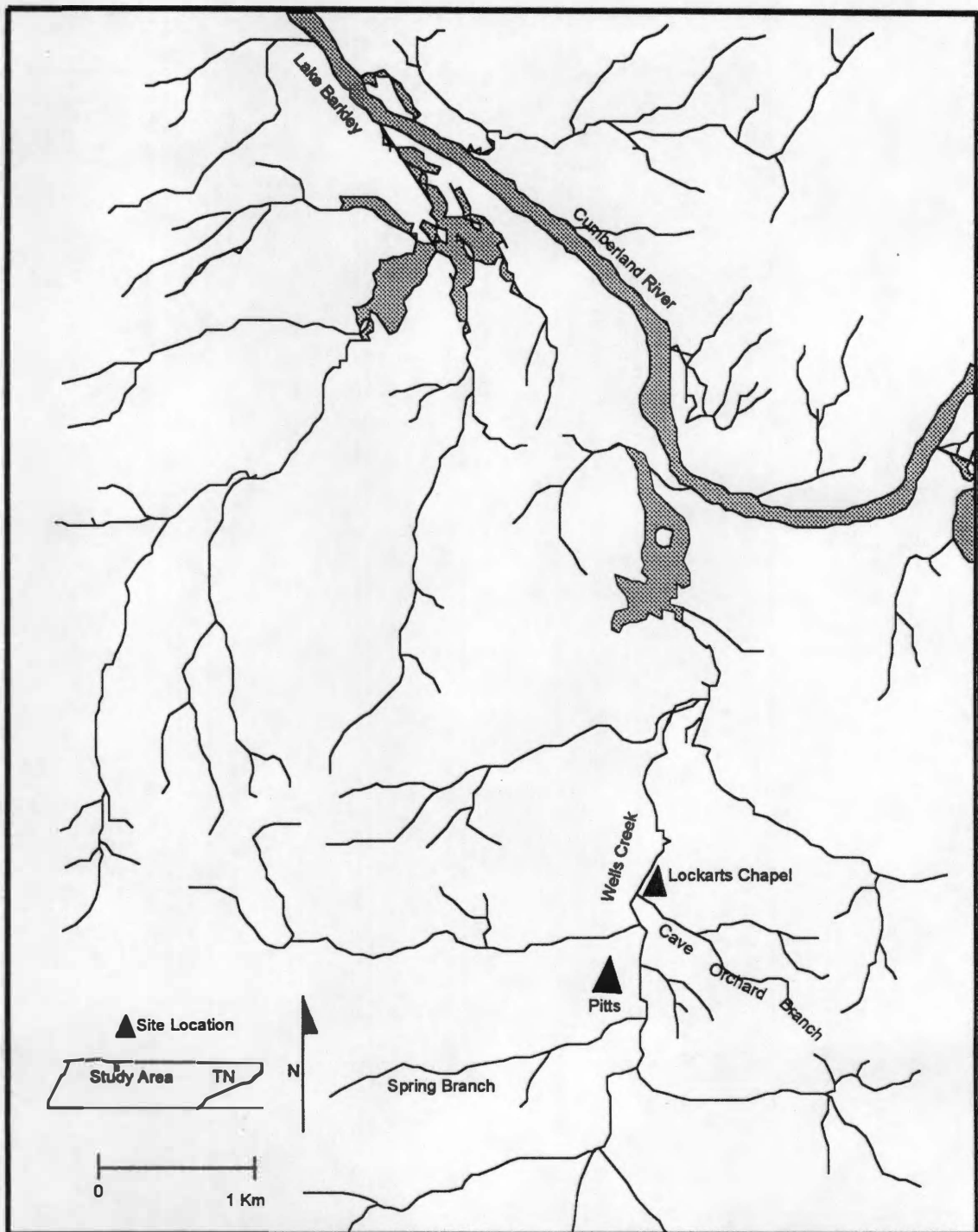


Figure 1. Site Location.

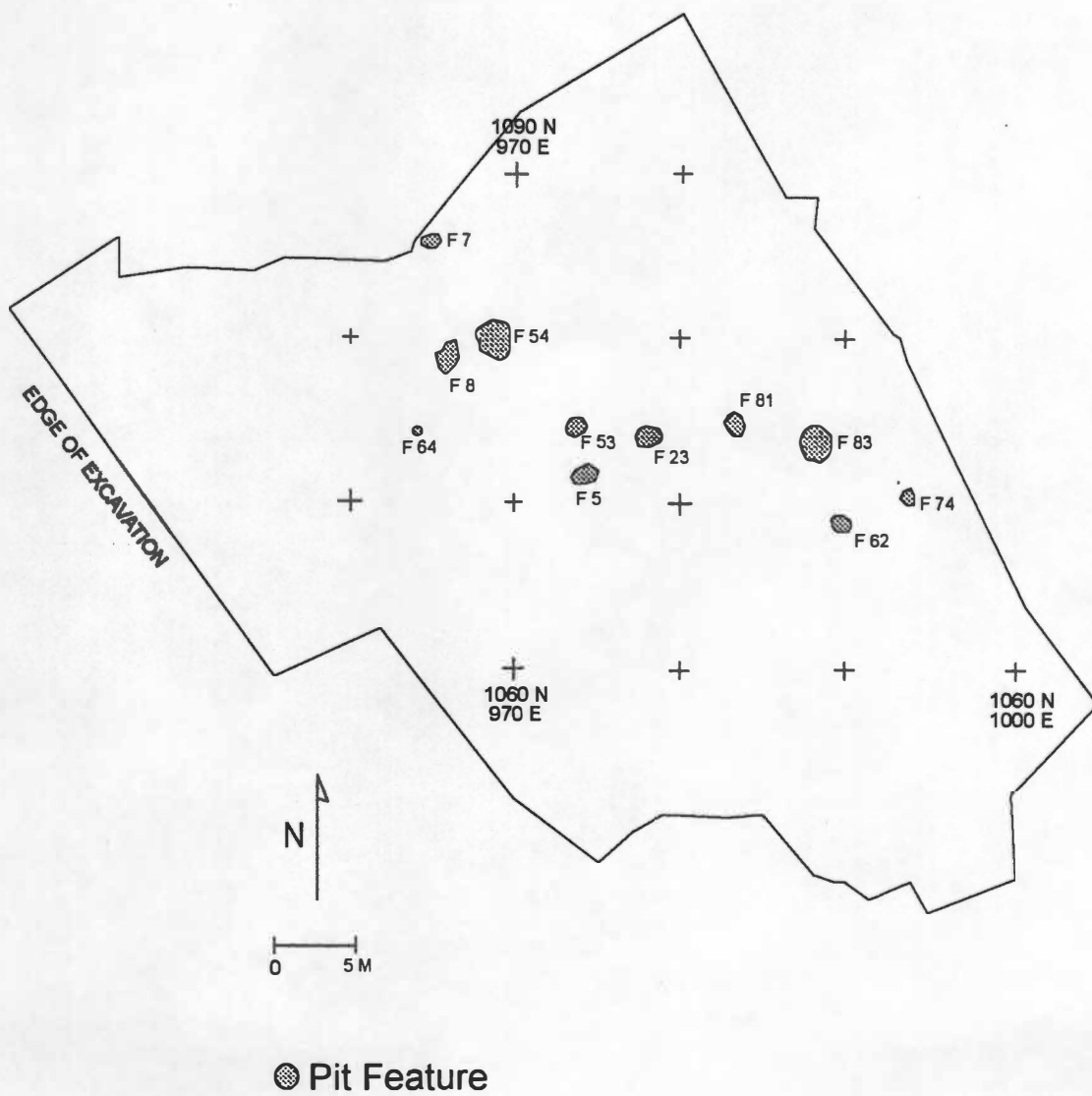


Figure 2. Distribution of Wells Creek Features, Pitts Site.

were associated with this occupation.

Material recovered from feature contexts included lithic debitage, modified chert artifacts, fire cracked rock, botanical remains, and small quantities of faunal remains. Three of the Wells Creek features were large silo pits. These were deep circular pits that ranged from 1 meter to 2.6 meters in diameter and 130 cm to 169 cm in depth. Several of the features contained multiple zones. Material density in the Wells Creek features was quite heavy.

Faunal material recovered from the Wells Creek features consisted of 691 bone fragments and one gastropod shell (Beauchamp 1992). The majority of the faunal remains were unidentifiable to genus or species and much was calcined. Identifiable materials included white-tailed deer (Odocoileus virginianus), eastern box turtle (Terrapene carolina), several indeterminate turtles (Emydidae and Testudines), and a non-poisonous snake (Colubridae) (Beauchamp 1992). Seasonality, based on the presence of turtle and snake, is for late spring, summer, or early fall (Beauchamp 1992).

Botanical remains from the Wells Creek component consisted of wood charcoal, nutshell fragments, one chenopodium seed, and one cucurbita rind (Crites 1992). Nutshell fragments representing hickory, walnut, and acorn were recovered. Based on the botanical remains, a fall to winter occupation is suggested (Crites 1992).

Lockarts Chapel Site

The Lockarts Chapel site was situated on a knoll west of the existing State Route 149 approximately 90 m east of Wells Creek. The eastern portion of the site was probably destroyed during previous road construction. Phase II testing at the site revealed the presence of prehistoric pit features intruding into sterile subsoil directly below the plowzone. Phase III excavations consisted of the removal of the plowzone in a block area to expose pit features. Thirteen features were excavated and determined to be associated with the Wells Creek phase occupation (Figure 3).

Material recovered from feature context included lithic debitage and cores, modified chert artifacts, fire cracked rock, botanical remains, and small quantities of faunal remains. Most features exhibited only one discernable fill episode. Material density at the Lockarts Chapel site was not as heavy as at the Pitts site.

Faunal remains at the site consisted of 438 bone fragments, the majority of which were calcined and unidentifiable (Beauchamp 1992). Identifiable specimens were white-tailed deer (Odocoileus virginianus), freshwater mussel (Pelecypoda), and turtle (Testudines) (Beauchamp 1992).

Botanical remains from the site consisted of wood charcoal and nutshell (Crites 1992). Nutshell fragments representing hickory, walnut, and acorn were recovered. Based on the botanical samples, a fall to winter occupation is

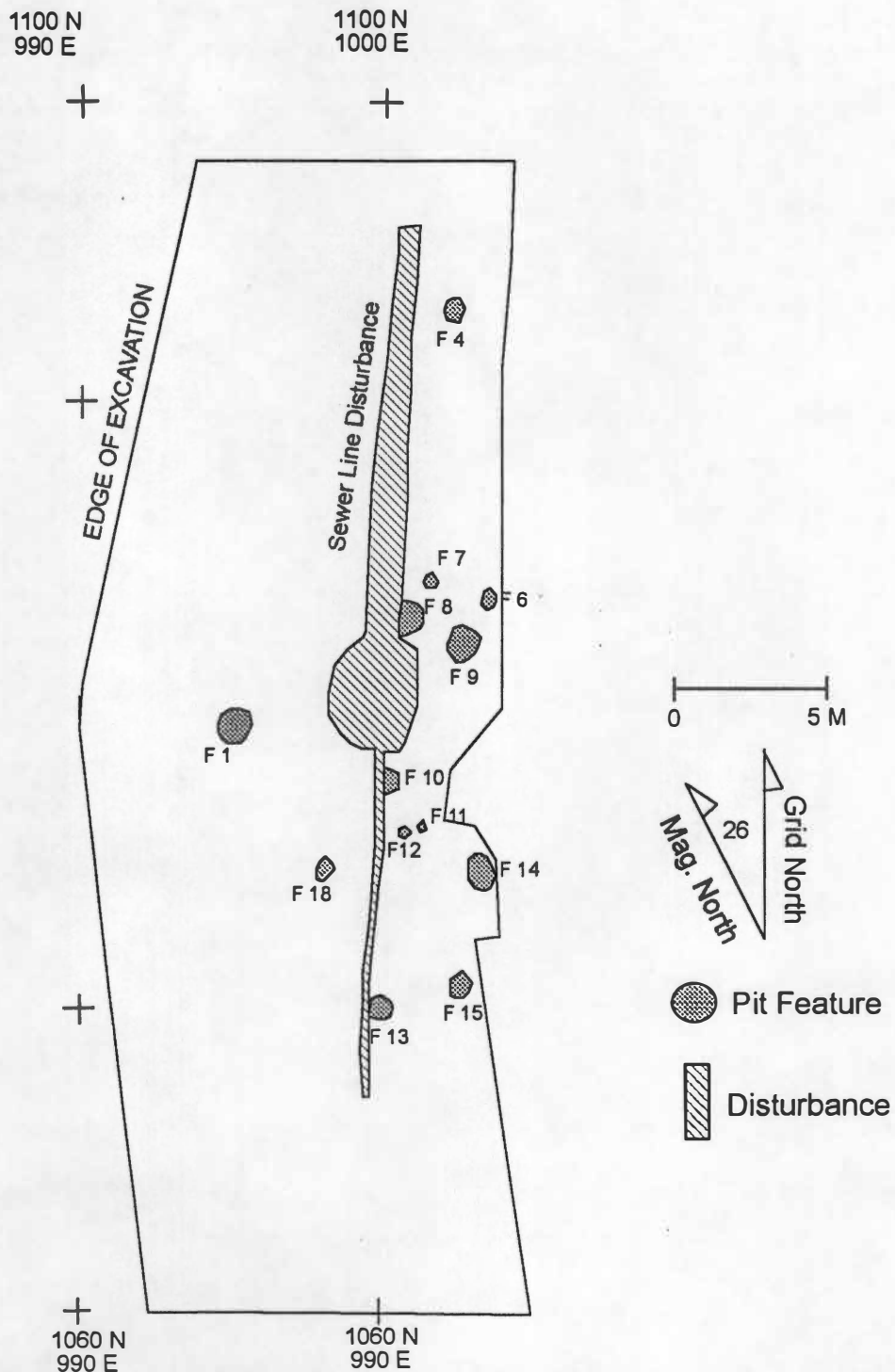


Figure 3. Distribution of Wells Creek Features, Lockarts Chapel Site.

suggested (Crites 1992).

Radiocarbon Dates

Samples of burnt nutshell recovered from Wells Creek phase features were submitted to Beta Analytic for analysis. Five dates were obtained for the Pitts site and two were obtained for the Lockarts Chapel site (Figure 4). The radiocarbon dates obtained for the Pitts site were; 3210+/- 60 B.P., 3330+/- 90 B.P., 3380+/- 60 B.P., 3390+/- 60 B.P., and 3660+/- 70 B.P. The radiocarbon dates obtained for the Lockarts Chapel site were; 3440+/- 60 B.P. and 3480+/- 60 B.P.

Using the C14 module in Kintigh's (1993) Tools For Quantitative Archaeology, the dates obtained for the Wells Creek sites were compared. The program uses the procedure developed by Wilson and Ward (1981; Ward and Wilson 1978) to compare dates and determine whether the dates can be assumed to be contemporary or not. All the samples used in the analysis were obtained from burnt nutshell, thus sunspot error was also considered (Clarke 1975). Three separate runs of the dates were made. The first run used only the dates from the Pitts site, the second used the dates from the Lockarts Chapel site and Feature 7 at the Pitts site, the third used the dates from the Lockarts Chapel site and all dates except Feature 7 from the Pitts site.

In the first run, a split was made between Feature 7 and the remaining dates for the Pitts site. This indicates that

C14 Dates

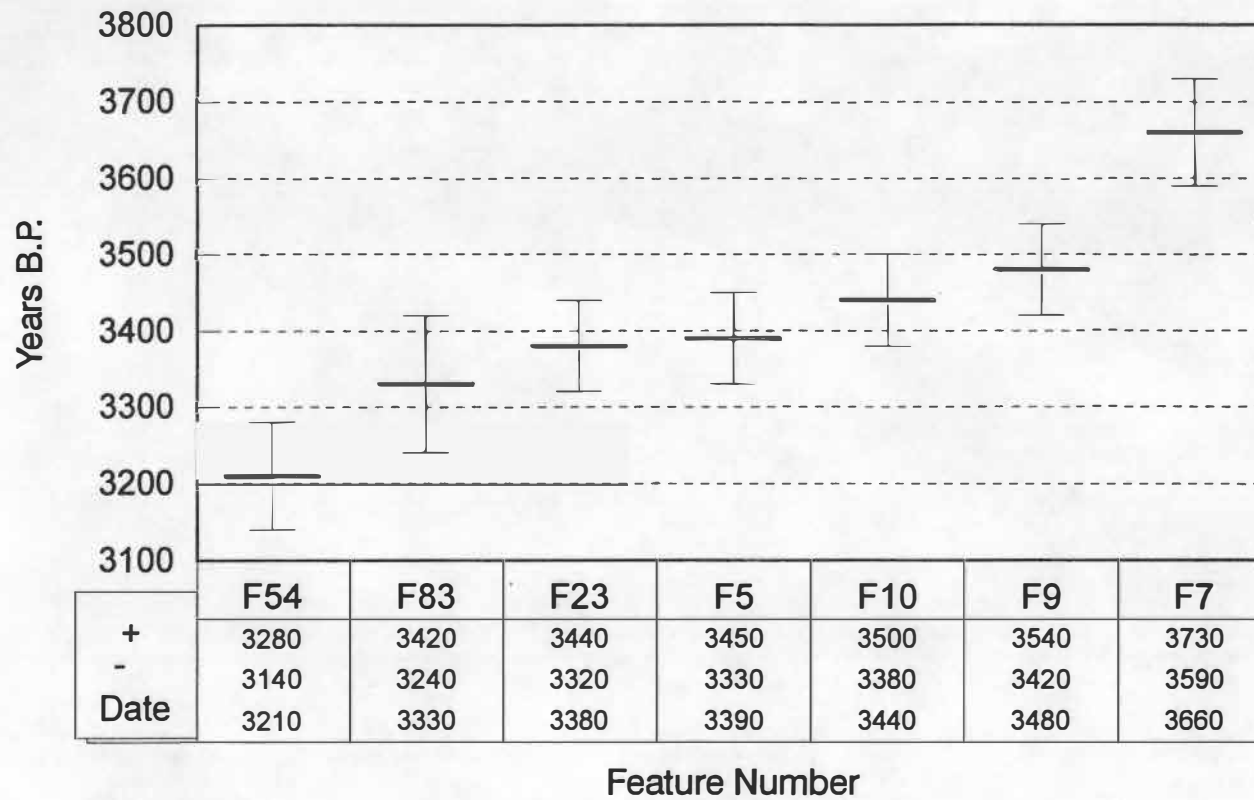


Figure 4. Radiocarbon Dates.

the dates obtained for Features 54, 83, 23, and 5 can not be assumed to be different and should be considered a contemporaneous occupation. The date for Feature 7 can be assumed to be separate from the other dates. It should also be noted that Feature 7 was situated away from the other features. A biface fragment recovered from zone C of Feature 23 was refitted with a biface fragment from zone A of Feature 54, further supporting the C14 analysis.

In the second run, using Feature 7 from the Pitts site and the Lockarts Chapel dates, no splits were obtained. Feature 7 at the Pitts site and the features from Lockarts Chapel can not be assumed to be separate.

The third run, which examined the Lockarts Chapel dates and all dates from Pitts except Feature 7, did not find any splits. These dates can not be assumed to represent separate occupations.

Raw Material Survey

In addition to the site excavations, a raw material survey was conducted in the Wells Creek drainage to determine the quality and quantity of chert resources that would have been available in the area. This survey documented the presence of four prehistoric quarries (40HO51, 40HO52, 40HO53, and 40HO54) within a 1.5 km radius of the two sites (Bradbury 1992a). An abundance of chert was also documented in the form of river gravels from Wells Creek and as natural inclusions in the subsoil at the sites. Experimental knapping and thermal

alteration of these materials was conducted to determine the suitability of each source for chipped stone tool manufacture. The highest quality material was recovered from the quarry areas. Some high quality chert could also be obtained from gravel bar locations. Raw material from the quarry and gravel bar sources was conducive to thermal alteration. The residual chert obtained from within the subsoil matrix at the sites was of lesser quality than the other two sources. However, thermal alteration of the residual gravels greatly enhanced the quality of this material making it suitable for chipped stone manufacture. The overwhelming majority of the collected chert originated from the Fort Payne Formation. Minor amounts of St. Louis chert were recovered in the form of river gravels in the local creeks. Chert nodules in excess of thirty pounds were recovered from natural outcrops of the Fort Payne Formation. River gravels were of much smaller size, but many in the 10-15 cm range were recovered.

The raw material survey documented that the area surrounding the Wells Creek Valley contained an abundance of lithic resources and could be characterized as a resource rich area. Most lithic resources in this area occur in Mississippian age formations (predominately Fort Payne). However, around the Wells Creek Crater, earlier formations are exposed and could have been utilized. Hematite also occurs in local formations and was readily available. This mineral was often used by prehistoric groups as a pigment source.

Overview of the Late Archaic

The following provides a general overview of the Late Archaic in the Interior Low Plateau Physiographic Province. Emphasis is placed on groups that were contemporaneous with the Wells Creek phase. This will provide a general descriptive background to allow further discussion in later chapters.

Numerous excavations in the Interior Low Plateau have documented the presence of Ledbetter and Wade material in the area. Diagnostic projectile points/knives (PPks) of this period are of the straight stemmed Ledbetter, Little Bear Creek, and Wade clusters. Other artifacts include large bifacial tools, ground stone tools (pitted manos and bannerstones) and steatite vessels.

Ledbetter

Radiocarbon dates place the Ledbetter phase between 2500 B.C. to 1000 B.C. (Bowen 1979:142). Lithic assemblages from Late Archaic (Ledbetter) sites indicate considerable interassemblage homogeneity (Amick 1984; Bowen 1979). The intensive utilization of Fort Payne chert has been noted for this time period in the Duck River Valley (Prescott 1978). High percentages of thinning and retouch flakes are common at base camp locations. Faulkner and McCollough (1974:224-225) suggest that "this could indicate that primary flaking was often accomplished at the source locality and/or elsewhere on the site away from the main living areas, but the shaping and

finishing of bifacial implements was often done in and around the individual family shelters". Amick (1982) noted similar occurrences at the Topsy site and suggested that much of the earlier stages of reduction were possibly taking place at the raw material source. "This pattern of discretely staged biface manufacture applies regardless of source material distance" (Fogarty et al. 1985:25). Johnson (1981) notes that staged bifacial manufacture is present in the Yellow Creek area. This may reflect an increased development of specialized craft/task groups and logistical organization (Amick 1984), or merely differential reduction technologies associated with the Late Archaic.

Amick (1984) developed a model of Middle and Late Archaic technological organization in the Central Basin area of Tennessee. In this model, Late Archaic technological and settlement organization was characterized as highly logistical and less expediently organized. Late Archaic groups depended less on readily available, but lower quality raw materials and more on higher quality material, such as Fort Payne. This higher quality material would have been obtained from the Highland Rim by logistically organized task groups. More recent analyses of lithic material at the Hayes site in Middle Tennessee (Carr 1991; Juchniewicz 1991) show similar patterns of lithic reduction to those reported by Amick. The same activities were increasingly located at the same sites as an effect of reduced residential mobility during Late Archaic

times. Early stage reduction appears to be taking place away from the living areas and possibly at the raw material source (Amick 1982). This pattern of 'staging' was also seen in the Yellow Creek area of northern Mississippi (Johnson 1981).

Herbert (1986) examined lithic assemblages from the Hayes shelter and proposed a different explanation for raw material variability than Amick's (1984) model. Comparisons of the Hayes shelter and seven other sheltered sites in addition to eight open air sites in the area were made. From these sites, Herbert (1986) determined that the differential utilization of resources was a reflection of the local availability of lithic resources and distance to the Highland Rim.

Wade

Wade cluster PPks and steatite bowls are diagnostic artifacts associated with the Terminal Archaic period. Other lithic artifacts typically found associated with Wade materials include large bifacial hoes manufactured from Dover chert, along with slate or shale artifacts such as gorgets. Bone and antler artifacts include bone awls, antler punches or drifts, and scrapers. Alexander Pinched ceramics have also been recovered from late Wade contexts (Herbert 1985b:155-158).

Extra-local trade is evidenced during the Wade phase by the presence of steatite and exotic raw materials used in PPK production (Prescott 1978). Burial ceremonialism is represented during the Terminal Archaic by the placing of

exotic lithic artifacts such as steatite in graves (Davis 1978). Numerous archaeological investigations in the Middle Tennessee area have identified and defined the Terminal Archaic Wade phase (e.g. Bentz 1986; Faulkner and Graham 1966; Faulkner and McCollough 1973; Morse 1967).

The Wade phase generally dates from 1200 B.C. to 700 B.C.; however, more recent dates of 450 B.C. from the Chapman site (Bentz 1986:65), 625 B.C. from the Oldroy site (Amick and Stoops 1985:545), and 460 B.C. to 680 B.C. from the Robinson shell midden (Morse 1967:143-149, 317-318) have been reported.

Both Wade and Ledbetter materials have been recovered from sites in close proximity to the Wells Creek area and elsewhere along the Cumberland River. In the Barkley Reservoir, Coe and Fisher (1959) reported Ledbetter components on the Ralls and Wallace sites and a Wade component on the Wallace site. Further down the Cumberland River, Jolley (1978) reported extensive exploitation of this area during the Late Archaic period. Ledbetter components were numerous and Wade material was recovered from several sites. Nance (1975) recovered Ledbetter and Wade material from several sites in the Land Between the Lakes area just north of the Wells Creek area.

Riverton

The Riverton Culture was defined by Winters (1969) from excavated sites in the Wabash River Valley, Illinois. Many of these sites were associated with shell middens. Based on a

series of nine radiocarbon dates, Winters (1969:105) suggested that the Riverton Culture lasted from slightly before 1500 B.C. until about 1000 B.C.

Diagnostic artifacts associated with the Riverton Culture are the Merom cluster PPks. Many other lithic artifacts are associated with Riverton assemblages and include; a microtool industry, bifacial knives, drills and other perforating tools, along with a few examples of scrapers. Bone and antler artifacts are numerous and include antler projectile points, antler drifts or punches, antler gouges, bone awls, and needles. Other associated artifacts are pipes, flutes, and red ocher associated with burials (Winters 1969:30-87).

Riverton-like materials have been recovered from several sites in Indiana. Pace and Coffing (1978) reported a Riverton Culture gathering site in Parke County, Indiana. No faunal material was recovered; however, "nuts and traces of oil indicated a highly specialized gathering station, suspected but not previously reported as part of the Riverton settlement pattern" (Pace and Coffing 1978:81). A date of 810 B.C. was obtained for the site. In Bartholomew County, Wolfal et al. (1978) reported a Riverton base camp on a high floodplain terrace of the White River. Faunal remains, nuts, and mussel shell were recovered along with Riverton PPks. Denbrow (1976) reported two rock shelters within the boundaries of the Patoka Reservoir in Dubois County that contained Riverton materials.

Both rockshelters appeared to be utilized as small hunting camps. In addition to these sites, Tomak's (1982) discussion of the distribution of Riverton points reveals their presence throughout southern Indiana. Many of these sites are located on the White and Ohio rivers.

Riverton-like materials are known from many areas of Kentucky. Excavations associated with the Floodwall Project (Collins, ed. 1979) in the Lower Ohio Valley in Jefferson County, Kentucky revealed two sites with Riverton-like materials. A date of 1440 B.C. was obtained from the Spadie site. Groundstone tools similar to those found on Riverton sites were also recovered from both sites. Bone preservation was poor at these sites; therefore, no comparison of these artifacts was attempted. Shell middens that are characteristic of the Wabash sites were not present in the Lower Ohio Valley (Robinson and Smith 1979). Jefferies' (1988, 1990) overview of the Archaic period in Kentucky documented many Late Archaic sites that contain Riverton-like materials. These sites were located in the Green and Salts river valleys, Southeastern Mountains, Northern Bluegrass, Eastern Bluegrass, and Upper Kentucky/Licking management areas along the Ohio and Green rivers in Kentucky.

Vickery (1976) defined the Maple Creek phase based on recovered material from the Maple Creek site. The site was situated on a terrace of the Ohio River near its confluence with Maple Creek. Merom cluster PPks (called Diminutive

Brewerton PPks by Vickery) were recovered from the site along with a microtool industry, and bone and antler tools. A date of 1310 B.C. was obtained for the Maple Creek phase at the site. The site probably served as a base camp during the summer and early fall as inferred from the plant remains (Vickery 1976:148). The Maple Creek phase probably represents an Ohio variant of the Riverton Culture.

Anslinger (1986) has described the Riverton chipped stone industry as an expedient technology geared toward the production of small sized implements. Riverton chipped stone technology was limited by the small size of the available chert resources. This limiting factor played a key role in determining the implements that could be produced from these resources.

What precedes Riverton is still debated. Justice (1987:132) has suggested that Helton, French Lick, or some other Late Archaic phase that used Matanzas forms is responsible for the lithic technology of Riverton. Anslinger (1986:19), however, argues that there is no evidence of a direct ancestor to Riverton. It should be noted that elements of Riverton lithic technology are shared by Matanzas also. For example, at the Koster site, Matanzas forms exhibited thermal alteration (41%) and basal grinding (11% basal, 56% base and notches) (Cook 1976:140-143). These forms also exhibit similar overall morphology. A micro-tool industry and many bone and antler tools are also present.

Wells Creek

The lithic assemblage recovered from Wells Creek context is unusual for this area for the Late to Terminal Archaic periods. In contrast to the large bifacial implements common in Ledbetter and Wade components, the Wells Creek assemblage is dominated by the presence of small sized lithic implements (Figures 5 and 6). Due to the major differences between the assemblages associated with the Wells Creek sites and those of other contemporaneous groups, the Wells Creek sites were designated as a separate phase. Willey and Phillips (1958) define a phase as "an archaeological unit possessing traits sufficiently characteristic to distinguish it from all other units similarly conceived, whether of the same or other cultures or civilizations, spatially limited to the order of magnitude of a locality or a region and chronologically limited to a relatively brief interval of time." The material recovered from the Wells Creek sites meets these criteria. The Wells Creek phase is a Terminal Archaic phase that dated from at least 1260 to 1710 B.C. The main diagnostic artifact is the Merom cluster PPk. Other lithic artifacts associated with the Wells Creek assemblage are a microtool industry, drills, and triangular bifacial forms similar to those at Riverton culture sites. Red ocher, and bone and antler artifacts are present, but due to poor preservation, the latter are few in number. One noticeable aspect of the Wells Creek phase tools is that they are predominantly of small

Figure 5. Merom Cluster Projectile Points/Knives.
Lockarts Chapel site (top), Pitts site (middle and bottom).

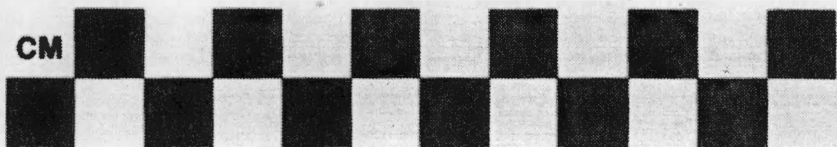
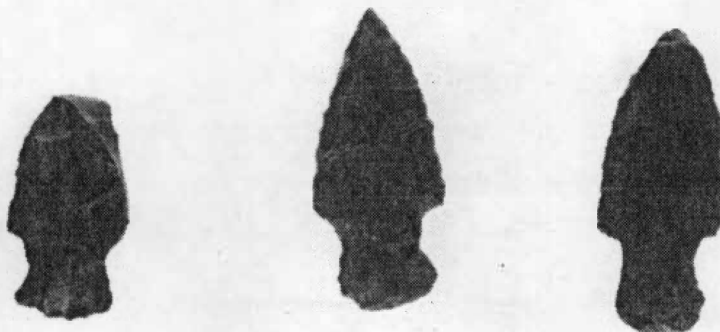
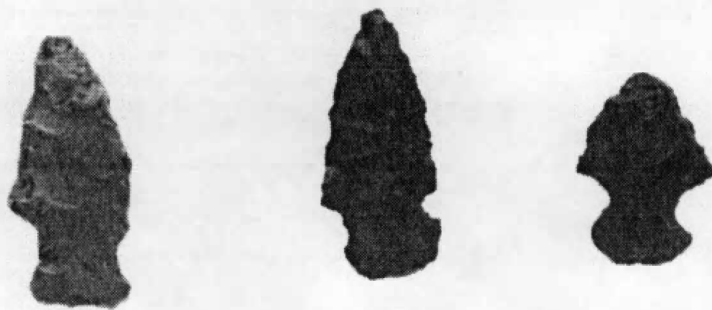
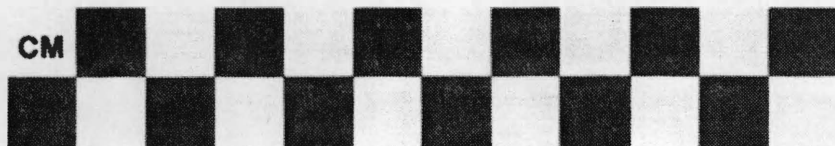


Figure 6. Other Lithic Artifacts. Bifaces (top),
drills (middle), and microtools (bottom).



size, and often quite unrefined. Local chert resources were the predominate choice for chipped stone tool production. Thermal alteration was used, especially for the manufacture of PPks.

Riverton chipped stone technology was limited by the small size of the available resources. This raw material constraint limited the variability possible for chipped stone tool manufacture (Winters 1969:23-24). The Riverton and Wells Creek lithic assemblages seem to represent assemblages that were based on the utilization of small sized gravels. It is interesting to note that chert resources available to the Wells Creek knappers were of high quality and large size, yet the lithic assemblage is geared towards the production of small sized implements. In contrast to this, other Late to Terminal Archaic groups (i.e. Ledbetter and Wade) utilized the same resources to manufacture large bifacial implements.

Lithic resources in the Wells Creek area are of large size, high quality, and are easily obtainable. Given this fact, one would not expect the development of an expedient technology based on the production of small sized implements. For these reasons, I suggested that the Wells Creek phase represents an intrusive culture (Bradbury 1992c). This interpretation was based on the marked similarity to Riverton and Riverton-like assemblages, the dissimilarity to Late to Terminal Archaic assemblages found in other areas of Middle Tennessee, and the reduction end of the lithic system. What

predates and post-dates Wells Creek in this area is unknown at this time.

Summary

Excavation of the Pitts and Lockarts Chapel sites were discussed. Radiocarbon dates place occupation of these sites between 1260 B.C. and 1710 B.C.. A raw material survey in the area indicated that the area can be characterized as raw material rich.

The Wells Creek lithic assemblage has been characterized as an expedient industry geared toward the manufacture of small sized implements. This pattern of lithic reduction is very different than that of other contemporary groups (i.e. Ledbetter and Wade) in the area. It has also been suggested that Wells Creek and Riverton share much in the way of material culture. Radiocarbon dates indicate that these groups were contemporary. The remainder of this thesis examines why the Wells Creek assemblage is so different from other groups in the area and so similar to the Riverton Culture.

Chapter III

Theoretical Perspectives

The development of a solid theoretical base is an important first step in any line of scientific inquiry. "Theory will designate the system of units (classes) and relationships (laws or principles) between units that provides the basis for explanation of phenomena" (Dunnell 1971:34). Thus the theoretical base presented in this chapter is used to provide a framework for development of appropriate methods for answering questions posed of the present study. One of the main goals of this thesis concerns the application of evolutionary theory for explanation in lithic analysis. To provide a solid background for the completion of this goal, it will be necessary to outline the current views pertaining to evolutionary theory as applied to biological organisms. Next, a discussion of how evolutionary theory can be applied to cultural phenomena will be presented. Building on this theoretical base, I will then extend this discussion to the analysis of lithic artifacts. Operational definitions of the concepts discussed will be presented as they are to be used throughout the remainder of this thesis.

Evolution and Biological Organisms

The modern synthetic theory of evolution "regards the diversity and harmonious adaptation of the organic world as the result of a steady production of variation and of the selective effects of the environment" (Mayr 1970:1).

Evolutionary explanation can take two forms; historical and causal (Grant 1991:15). The historical, or reconstruction, explanation is merely a description of what changes have taken place. Causal explanation examines these changes and seeks to provide explanations of why these changes occurred when and where they did.

Evolution is perceived as a two stage phenomena, 1) the production of variation and 2) selection from this variation through the process of natural selection. Two important factors in evolutionary theory are: 1) the target of selection is at the individual level and 2) the environment is variable in space and time, therefore there can be no best genotype (Grant 1991:97; Mayr 1970:129).

Biologists examine evolutionary phenomena at three levels; microevolution, macroevolution, and speciation. Microevolution is the study of the mechanism of evolution and evolutionary changes within a single population (Grant 1991:15; Minkoff 1984:112; Riddiford and Penny 1984:4;). Macroevolution is the study of the evolution of major groups and evolutionary processes beyond the species level (Grant 1991:15,36; Mayr 1970:425; Riddiford and Penny 1984:4). Speciation is the study of the evolution of races and species. The understanding of microevolution and speciation are essential for the understanding of macroevolutionary processes.

There are four postulates of Darwinian evolution: 1) the

world is not static, but is continually evolving; 2) evolution is gradual and continuous; 3) common descent; and 4) natural selection (Mayr 1978:48). Modern evolutionary biology has expanded on the principles set forth by Darwin by examining evolution at genotypic and phenotypic levels. The synthetic evolutionary theory:

can be characterized as the population genetical approach to microevolution and its extensions to other evolutionary levels and to other biological fields. In its core it represents a combination of the population geneticist's approach, which provides theoretical precision, with the materialist's approach to living populations and species, which brings the former in touch with reality. In its entirety it encompasses a much larger range of fields. Thus considered, it is not a special theory, which can be verified or falsified, but a general theory, a paradigm, which can absorb the changes and modifications within wide limits, and has done so over the years since its inception (Grant 1991:17).

Mayr (1978:52) has stated that "the new synthesis is characterized by the complete rejection of the inheritance of acquired characteristics, and emphasis on the gradualness of evolution, the realization that evolutionary phenomena are population phenomena and a reaffirmation of the overwhelming importance of natural selection." Through the study of evolutionary processes in biological organisms one can examine: 1) gradual change through time; 2) variability in the expression of various traits; and 3) the role that selection played. Each of these are important for understanding evolutionary processes. These changes are generated through a series of intermediates that are found within the normal

variation of a population (Riddiford and Penny 1984:25). Although we should be able to examine these intermediates, often times the fossil record is incomplete and we only view a small part of the actual record. Although rapid change is possible in some cases, the majority of evolutionary change occurs at a slow rate.

There are four primary evolutionary forces: mutation, gene flow, natural selection, and genetic drift (Grant 1991:39). These four forces are responsible for producing variation and subsequent selection from this variation.

Variation in populations is produced by the forces of mutation and gene flow. Mutations are any sudden hereditary changes that result from rapid structural and functional alteration in the genetic material (Grant 1991:42; Minkoff 1984:115). Some mutations are adaptively superior while others are not. In either case, it is the minor mutations that are the most important source of variation. This is because "each minor mutant produces only slight phenotypic effect...a slightly superior minor mutant allele can therefore be fitted into the pre-existing genotype without bringing about any drastic disharmonies" (Grant 1991:48-49).

Gene flow is movement of genetic material within a single population and/or between several different populations (Grant 1991:53; Mayr 1970:417). This occurs through migration and the subsequent interbreeding of the native and the migrant populations. The forces of mutation and gene flow are

important in evolution because they introduce new raw material into the existing gene pool that is subsequently acted on by natural selection (Minkoff 1984:112).

The forces of genetic drift and natural selection sort out the variation that has been produced. Genetic drift can be defined as genetic changes that occur because of random phenomena (Mayr 1970:417; Minkoff 1984:147-148). These changes are not brought about by selection. Natural selection plays a larger role in evolution than genetic drift.

Natural selection is the differential survival of the various genotypes. Natural selection works with the variation that is present by processes that are independent of selection itself (Godfrey 1985). Individuals that are less fit are selected against while more fit individuals continue to survive. As Grant (1991:98) has noted:

the individual organism, particularly the more advanced forms of life, is a complex machine composed of many organs with different functional roles. The diverse organs and functions must be coordinated and harmonized. A change in one character may well be advantageous in relation to its own particular function, but have disadvantageous side effects on the other functions of the organism.

This is also true of many aspects of material culture. For example, a minor change in a particular projectile point form may increase the effectiveness of the projectile as a whole. However, major changes in projectile point form may not produce the desired results if the rest of the projectile (i.e. shaft, fletching, method of delivery) are made less effective. For example, an increase in projectile point size

could make the point more effective since it would cause greater damage to the animal when it penetrated. It would be disadvantageous, however, if the increased size caused the projectile to be poorly balanced. In this case the change would be too great and, as a whole, the projectile would be less effective.

It is important to keep in mind that selection does not act on specific characteristics of an organism, but on the individual as a whole. Therefore, there are occasions where maladaptive traits are passed on because, as a whole, the individual is well adapted. Selection acts on the individual within a population. Those individuals that are better adapted have a greater chance of survival and of producing offspring. This, in turn, affects the population as a whole.

Natural selection is best viewed as a statistical phenomena; this means that the better genotype has a better chance of surviving (Mayr 1970:107). Because of this, there are instances where a less fit individual survives while a more fit individual does not. Because natural selection is a statistical phenomena, "it is not deterministic; its effects are not rigorously predictable, particularly in a changeable environment" (Mayr 1970:108). Progress is a prediction, but not a necessary consequence, of natural selection. Because of this, regression (in the biological sense) is possible.

Essentialism and Materialism

Two different ways of viewing reality are common in contemporary anthropological thought: the essentialist and materialist views. These views have their origins in other disciplines, but will be discussed here as they apply to archaeological theory. The essentialist and materialist views can be differentiated by the way in which cultural phenomena are viewed. An understanding of these two views is necessary if we are to incorporate the principles of evolutionary biology to cultural phenomena.

The Essentialist View

The essentialist view, also termed typological thinking (Mayr 1970:4), is common in both traditional archaeology and cultural evolution. Dunnell (1986:153) has defined the essentialist view as:

The phenomenological world is taken to be constituted by a finite set of discrete entities, between which only variation is of explanatory significance. Internal variation is regarded as 'noise' arising from imperfect expression in a contingency bound world. This view implies a methodology directed toward distinguishing difference, the variation between kinds from noise.

This approach sees types as entities that have meaning in the real world. Stages represent divisions with definite beginnings and endings. As noted by Grant (1991:30) for biological studies; "typological thinking is an obstacle to understanding evolution, which requires population thinking instead, since evolution is a change in the genetic composition of populations." In the essentialist view,

variation is of little importance. Groups of phenomena are defined, and the differences between these groups are the main thrust of investigation.

The Materialist View

The materialist view, also termed population thinking, has gained much support in recent years from those using Darwinian theory in conjunction with anthropological data. Dunnell (1986:153) has defined the materialist view as:

Kinds are illusory, transitory configurations; it is the observed variation that is of explanatory significance. Noise is epistemological, not ontological, and limited to measurement error.

Types are viewed as entities that are produced by the researcher and are therefore not 'real' except in the mind of the observer. Hoffman (1985), for example, demonstrated that many of the so called different projectile point "types" associated with the Late Archaic are, in fact, only one "type". The differences used to distinguish the "types" were due only to differential use and maintenance of the original forms. Typologies are seen as atheoretical (in evolutionary theory) because they obscure the variation that is present. The same can be said about stage divisions because they too are a form of typology. In the materialist view, one examines change at the population level because "evolutionary phenomena are population phenomena" (Mayr 1978:52). One needs to understand the differences that are observable both within and between populations.

The difference between these two views is that

essentialists examine only difference, the materialist examines both difference and change (O'Brien and Holland 1990:38). Since change is both gradual and continuous, kinds are always in a state of becoming (Dunnell 1992:213). Because of this, types are only an illusion created by the observer. It is the variation that is important. One must examine both the variation that is evident and how this variation is acted on by selection to produce changes through time. For this reason, Dunnell (1989:45) has argued "the materialistic view of variation mandates the abandonment of modal descriptions that suppress variation, including such archaeological favorites as phases, cultures, and periods." I would agree with Dunnell on this point. However, I also recognize that these "archaeological favorites" can be useful for general description and communication purposes. As Boyd (1986:177) has noted, "some means of categorizing and ordering data for purposes of discussion is necessary", as long as one recognizes that the names given are merely labels for means of identification and for the purpose of discussion (Dunnell 1971:58-59). For the most part, traditional types serve a time markers only and should not be used as a substitute for explanation of the data. If traditional types are to be used in any form of analysis, some means of evaluating the validity of these types is necessary before proceeding further with the analysis.

Application of Evolutionary Theory to Cultural Phenomena

Evolutionary biology provides a powerful set of principles for the understanding and explanation of change in biological organisms. The question for the present study is, can these principles be extended to the explanation of cultural data and can elements of biological evolution be applied to cultural phenomena? In Darwinian evolution, "variation was evident generational and included, as we term it now, the genotype. Variation as seen in the archaeological record does not necessarily pass through the phenotype-genotype-phenotype process" (O'Brien and Holland 1990:35). How then can we apply the principles of evolutionary theory to cultural phenomena?

Several authors (e.g. Dunnell 1978b, 1980, 1989; Leonard and Jones 1987; O'Brien and Holland 1990) have argued that one can not transfer the principles of biological evolution to cultural phenomena in a wholesale fashion. Much of biological evolution involves discussion at the genotypic and phenotypic levels. In these terms, how can we examine the archaeological record from an evolutionary perspective? In evolutionary archaeology "we accept the premise that things viewed in the archaeological record were part of the past phenotypes. Or, as one might argue, the behaviors that created the objects were parts of human phenotypes" (O'Brien and Holland 1990:35). Artifacts represent "an expression of human behavioral variability and thus should be regarded as one class of

cultural traits and hence a component of the human phenotype" (Leonard and Jones 1987:213). By viewing artifacts or cultural phenomena in this way, one can examine the processes that create variability, and how selection then acts on this variability. The goals are two-fold: 1) describe the change that has taken place; and 2) provide an explanation of why this change occurred when and where it did. This is accomplished by examining the variability that is present and determining what selection is acting on.

On a broader scale, Leonard and Jones (1987) have argued for a more inclusive evolutionary theory to explain both biological and cultural evolution. Marks and Staski (1988:148) also note that such a theory could come from either biology or from anthropology. In fact, it could be argued that the two disciplines would benefit by working together to build such a theory.

Both Leonard and Jones and Dunnell have outlined the requirements of a scientific evolutionary paradigm. According to them (Dunnell 1980:38; Leonard and Jones 1987:212) the phenomena being studied must: 1) exhibit empirical variability; 2) have a mechanism for the transformation of some of that variability; and 3) demonstrate the operation of selective factors that can account for the differential persistence of variability. Above all else, we must examine variation and the change in frequencies over time. An explanation for why certain phenomena were selected over

others is necessary. Our goals need to go beyond that of merely describing change. Explanations of what caused the change or why the observed change occurred need to be examined.

Operational Definitions

The major principles of evolution have been defined as they relate to biological organisms. It is now appropriate to examine these principles as they relate to cultural phenomena. The definitions below represent how the concepts are viewed in this thesis.

Evolution

Evolutionary theory provides the framework for explaining change as differential persistence of variability (Dunnell 1980:38). Evolution is defined as "change through time in the frequencies of empirical variables (material variables in archaeology) scaled at the appropriate levels of inclusiveness (i.e. selected at a scale that allows one to monitor changes in the variables of interest; in most applications neither "cultures" nor "societies" but specific components of those or similar constructs are likely units of investigation" (Leonard and Jones 1987:210). Or, stated more simply, evolution is a change in attribute frequency over time. Importantly, change is seen as a selective rather than a transformational process (Dunnell 1980:62,84; O'Brien and Holland 1990:41).

Variation

Variation is defined as differential expression of a trait or characteristic. "It is variation across characteristics within populations that constitutes the primary focus of selection and thus evolutionary change" (Leonard and Jones 1987:203). It is important to remember that variation is in no way causal. In cultural beings, such as humans, rationality can introduce variation into the cultural system. Variation can also be introduced in the form of teaching or learning error, innovation, or invention. The distinction between invention and innovation is that an invention is a discovery and an innovation is the process by which this new idea is put into use (Knecht 1991:20). In evolutionary terms, invention produces variation and innovation is the selection from this variation. Invention and innovation are analogous to reproduction and mutation in biological evolution (Cavalli-Sforza and Feldman 1981:10; Dunnell 1978b:197). The diffusion of ideas is analogous to genetic flow. Thus the primary forces that produce variation can be identified in cultural phenomena and are analogous to those in biological evolution.

Selection

Selection is defined as differential perpetuation of a trait or characteristic. Selection acts upon the variation that is present and can be seen as a "weeding out process that leads to differential reproduction of transmissible traits in

a succeeding population" (O'Brien and Holland 1992:37). Selection may be in the form of natural selection as seen from a biological point of view or from a cultural perspective. Traits may also be selected for or against because of cultural preferences. This form of selection has been termed cultural selection (Cavalli-Sforza and Feldman 1981; Durham 1992; Rindos 1984). It is important to note that "man may indeed select, but he can not direct the variation from which he must select" (Rindos 1984:4). Nor can man know the outcome of this selection. Selection operates on variation, and statistically speaking, those variants which exhibit a greater adaptive advantage will survive (Mayr 1970:107). Less fit individuals, may on occasion reproduce more frequently than more fit individuals. However, over the period of many generations, the more fit individuals tend to survive in larger numbers than those that are less fit.

Function

One of the key concepts in evolutionary studies is that of function since "the role of evolutionary theory is to organize the functional meaning thus created into a historical account that explains why those functions occur where and when they do and in what forms" (Dunnell 1992:217). In a series of papers, Dunnell (1978a, 1978b) introduced the concept of function for evolutionary studies in archaeology. Function, as defined by Dunnell (1978a:51), is "the relationship that obtains between an object at whatever scale conceived and its

environment both artificial and natural". The subject of analysis is variability (Dunnell 1978a:52). Attributes that can be defined as functional directly affect Darwinian fitness (Dunnell 1978b:199). In this perspective, function is not the same as use.

Dunnell (1978a) has criticized the use of micro-wear analysis in functional studies because, according to him, they are reconstructionist and based on analogy. In Dunnell's view, functional analysis should be conducted by forming functional classes based on attributes determined from macroscopic criteria. While I agree that it is imperative that functional classes are formed based on attributes, I disagree with the methods that Dunnell uses to define functional classes and his criticisms of microwear analysis. These are outlined below.

If use-wear is assessed purely by macroscopic assessment, there are very clear dangers involved. As has been noted by several micro-wear analysts (e.g. Odell 1977:122, 1982:19,28; Tringham et al. 1974:189), damage produced by using an implement on a variety of soft material (i.e. meat, leather, plants) is rarely visible under magnifications of less than 20X. Even at this magnification, damage can be difficult to assess. If one is using only macroscopic criteria, then any implement used on soft material will be mistakenly identified as not used. This, in effect, limits the variability that can be examined. In addition, determining use-wear on

artifacts that have been intentionally retouched can also be problematic without the aid of higher magnification (Odell 1980:96).

Post-depositional damage (e.g. trampling, excavation wear) can mimic use-wear. These are often difficult or impossible to determine without the aid of magnification. Using macroscopic criteria only, damage produced by non-cultural means can be confused with damage produced by cultural means. In essence, if these are interpreted as use, one can not be sure if functional classes that are formed using macroscopic criteria are actually documenting change in use, technology, or the result of non-cultural phenomena. In an extreme example, one may be documenting changes in wear produced by trampling. Such a study would not be useful for understanding cultural evolution.

Dunnell also notes that use-wear analysis is too time consuming to be useful for the examination of large assemblages. If our goal is the implementation of a more scientific discipline, and I would strongly agree that it is, then time should not be our most important consideration. The most important consideration is that of ordering data in such a manner as to produce meaningful classes. These classes, in turn, provide the basis for explanation of the data. It should also be noted that using a low-power approach, an artifact can be assessed, on average, in five minutes (Odell and Odell-Vereecken 1980:117). A large number of artifacts

can be examined in this manner and the data used in a variety of studies.

Also, for archaeologists, analogy is not necessarily an inappropriate endeavor. For example, in studying the effects of gravitational forces on large bodies, physicists first examined gravitational effects on objects that could be directly observed. Knowledge gained was then applied to more distant objects that could not be directly observed. The last two planets to be discovered in our solar system were known to exist long before they were actually discovered due to gravitational effects observed on the other outer planets. By analogy, physicists apply what they have learned from these observations to far more distant objects. In this case analogy is appropriate because it is based on physical properties that are being acted upon. The same is true for micro-wear studies. Physical properties of the implement are altered due to use. Whether an implement was used by a Neanderthal, Homo erectus, a chimpanzee or myself is irrelevant. If the implement is used for the same task and in a very similar manner, then the implement will be altered in the same way. While the methods of micro-wear analysis are not yet exact, they still are the best means available for assessing the damage produced by use.

Dunnell's (1978a:66) assertion that microwear studies are merely "reconstructive approaches" that can not be adequately tested is also unfounded. In Dunnell's view, one

assigns artifacts to functional classes based on their attributes of wear that can be assessed macroscopically and no further interpretation of these functional classes is necessary. Odell (1982:27) has argued that:

to terminate one's analyses at a low level of investigation when the data suggest much more is to avoid one of our primary functions as archaeologists, which is to interpret archaeological data. Besides, who cares if sites A and B share 13 wear types if we have no idea what those wear types represent? I can not imagine a more sterile enterprise than delineating taxa solely for their own sake. Without some degree of interpretation, there is no way that use-related variables can ever be compared with other higher-order abstractions, such as environment, social milieu, cultural adaptation, etc. The reason for this is that function relates to people, whereas wear, as employed by Dunnell, does not. Since people adapt to natural environmental and social situations, one simply cannot introduce the human element into the equation without recognizing at some point, that, for example, wear pattern q represents chopping and, yes we do have axes on the site.

I do not agree that it is necessary to apply functionally loaded names, such as axe, to denote specific activities. However, the combining of specific attributes that relate to how the implement was used and on what material is important. For example, if we were to examine small, feather fractures, on a straight edge, that occurred in an alternate pattern, on both faces of an implement, then we could interpret the implement as being used to cut soft resistance material (i.e. functional class cutting soft). No further naming of the specific wear pattern is necessary. I do agree with the remainder of Odell's argument. Some interpretation of the functional classes is important. Statements such as 10

functional classes were defined for time A and 14 functional classes for time B provides a general description. This is the first step in evolutionary studies. However, the main goal of evolutionary studies is that of explanation. We need to go beyond general descriptive statements to explain why we have 10 functional classes at time A and 14 at time B. Are these changes due to changing functions? changing use of the site? changing technology? culture change? or the result of selection? How do these functional classes articulate with other aspects of the natural and/or cultural environment and effect fitness? These are the kinds of questions that need to be addressed through evolutionary theory. Explanations can then be derived by linking this theory to observable phenomena. What is of greatest importance in evolutionary studies (cultural or biological) is to understand what is changing and the causal factors that underlie this change.

The other problem that occurs when one defines functional classes solely on the basis of attributes without interpretation of what the combination of these attributes represent is that some of the functional classes formed in such a manner may be indicative of the same prehistoric function. For example, an implement with a straight edge, and small, scaler scars that occur on two faces in an alternating pattern is indicative of cutting soft resistance material. An implement with a straight edge, and small, feather scars that occur on two faces in an alternating pattern is also

indicative of cutting soft resistance material. Both of these implements represent the same functional class, cutting soft. However, using Dunnell's approach, these two implements would represent two separate functional classes.

Evolutionary Theory and Lithic Analysis

The concepts of evolutionary theory as they relate to cultural phenomena have been presented. More specific discussion of how these concepts relate to lithic artifact analysis is now appropriate. Artifact morphology can be viewed as the outward expression (phenotype) of a technological response (genotypic) to specific functional requirements. Variability in morphology will occur because of individual skills, raw material constraints, errors in teaching or learning, and in invention and innovation. Selection will then act on this variability and thus, over a period of time, specific implements and/or attributes will become associated with specific functions.

The examination of variability within the lithic component is an important aspect of lithic artifact analysis. Variability can be demonstrated with respect to the differential use of raw materials, reduction methods, technological and morphological attributes of modified lithic materials, and specific functions of the artifacts. Attributes such as raw material, technology, and artifact form are primarily functional in the evolutionary sense because these attributes are related to the implements efficiency for

food procurement and processing, its use-life, and maintenance (Boyd 1986:178).

Selection can be demonstrated with lithic artifacts. For example, selection of specific raw materials, different reduction techniques for these raw materials, and specific morphological/technological forms for specific functional requirements. Some of these may be related to choices of the individual. However, when examined over a large temporal depth, the continued replicative success of these choices indicates a selective advantage. Thus, selection, in the evolutionary sense, can be demonstrated.

For this study, the concept of function in lithic analysis is viewed in three dimensions: 1) how the implement was actually used; 2) how this articulates with the environment (both cultural and natural); and 3) how this affected fitness. For the sake of clarity in the remainder of this thesis, function will refer to the latter two dimensions and use or use-wear will refer to the first dimension. One can examine microwear traces on a lithic artifact and determine use and then determine how this activity related to other aspects of the society and affected fitness. Once we have determined both the use and function of an implement, we can relate this to technological and morphological factors. In other words, are there specific technological or morphological requirements associated with a specific function.

To examine function within the Wells Creek lithic assemblage, functional classes were formed using criteria established from low power micro-wear analysis (e.g. Odell 1977; Odell and Odell-Vereecken 1980; Tringham et al. 1974). By using a low-power approach, attributes (e.g. scarring, edge angle, location of wear, etc.) that define a specific use (e.g. cutting, scraping, boring, etc.) can be examined. These attributes are recorded and then used to define the functional classes. These functional classes can then be compared to technological and morphological attributes to determine if specific technological or morphological attributes were being selected for specific tasks. Changes in how these attributes articulate can be examined over time. After use has been assessed, one can then examine how implements articulate with other aspects of the society and how this would affect fitness.

Technological considerations are important in evolutionary studies. This is because technology provides the means by which humans can interact with and manipulate their environment. Technology can be defined as "an integrated system of techniques and the knowledge necessary to perform the techniques" (Knecht 1991:19). Technology is somewhat historically determined because new technologies, or improvements on an established technology, build on what has previously been accomplished. As the intermediate between humans and their environment, technology is directly affected

by evolutionary processes. An increase in technological efficiency will increase the fitness of the user whereas a decrease in technological efficiency will decrease the fitness of the user. This is most clearly seen in technologies that are associated with food procurement. For example, an improvement in the efficiency of a projectile will increase the ability of a hunter to procure game animals. During periods when game is scarce, this increased efficiency will be most beneficial. The study of technology "allows for distinction of group identity by delineation of a characteristic way of doing things" (Knecht 1991:24-25). Technology can be studied by examining what specific tools were used for, differential use of raw materials, particular sources used for raw material procurement, and the methods used to reduce these raw materials.

O'Brien and Holland (1990:34) have noted, that "animals carry historical baggage with them; in essence they are products of their histories." I would take this one step further and argue that cultures are also a product of their histories. The manufacture of material items is generally passed down through teaching from one generation to the next by what Cavalli-Sforza and Feldman (1981) term vertical transmission. Through errors in teaching or learning, innovation and invention, variation is produced. This variation is then acted on by environmental factors (natural and/or cultural) specific to the group in question. Because

of this, variation and selection are group specific. In essence, each group has its own unique evolutionary history. Through lithic analysis, one can examine the variation present in the lithic component and how this in turn affected selection for the particular group(s) under consideration. Once this has been understood, we can examine how this changed through time and using evolutionary theory, offer explanations for why the change occurred.

Chapter IV

Ethnic Markers and the Archaeological Record

The present study is concerned with cultural phenomena. An important aspect of this is an examination of ethnic markers and information exchange and what role these play in evolutionary processes. This is important because "many of the usual interpretations of material culture patterning are inadequate because they do not take into account the ability of groups and individuals to use artifacts as a medium for the communication of information about, for example, one's membership of identity groups and status groups" (Hodder 1977:242). In addition, when dealing with cultural organisms, traits must undergo cultural selection before they can be affected by natural selection (Cavalli-Sforza and Feldman 1981:66). The following will examine the use of material culture for information exchange and its application to lithic artifacts. This discussion draws much from ethnographic data. However, the main focus is on what relevance this has for the present study, and for archaeological data in general.

The Style/Function Dichotomy

Dunnell's (1978b) style/function article defined the concept of style and function as used in evolutionary archaeology. In this paper, Dunnell (1978b) argues that traits should be separated into those that are functional and those that are stylistic. O'Brien and Holland (1990) have argued that non-functional should be used in place of style

due to connotations associated with this term. Functional traits are those that are directly affected by selection. Stylistic (or non-functional) traits are those that are neutral and are not acted on by selection. In this sense, style is analogous to genetic drift in biological organisms. When referred to in this thesis, style is defined as "formal variation in material culture that transmits information about personal and social identity" (Wiessner 1983:256). In the present study, traits are not separated into Dunnell's style/function categories due to problems with this line of inquiry and the problems in determining style in lithic artifacts. These are outlined below.

One of the main problems with the style/function dichotomy is its essentialist nature. Traits are separated into those that are stylistic and those that are functional. In essence, this is a typology that allows for the examination of two types of traits; functional and stylistic. The possibility that some traits may exhibit varying degrees of functional or stylistic characteristics is not considered and technological traits are ignored altogether. These problems are especially relevant to lithic implements as these implements must meet specific technological and functional requirements. Only minor deviations that could represent stylistic traits would be possible. It is also recognized that style may not be related to specific elements of an implement, but to the implement as a whole (Knecht 1991:15).

In other artifact

classes, such as ceramics, the existence of stylistic elements that are completely unrelated to functional elements is possible. For example, surface treatment is usually unrelated to vessel function. One can choose to paint many different designs on vessels with the same function. In this case, the choice of surface treatment is separate from, and has no effect on, vessel function. Such is not the case with lithic artifacts. Some aspects of both style and function are contained in the same attributes. In her study of San projectile points, Wiessner (1983:273) notes that:

style was contained in a wide range of attributes on projectile points including those of shape as well as others that might have important functional properties, such as size and tip thickness. The choice of attributes in which to invest style appeared to be the result of historical events, rather than following coherent principles. To further complicate matters, different attributes on projectile points simultaneously carried different kinds of social information.

In examining lithic material from an archaeological context, it would be difficult, if not impossible, to determine which morphological attributes were the result of differences in use requirements, stylistic differences, or a combination of the two. Wiessner was able to discuss directly with her !Kung informants how they actually perceived the artifacts they made and used. An archaeologist can not confer with the people that are being studied and is limited to those attributes that they, biased by their own culture, can identify solely as stylistic traits. It is also realized "that almost all

behavior patterns are influenced to some extent by almost all aspects of the total cultural system, so that stylistic preference probably exists in almost all parts of the archaeological record, although few aspects are likely to be determined exclusively by style" (Close 1978:223).

According to Dunnell (1978b:199) stylistic traits are those "that do not have detectable selective values." However, people use style to identify themselves as individuals or as members of a particular group. In this respect, style is a means of information exchange "thus it is subject to selection and may confer an adaptive advantage on its users" (Wiessner 1983:256). Rindos has noted (1984:47) that

evolutionary processes must be context sensitive (evolution occurs within a specific environment and other individuals are part of ego's environment), it is expected that traits conditioning or arising from, the interaction of individuals will be subject to natural selection, and therefore that such traits will evolve.

The manufacture of material items is conditioned by several elements: 1) individual ability; 2) raw material constraints; 3) prior knowledge of the manufacturing process; and 4) technological and/or functional requirements of the item. It is the selection of a combination of these elements that contributes to the style of a particular item (Knecht 1991:15). The above elements represent a series of selective processes that, over a period of time, become incorporated into the manufacturing process. Therefore, style is conditioned by selective pressures and represents an

evolutionary process that is group specific.

It is also possible, when one is dealing with the archaeological record, that some of the random variations observed over time are due to innovations that gain popularity for a period of time, then due to selection (in the evolutionary sense) against these innovations they disappear from the archaeological record. This process may also reoccur at a later time. Separating these from actual stylistic traits is not possible.

As has been demonstrated, conforming to the group norm can be important. Cavalli-Sforza and Feldman (1981:63) note "there is a clear danger involved in non-conforming, in that individuals who do not accept a significant proportion of these routines may be discriminated against and therefore have a lower chance of finding mates and reproducing." It is important to realize, however, that although there may be a tendency for individuals to conform to group norms, we should not limit ourselves to defining such elements as a central tendency "since neither boundaries nor central tendencies exist apart from the effects of the observer" (Dunnell 1988:16 cited in O'Brien and Holland 1990:37). Such essentialist thinking suppresses much of the variation that is present. It is also impossible to determine whether conformity, as seen by the researcher, is actually due to prehistoric peoples conforming to "group norms", or if there are technological/and or functional factors that are influencing this "conformity".

Such questions fall outside the realm of falsifiable hypotheses and are therefore atheoretical in evolutionary studies.

It is also realized that stylistic traits are governed by cultural preferences. We have no way of testing whether the traits that we define as stylistic are actually stylistic. Even more complicated are those morphological attributes that we define as use related. Defined as such, we have no way of knowing if there were stylistic reasons for these "functional" traits.

Ethnic Markers and Information Exchange

Wobst (1977) examined stylistic behavior as a means of information exchange. Information exchange was defined as "those communication events in which a message is emitted or in which a message is received" (Wobst 1977:321). Stylistic messages often include information relating to identification, ownership, or authorship of the person in possession of the object. The possession of a certain object, or stylistic decoration on the object, can convey information to others. As Wobst (1977:327) notes; "stylistic messages are there for everyone to see...it helps other members of the group to evaluate how closely a given individual is subscribing to the behavioral norms of that group". Stylistic messages may also be important sources of information for people of other groups. "Where a number of different socio-economic groups compete for niche-space, stylistic messages furnish predictors

for the behavior that may reasonably be expected from individuals of the different groups. Style helps to mark, maintain, and further the differences between these groups at little cost" (Wobst 1977:328). Wiessner (1983) also observed this in her !Kung study.

In many cases, certain attributes of artifacts can be used to identify group affiliation. Wiessner's (1983) study of style in San arrow points demonstrates this case. For the !Kung groups, Wiessner (1983:266) found no regionally specific stylistic features in arrow points at the band level. However, certain stylistic features could be observed at the language group level (Wiessner 1983:271). The !Kung could identify arrows that were made by non-!Kung groups.

For the San, the emblematic style carries a clear message to members of a linguistic group to whether arrows come from their own group or a foreign one. In the former case it signals that the maker also holds similar values. In the latter case, the stylistic difference may either signal another set of values and practices, if the two groups are known to each other, or if not, that, its maker is foreign and his behavior is unpredictable (Wiessner 1983:269).

In either case, stylistic elements are a form of information exchange.

Other studies have examined arrows as a means of information exchange. Sinopoli (1991) examined an ethnographic collection of arrows from the Great Basin of the Western U.S. from the perspective of information exchange. From this study it was determined that the higher the energy investment to produce the item: the greater the chance of

style (Sinopoli 1991:64). Durability and use life of the item also played a significant role in determining whether the item would contain stylistic messages. Another important consideration was that "communication in the stylistic mode is expected to be most important in defining group boundaries between groups that are most likely to encounter and be able to decode such messages" (Sinopoli 1991:73). Groups that rarely encounter others are unlikely to invest time in the development of stylistic aspects of material culture. As was previously stated by Wobst (1977), stylistic messages were most common on the more visible traits of material culture. This held true for Sinopoli's study also, the more highly visible parts of the arrows such as the shaft and fletching contained the most stylistic variation (Sinopoli 1991:66). The arrow points were determined to be most important in individual identification because they would only be seen at times of close contact (Sinopoli 1991:66).

Greaves (1982) examined projectile points from several late prehistoric sites in the northwest Plains to determine if ethnicity could be a source of metric variation in stone arrow points. She (1982:10) notes that the projectile point is "numerous, has a large geographical distribution, and is utilized by several groups occupying the same ecological niche, the projectile point should display ethnically-affiliated variability." For the sample of arrow points in her study, body length was determined to be the most

significant attribute for explaining variation between groups measured (Greaves 1982:97). Other important attributes were those associated with the haft area of the point (Greaves 1982:58). On the basis of her analysis, Greaves was able to determine, with a high degree of confidence, ethnic affiliation of the group responsible for the points. However, it must be noted that ethnic affiliation was determined from archaeological evidence only. In essence, Greaves merely confirmed archaeological inferences by using the archaeological record.

Unfortunately for the archaeologist, the artifacts that are most likely to have contained stylistic messages do not survive in the archaeological record. Mediums of information exchange are greatest for items that have high visibility and are likely to be seen by others (Sinopoli 1991; Wiessner 1983; Wobst 1977). Other important variables are manufacturing time and use-life of the object (Wiessner 1983:260). It is not surprising that items of clothing and body ornamentation are the most common artifacts to contain stylistic messages.

Ethnic Markers and the Wells Creek Assemblage

The above discussion of ethnic markers and information exchange dealt mostly with ethnographic data. What implications does this have for the study of archaeological material, and more precisely, the present study? Can, in fact, the information obtained from ethnographic data be applied to the Wells Creek assemblage? Unfortunately, it is

a difficult task at best. As noted by both Wobst (1977) and Sinopoli (1991), the more visible the object, the more likely it is to carry social information. Other important considerations are the actual use-life of the object and energy expenditure in manufacture (Sinopoli 1991; Wiessner 1983). The material remains of the Wells Creek people is predominately of small size and appears to be that of an expedient technology. Most items recovered from an archaeological context would not be seen by many people outside the local social group. One possible exception to this are the projectile points/knives. These may be seen by other hunters that are encountered during hunting trips or, as evidenced by Wiessner (1983:269), in the carcass of an animal that was wounded in one area but died in another area outside the local range.

Further investigation along these lines of inquiry are encouraging for the present study. As seen in Wiessner's study of San projectile points, stylistic differences could be seen at the language group level. "For archaeologists, these stylistic differences could be used to delimit the boundaries between language groups, but they give no further information about degree of contact across them" (Wiessner 1983:269). The differences between Wells Creek and other contemporary groups as represented in the material remains appear to be great. Differences in material culture resulted from differing levels of variation and selection. In essence, each group has its

own evolutionary history, and thus is distinctive. It can be hypothesized that the differences between Wells Creek and other contemporary groups, as determined from lithic artifacts, represent two separate, but contemporaneous, language groups occupying the same area. The data appear to support this hypothesis and will be discussed more fully in Chapter 6.

Rindos (1984:74) has stated that "we should adopt a case study approach to the understanding of selective components of cultural variation and change." I agree with this position. By examining individual sites or limited spatial and/or temporal dimensions, we can more fully examine the variability that is present. Each new case study can build on what was done before. The Wells Creek phase presents a unique case study due to the distinctive lithic implements and their dissimilarity to other contemporaneous groups in the area.

Summary

This chapter and the preceding chapter provide the theoretical framework for the development of appropriate methods to test hypotheses generated through the analysis of the recovered lithic material. The preceding chapter focused on evolutionary theory. The principles of evolution were presented as viewed from a biological standpoint. These principles were then extended to anthropological data and ultimately to lithic artifact analysis.

The main focus of this chapter was the examination of how

material culture can be used as a medium for the exchange of information. Methods of the manufacture of material items are generally passed from generation to generation. Within the framework of the learning process, elements of technological, stylistic, and functional traits that are group specific will be passed on. Each of these elements represents a series of selective processes that are unique to each group. Now that a firm theoretical base has been established, attention to the methods used in the analysis of the Wells Creek material can be considered. This is the topic of the following chapter.

Chapter V

Methods

This chapter focuses on the analytical methods used to classify the lithic artifacts recovered from the Wells Creek sites. Using the previous chapters as a framework for the analysis, appropriate methods were developed to examine the assemblage. The analysis examines artifacts from technological, morphological, and functional perspectives.

The analysis of lithic material associated with the Wells Creek assemblage was conducted for the original contract report (Bradbury 1992a). The original debitage analysis was sufficient for answering questions posed in this thesis, thus no modifications were made to the original format. The coding scheme used to analyze the debitage is discussed below. Some modifications for the analysis of modified chert artifacts were made. I felt it was necessary to develop a new classification for the modified chert artifacts that was specifically designed around the theoretical base discussed in the preceding chapters. This was to accommodate the functional analysis conducted for this thesis that was not a part of the original contract report. This also enabled better resolution of how technology, morphology, and function interacted.

The major focus of this analysis was to record attributes that would allow for the examination of variability, selection, and function in the prehistoric lithic technologies

utilized by the inhabitants of the sites. Attributes were recorded that would allow for meaningful interpretation of the data and to allow for analysis at various levels of detail. A typological coding format was not utilized as this type of format tends to obscure artifact variability (i.e. functional, stylistic, morphological, and material variability), lends itself to bias of the analyst, and is atheoretical in evolutionary studies.

Debitage Analysis

Debitage is defined as lithic waste flakes that exhibit evidence of intentional removal from a parent piece and exhibit no evidence of further modification or use. Unlike modified chert artifacts,debitage is usually deposited where it was generated and usually occurs in large quantities making it conducive to statistical analysis. In and of itself,debitage is non-functional. However,debitage analysis does allow for examination of variability and selection. This variation and selection can be seen in raw material usage, technology, and reduction strategies.

The sample ofdebitage analyzed from the Lockarts Chapel site represents the totaldebitage recovered from one half of each feature excavated. Thedebitage assemblage from the Pitts site was too large to fully examine, thus only a sample was analyzed. To aid in determining the sample to be investigated, a Mass Analysis approach (Ahler 1975, 1989) was used. This form of analysis emphasizes attributes such as raw

material, size grade, cortex presence, and weight. The debitage from one half of each feature underwent Mass Analysis. The results of the Mass Analysis were used as a framework for the development of hypotheses to be further tested by the more extensive lithic analysis. The attributes examined in the lithic analysis were: size grade, flake portion, platform configuration, platform facet count, dorsal configuration, cortex type, presence of thermal alteration, raw material type, and weight.

Lithic Analysis Attribute Definitions

Size grade. All debitage was "size graded" by passing the material through a series of nested wire screens. Material was passed through six screens ranging in size from 3.1 mm (1/8 inch), 6.4 mm (1/4 inch), 12.7 mm (1/2 inch), 19.1 mm (3/4 inch), 25.4 mm (1 inch), 50.8 mm (2 inches). All lithic material that was greater than 6.4 mm was analyzed. All modified chert artifacts and cores were removed at this time and set aside for further analysis.

After size grading, debitage was separated based on the presence or absence of a striking platform. Several classes of debitage were formed based on the completeness of the flake. These were: complete, broken PRB (platform remnant bearing), flake fragment, and flake shatter. Debitage that showed no basic flake morphology (i.e. platform, ripple marks, force lines) was coded as blocky shatter. Debris that had been burnt beyond recognition was coded as thermal shatter.

Thermal shatter was counted and weighed by size grade with no other attributes recorded.

Portion. Flakes were separated based on the portion present. Complete flakes have an intact striking platform, bulb of percussion, intact margins, and a distal terminus. Broken PRB flakes have an intact striking platform and bulb of percussion, but do not have an intact distal terminus. Flake margins may also be intact. Flake fragments (distal and medial) do not have a striking platform; however, they do have intact margins and may exhibit a distal terminus. Flake shatter are flakes that do not have intact platforms or margins.

For debitage that retained a striking platform, two additional attributes were recorded: platform configuration and platform facet count. These attributes were recorded for debitage with complete platforms only. Several attributes were recorded for both platform and non-platform flakes: dorsal configuration, raw material, weight, and thermal alteration. Debitage that exhibited incomplete or crushed platforms were coded with the non-platform bearing debitage.

Platform Configuration. Platform configuration categories used in this analysis were: non-lipped, lipped, cortical, and retouch. Lipped platforms have a projection of the striking platform over the ventral face of the flake. This category contains the larger lipped flakes which are often associated with biface thinning. Lipped platforms are

associated with soft hammer (billet) percussion; however, some hard hammer percussion techniques produce lipped platform flakes. Retouch platforms are small, often lipped platforms, that are commonly found on small ovoid shaped flakes. These flakes are produced by pressure flaking techniques. Cortical platforms have cortex on the platform. Platforms that did not exhibit lipping, cortex, or retouch characteristics were coded as non-lipped platforms.

Platform Facet Count. Platform facets are negative flake scars on the platform. Three categories were used for this variable: 0-1 facets, 2 facets, 3 or more facets present. Flake scars associated with platform preparation or that were less than 2 mm in size were not included in this count. A 10 x hand lens was used to aid in this determination.

Dorsal Configuration. Dorsal configuration describes the nature of the dorsal face of the flake. This was the presence or absence of cortex or the presence of a core rejuvenation arris. Five categories of dorsal cortex cover were used: no dorsal cortex, < 50% dorsal cortex cover, > 50% dorsal cortex cover, 100% dorsal cortex cover, and cortex on platform only. Flakes that exhibited a core rejuvenation arris on the dorsal face were coded as such. This attribute was also recorded for non-platform bearing debitage.

Cortex Type. Cortex type described the type of cortex present on debitage that retained cortex. Cortex categories consist of matrix/residual, waterworn, and patination. Matrix

residual cortex was identified by a thick chalking or rough appearance. Waterworn cortex is the result of tumbling action in a stream. It is characterized by a dense, hard, often brown stained appearance with rounded or smooth edges. Patination is a thin milky discoloration of the surface. It is caused by the weathering of exposed surfaces. Patination was only recorded for artifacts that had been flaked, discarded and left to weather, then picked up at a later date and worked again since most debitage and tools show some degree of patination. Incipient fracture planes were not recorded as cortex unless they had weathered sufficiently to indicate the association with the outer surface of the parent material.

Raw material. When possible, all debitage was classified according to parent geological formation (e.g. Fort Payne, St. Louis, etc.). Determination of raw material type was made by using macroscopic criteria. Descriptions of the various chert types is provided in Amick (1984). A comparative collection assembled by the author was also used extensively to aid in identification.

Thermal Alteration. Thermal alteration has been recognized as a step in some core and biface reduction strategies (e.g. Grubb 1986; Hood and McCollough 1976; Johnson and Morrow 1981). Thermal alteration was recorded as a presence or absence variable. Thermal alteration has taken place when one or more of the following traits are observed:

color change, increased luster, and heat fractures (pot lids, crenelation, crazing). Characteristics such as pot lids, crenelation, and crazing are interpreted as unintentional products of thermal alteration and were recorded as such. Debitage was considered to have been intentionally thermally altered if there was a noticeable color change and increased luster. Debitage that exhibited partial color change was not recorded as thermally altered since the intention was not obvious. Chert samples from the study area were collected and thermally altered experimentally to provide a comparative collection for this attribute.

Weight. Alldebitage was weighed using a digital scale. Weight was recorded in grams to the nearest .1 gram.

Raw Material and Source Area

The Fort Payne Formation was the most extensive chert bearing formation in the area. A lithic raw material survey conducted in the area documented four prehistoric quarries at the location of Fort Payne outcrops, within a 1.5 km radius of the two sites (Bradbury 1992a). Fort Payne chert could also be obtained as gravels within Wells Creek or as natural inclusions in the subsoil at both sites. Other chert bearing formations in the area included the St. Louis and Warsaw formations.

Raw material source can be assessed by examining cortex cover ondebitage and modified chert artifacts that exhibit cortex cover. Waterworn cortex indicates that the chert was

procured from river gravels. Matrix\residual cortex indicates the chert was procured directly from outcrops at the parent formation.

Modified Chert Artifacts

Modified chert artifacts are defined as chipped stone artifacts that have evidence of further modification or use. Both a technological/morphological and a functional analysis were conducted on the modified chert artifacts. Cores were also included in this analysis. A low-power microwear analysis was conducted to examine artifact use. A paradigmatic classification scheme was used for the analysis of the modified chert artifacts. In paradigmatic classification, "classes are defined by means of unordered, unweighted, dimensional features" (Dunnell 1971:84). The classification system is a method by which artifacts can be organized in such a manner that data can more easily be manipulated. Classification is a means to organizing, but not to explain, data (Dunnell 1971:64).

Technological/Morphological Analysis

The technological/morphological classification scheme used in this analysis consisted of seven attribute dimensions that were recorded for all modified chert artifacts and cores. Several additional dimensions that were specific to each class were also recorded. Several of the attribute states are coded differently for specific artifact classes. These differences are noted where they occur. In addition, four dimensions and

metric measurements were recorded for all bifacially worked implements. These differences were necessary to account for attributes that are class specific and to allow for the construction of a computer data base that contained all modified chert artifacts in a single computer file. The latter allowed for easier manipulation of the data.

Other information that was recorded for all artifacts was site number, artifact number, context, size grade, and weight (to the nearest .1 gram).

Dimension 1 (Material Class). Dimension 1 records for the material class of the implement. Two attribute states were possible in this dimension; unmodified lithic and modified lithic.

Dimension 2 (Technological Class). Dimension 2 records for the general technological class of the implement. Eight attribute states were possible for this dimension: 01) debitage; 02) fire cracked rock; 03) ground or pecked stone; 04) biface; 05) cobble tool; 06) core; 07) microtool; 08) uniface. This dimension, in combination with dimension 1, provides a means of separating the major artifact classes that are used throughout the remainder of this thesis. For example, class 201 contains all implements commonly referred to as flake or expedient tools, class 204 contains all implements that are commonly referred to as bifacial tools, etc.

Dimension 3 (Technological/Morphological Class). This dimension records the general technological and/or morphological characteristics of the artifact. For classes 201, 207, and 208, the same attribute states that were recorded in the debitage analysis were used (portion, platform configuration, facets).

For classes 106 and 206, three attribute states were possible: 01) tested cobble; 02) core fragment; and 03) core. Tested cobbles are blocks or nodules of chert with less than three flake removals. This class of core probably represents the testing of the raw material for its suitability for tool manufacture. Cores are blocks or nodules of chert that have more than three flake removal platforms. Core fragments exhibit flake removal platforms, but have been truncated due to impact or thermal alteration failures.

Twelve attribute states were possible for class 204 implements in dimension 7: 01) hard hammer biface; 02) hard and soft hammer biface; 03) soft hammer biface; 04) soft hammer and retouch biface; 05) projectile point/knife (PPk); 06) PPk, reworked; 08) drill; 09) drill on a reworked PPk; 10) scraper on a reworked PPk; 11) perforator on a reworked PPk; 12) indeterminate biface fragment.

Biface reduction is viewed as a continuous process of reduction. A biface may be taken out of the reduction sequence at any stage to be utilized for a specific task, then, after use, re-enter the continuum and further reduced.

Bifacial reduction usually starts with hard hammer percussion followed by soft hammer percussion. Pressure flaking is used for final shaping and haft modification (Amick et al. 1986, Johnson 1981) and to prepare striking platforms for the removal of large flakes during biface thinning.

The terms hard and soft hammer percussion are utilized in this analysis to reflect the form of flake scars present, and not necessarily to determine the type of percussor used to detach the flake. Hard hammer scars are defined as flake scars that exhibit prominent negative bulbs of percussion, usually circular in shape, and are relatively narrow and deep. The biface exhibits high intersecting ridges between flake scars and an irregular bifacial margin. Soft hammer scars are defined as flake scars that have a small negative bulb of percussion, are relatively shallow and broad, and often leave ripple marks in the negative flake scar. The biface usually has a regular bifacial margin and the ridges between flake scars are not as pronounced as on bifaces with hard hammer scars. Retouch scars are defined as flake scars that have a small negative bulb of percussion and are usually small, shallow scars that are usually restricted to the edge of the implement. Hard hammer flakes are associated with early stage reduction. Soft hammer flakes and retouch flakes are associated with late stage reduction. Bifacial implements that exhibited no haft modification were coded based on the above criteria. Attribute states 05-11 coded for

morphological tool forms. Technologically, all of these implements are bifaces. Attribute state 12 was used for fragments that were too fragmentary to assess.

Dimension 4 (Raw Material). Dimension 4 records for the raw material used to manufacture the implement. When possible, all implements were classified according to parent geological formation. The same codes used in the debitage analysis were used for the modified chert artifacts.

Dimension 5 (Thermal Alteration). This dimension records for the presence or absence of thermal alteration. Nine attributes states are possible: 01) no evidence; 02) dull both faces; 03) partial dull; partial gloss; 04) gloss both faces; 05) possible alteration; 06) incipient pot-lids; 07) pot-lids; 08) crenelation or crazing; 09) partial color change. Classes 06-08 are indications of unintentional thermal alteration or post depositional alteration. Classes 03-04 are indications of intentional thermal alteration. Classes 02, 05, and 09 are ambiguous to whether thermal alteration was intentional or not.

Dimension 6 (Cortex Type). This dimension records for the type of cortex present on those implements that retained cortex cover. The same categories used for the debitage analysis were used in the modified chert artifact analysis; matrix/residual, waterworn cobble, and patination. Incipient fracture planes were not included as cortex as they are internal.

Dimension 7 (Cortex Presence). This dimension records for the amount of cortex present on those implements that retain cortex. Due to differences in the various classes, it was necessary to subdivide this dimension by artifact class. For classes 201, 207, and 208, the same attribute states as used for this attribute in the debitage analysis were used. For classes 106, 205, and 206, cortex was recorded as present or absent. For class 204, four attribute states were used: 1) none; 2) cortex on one faced; 3) cortex on two faces; and 4) cortex on base only.

Dimension 8. Dimension 8 is the last dimension that was examined for classes 106, 201, 206, 207, and 208 and includes different attribute states for each of the major artifact classes.

Classes 106 and 206. For classes 106 and 206, dimension 8 records for flake orientation. Seven attribute states are possible for these two classes in dimension 8: 01) indeterminate; 02) unidirectional; 03) bifacial; 04) bipolar; 05) unidirectional subconical; 06) multidirectional; and 07) bidirectional. Flaking that was one directional from a single margin was classified as unidirectional. Bidirectional flaking is described as flake removals from two directions, but not bifacial. Multidirectional cores have random flake removals from several directions. This type has also been called amorphous core (Faulkner and McCollough 1973:80). Flake removals that formed a bifacial margin were termed

bifacial. The edge angles on these specimens were greater than 60°. Cores that were conical in shape with flake removals in one direction were termed unidirectional subconical. Indeterminate orientation was reserved for fragmented cores where the flaking orientation was not determinable.

For classes 201, 207, and 208, dimension 8 records the type of retouch, if any, that is present. Five attribute states were possible: 00) no retouch; 01) unifacial retouch only; 03) mostly unifacial retouch, but some bifacial (i.e., for platform preparation, margin maintenance); and 04) alternate unifacial retouch.

For class 204, dimension 8 recorded for the portion of the implement. Thirteen attribute states were possible: 01) indeterminate fragment; 02) complete; 03) proximal; 04) distal; 05) medial; 06) lateral; 07) facial; 08) basal fragment; 09) tip missing, otherwise complete; 10) partial stem and base missing; 11) medial/lateral; 12) partial base missing; and 13) basal/lateral.

The remaining attributes were recorded for class 204 implements only. No further technological or morphological attributes were examined for the other artifact classes.

Dimension 9 (Failure Type). This dimension records for any failures due to manufacture error, use, or post-depositional processes. Thirteen failure types are recognized: 02) hinge; 03) incipient fracture plane; 04) edge

collapse; 05) lateral snap; 06) perverse; 07) overshoot; 08) thermal; 09) impact; 10) transverse hinge; 11) lateral hinge; 12) haft snap; 13) post-depositional; and 14) indeterminate. Implements that exhibited no failures were coded as 01) none. For implements that exhibited multiple failures, all failures were recorded (e.g. an implement that exhibited a lateral snap and an incipient fracture plane was coded as 0305). Biface failure types have been sufficiently described and discussed by Amick (1985b), Crabtree (1972), and Johnson (1979, 1981a, 1981b) and need no further description here.

Dimension 10 (Haft Modification). Dimension 10 records for indications of haft modification. Eight attribute states are possible: 01) indeterminate; 02) none; 03) haft present, no further modification; 04) basal grinding; 05) basal cortex; 06) basal burination; 07) basal bevelling; and 08) unthinned base.

Dimension 11 (Blade Modification). Dimension 11 records for modifications on the blade of the implement. Eleven attribute states are possible: 01) indeterminate; 02) none (bi-convex); 03) serrated; 04) alternate bevel; 05) one edge bevelled; 06) unifacial bevel (plano-convex); 07) serrated, alternate bevel; 08) alternate unifacial retouch; 09) unifacial retouch; 10) bifacial retouch; and 11) serrated unifacial retouch.

Dimension 12 (Blank Type). When possible, the blank that the implement was manufactured from was recorded. Five

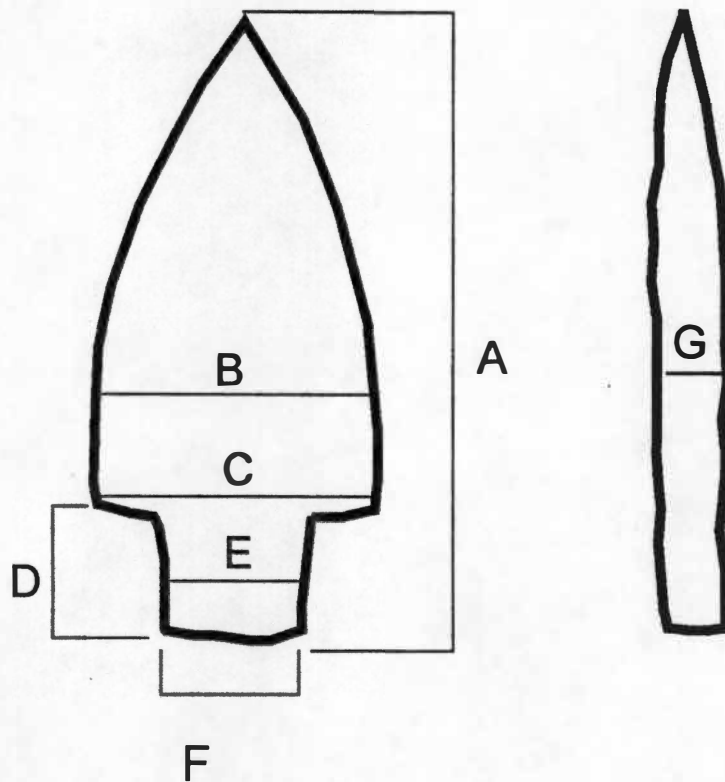
attribute states were possible: 1) indeterminate; 2) core; 3) flake; 4) tabular block; and 5) river gravel.

Other information that was recorded for all class 204 artifacts were metric measurements and cluster association.

Metric Measurements. A series of seven metric measurements were taken for all class 204 artifacts. Measurements were taken in millimeters to the nearest .01 millimeter with a set of digital calipers. In the case of fragmentary artifacts, all those measurements were taken that were not affected by the break. The measurements taken were: maximum length, blade width, blade thickness, shoulder width, stem length, neck width, and basal width (Figure 7). For bifacial implements that did not exhibit a hafting area, only three measurements were taken: maximum length, maximum width, and thickness.

Cluster Association. Finished bifaces (20404, 20405, 20406, 20409, 20410, and 20411) were identified by cluster association. "A type cluster is a group of named types which, by definition and illustration, overlap morphologically" (Justice 1987:9) and temporally. Traditional type names were recorded to allow for comparisons with other site assemblages, a general means of description, and for relative dating purposes.

Cluster definitions and identifications were made with the use of type collections in The University of Tennessee, Department of Anthropology and published technical reports.



A: maximum length

B: blade width

C: shoulder width

D: stem length

E: neck width

F: basal width

G: thickness

Figure 7. Metric Measurements.

The main sources of this typology are Ensor (1981), Faulkner and McCollough (1973), and Justice (1987). PPks that had been reworked into other tool forms (20409, 20410, 20411) were also typed according to cluster when possible. The assignment of cluster association to broken or reworked artifacts was somewhat conservative in nature. This was deemed the best approach since artifact breakage and/or reworking can obscure original form (Flenniken 1985; Flenniken and Raymond 1986; Goodyear 1974:19-21, 26-30; Morse 1971:10, 1973:25).

The above dimensions can be combined to define the classes being examined. For example, if an artifact has been coded as 204-02-015-03-2-2-03-0305-02-03-1, it is defined as an implement that is a proximal fragment of a modified lithic biface that has both hard hammer and soft hammer scars manufactured from Fort Payne chert that exhibits waterworn cobble cortex on one face, that has been thermally altered and then worked, with two failures (incipient and lateral snap), no hafting area, and a serrated blade.

Functional Analysis

In order to form functional classes with which to examine artifact function, a low power micro-wear analysis was conducted. A Wild-Leitz microscope with zoom lens with magnification capacities of 12.5X to 80X and an incident light source was used for the micro-wear analysis. Each isolated area of wear was treated as a unit of observation (functional unit). Eight attribute dimensions were recorded for all

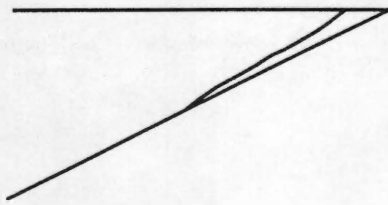
implements. Artifact number was recorded (with arbitrarily assigned letters to designate each area of use) to allow for the analysis to examine technological, morphological, and functional information for each implement, and how these interrelated.

Dimension 1: (Edge Shape). This dimension records the shape of the worked edge. Four attribute states are possible in this dimension: 1) excurvate; 2) incurvate; 3) pointed; and 4) straight. Edge shape was determined by placing the used edge against a straight edge and recording the edge in relation to the straight edge.

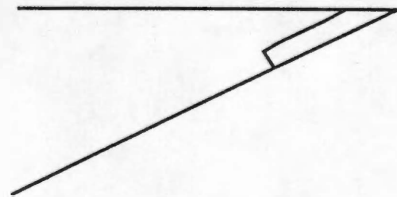
Dimension 2: (Wear Pattern). This dimension records the pattern of wear on the implement. The pattern of wear is useful for determining the motion of the implement that caused the wear. Five attribute states were possible for this dimension: 0) indeterminate; 1) bifacial; 2) unifacial; 3) facial; and 4) bifacial and facial.

Dimension 3: (Scar Form). This dimension records the form of the scars at the location of wear. Scar form is useful for determining the material that the implement was used on. Six attribute states are possible for this dimension: 0) indeterminate; 1) feather; 2) scaler; 3) hinge or step; 4) snap; and 5) snap and step. These are illustrated in Figure 8.

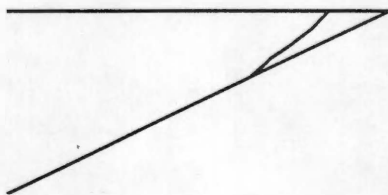
Dimension 4: (Scar Size). This dimension records the size of the scars. Four attribute states are possible for



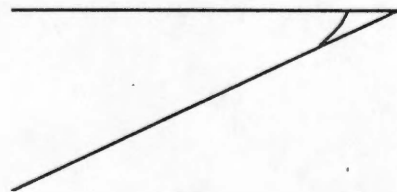
Feather



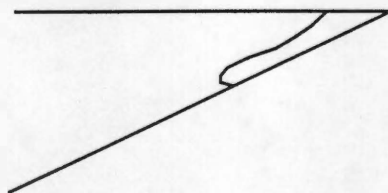
Step



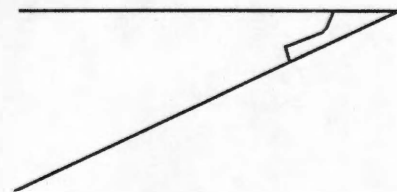
Scalar



Snap



Hinge



Snap and Step

Figure 8. Scar Forms.

this dimension: 0) indeterminate; 1) small; 2) medium; 3) large. Large scars are clearly discernable with the unaided eye. Medium scars are clearly discernable under magnification of 10x. Small scars are clearly discernable only under magnifications in excess of 20x.

Dimension 5: (Scar Pattern). This dimension records the scar pattern at the location of wear. Six attribute states are possible in this dimension: 0) indeterminate; 1) alternating; 2) continuous; 3) discontinuous; 4) random; and 5) isolate.

Dimension 6: (Other Edge Modifications). This dimension records for additional wear on edges. This can be useful in determining material worked, motion, and identifying edge damage that is due to technological factors (e.g. retouch or edge grinding). Eleven attribute states are possible in this dimension: 0) none present; 1) edge rounding; 2) nibbling; 3) impact fractures; 4) dorsal polish; 5) edge abrasion; 6) post-depositional or non-use related damage; 7) crushing; 8) burination/crushing; 9) edge rounding dorsal polish; and 10) hoe polish.

Dimension 7: (Location of Wear). This dimension records the location of each instance of wear. To determine location of retouch or use wear, Odell's (1977, 1979) polar coordinate system was used. In this system, a circle is divided into eight equal sections and each section is numbered. A flake is placed on the circle with the dorsal face up and proximal

end facing the analyst, and the numbers (or combination of numbers) that correspond to the utilized area are recorded. For non-flake implements, the artifact is placed on the circle with the flattest side down and the proximal end facing the analyst.

Dimension 8: (Edge Angle). This dimension records the angle of the worked edge. Edge angle was measured by attaching a straight edge to the center of a protractor. One edge of the implement is placed on the straight edge, the other against the protractor. The angle is then read from the protractor. Edge angle was measured in degrees to the nearest whole degree.

Chapter VI

Analysis of the Lithic Component

In evolutionary studies, the phenomena that is under investigation must: 1) exhibit variability; 2) have a means of transmitting some of this variability; and 3) demonstrate the operation of selective factors that can account for the differential persistence of this variability (Dunnell 1980:38; Leonard and Jones 1987:212). Variability can be demonstrated with reference to the differential use of raw materials, source areas for obtaining the raw material, different morphology, and function of the modified chert artifacts. Some of this variability is transmitted by way of teaching. Selection then acts on this variability. The demonstration of selective factors that can account for the differential persistence of the variability is a somewhat more difficult topic to address. This latter element can only be demonstrated when larger temporal dimensions have been examined. However, it is possible to identify those elements that appear to be under selective pressures. Hypotheses may be generated to account for these selective elements that can be supported or rejected when additional data have been analyzed. The emphasis of this chapter will be the demonstration of variability and identification of selective elements as exhibited by the Wells Creek lithic component.

Results

Pitts Site

The Mass Analyzed material served only as a means of determining a sample for further analysis. Thus no further consideration of this material is presented. The analysis presented here is based on data obtained from the sample of debitage that underwent lithic analysis. Fort Payne chert was by far the predominate raw material utilized for chipped stone tool production. Fort Payne chert was represented by 97.7% (n=17085) of debitage, 100 % (n=34) of the cores, and 94.6% (n=263) of the modified chert artifacts that were identifiable to a parent geologic formation. Other locally available raw materials were utilized to a lesser degree and are summarized in Table 1. Thermal alteration was observed on 15.7% (n=2865) of the debitage, 22.1% (n=64) of the modified chert artifacts, and 2.8% (n=1) of the cores. Cortex was observed on 4.9% (n=904) of the debitage, 5.5% (n=16) of the modified chert artifacts, and 63.9% (n=23) of the cores. Twenty pieces of debitage and 11 modified chert artifacts exhibited differential patination on at least one face. An additional 80 pieces of debitage exhibited hoe polish on their platform and/or dorsal face. The micro-wear analysis identified 144 functional units that were the result of use (Table 2).

Lockarts Chapel Site

Except for the lower density of recovered material, the Lockarts Chapel site showed similar patterns of raw material

Table 1. Raw Material by Site.

Raw Material	Pitts	Lockarts Chapel
Fort Payne	17246	4852
St. Louis	352	212
Chalcedony	48	17
Dover	4	2
Quartzite	0	1
Indeterminate Local	622	82
Indeterminate Non-local	7	0
Shale	3	0
Total	18282	5166

Table 2. Functional Class by Site.

Functional Class	Pitts	Lockarts Chapel
Boring Soft	22	0
Boring Medium	1	0
Boring Hard	2	0
Cutting Soft	59	8
Cutting Medium	14	2
Cutting Hard	8	3
Projectile	17	3
Scraping Soft	8	1
Scraping Hard	2	0
Scraping Indeterminate	0	1
Hoe	2	1
Battering Hard	8	0
Indeterminate	1	1
Totals	144	20

use as the Pitts site. Fort Payne chert was represented by 95.4% (n=4852) of debitage, 100% (n=8) of the cores, and 94.1% (n=16) of the modified chert artifacts identified to a parent geologic formation. Other locally available raw materials were utilized to a lesser degree and are summarized in Table 1. Thermal alteration was observed on 14.9% (n=770) of the debitage and 33.3% (n=7) of the modified chert artifacts. None of the cores exhibited evidence of thermal alteration. Cortex was observed on 3.9% (n=198) of the debitage, 9.5% (n=2) of the modified chert artifacts, and 75% (n=6) of the cores. Two pieces of debitage and two modified chert artifacts exhibited differential patination on at least one face. An additional 14 pieces of debitage exhibited hoe polish on their platform and/or dorsal face. Through micro-wear analysis, 20 functional units that were the result of use were identified (Table 2).

Site Comparisons

Comparisons of the lithic component recovered from the two sites are useful for examining lithic technology of the site inhabitants. As both sites appear to be occupied by peoples utilizing the same lithic technology, comparisons can be made directly by using the assemblages. In this way, the sites can be discussed in terms of the archaeological record.

Both the Pitts and Lockarts Chapel sites evidenced a heavy reliance on Fort Payne chert for chipped stone tool manufacture. As was noted in Chapter 2, four quarries that

are situated at Fort Payne outcrops were located within 1.5 km of the two sites. Fort Payne chert could also be procured in the form of river gravels below both sites and as natural inclusions in the subsoil matrix at the sites. All three sources are suitable for chipped stone tool manufacture and chert from each source is amenable to thermal alteration. Given these facts, selection for Fort Payne chert would be expected. In this instance, selection was the direct result of local environmental factors (i.e. the availability of suitable raw material).

As determined from the presence of cortex, both river gravel and natural outcrop locations were utilized for the procurement of lithic raw material. It was expected that the Lockarts Chapel site would evidence a greater amount of matrix residual cortex as this site is located in close proximity to a quarry (40HO53, approximately .4 km from the site). A Chi-square test of independence (Ott 1988:252) was computed to test whether cortex type and site were related (Table 3). No significant difference was observed ($p=.708$). As evidenced from the debitage analysis at both sites, waterworn cortex appears to be more highly represented than matrix residual cortex. To test this hypothesis, the debitage samples from both sites were combined and a Z-test for proportions (Blalock 1979:232-233) was computed. The null hypothesis of no difference in proportions of matrix residual and waterworn cortex was rejected at $p<.01$ (Confidence score = 2.601, $z =$

Table 3. Chi-square Table of Cortex Type by Site.

Site	Waterworn	Matrix	Totals
Pitts	504	380	884
expected	501.64	382.36	
Lockarts Chapel	110	88	198
expected	112.36	85.64	
Totals	614	468	1082

Chi-square = .14 Df = 1 p = .708

4.438). This pattern of higher representation of waterworn cortex was exhibited by the cores and modified chert artifacts also. Due to the small sample sizes, however, this was not tested statistically. From the above results, it is concluded that river gravel sources were utilized more extensively than natural outcrops.

Experiments in lithic reduction (e.g. Magne 1985; Magne and Pokotylo 1981) have demonstrated that as lithic reduction continues, there is an increase in the number of facets on platform bearing flakes. Flakes exhibiting platforms were compared between the two sites. A Chi-square test showed significant differences ($p < .0001$) in facet counts between the two sites (Table 4). Inspection of the table also reveals that the Pitts site is over represented in the 0-1 facet category while the Lockarts Chapel site is over represented in the 2 and 3 or more facet categories. This suggests that a greater portion of the Pitts debitage was the result of early stage (i.e. core) reduction. Experiments by Ahler (1975, 1989) have shown that as reduction continues, the average weight of flakes decreases. If this were the case for the present study, the mean debitage weight from the Pitts site should be greater than that from the Lockarts Chapel site. This hypothesis was tested using a single sample Hotelling's T-square test. Hotelling's T-square is the multivariate version of the univariate T-test and is used to determine if the means for two populations are significantly different

Table 4. Chi-square Table of Facet Count by Site.

Facets	Lockarts Chapel	Pitts	Totals
0-1	714	2856	3570
expected	813.2	2738.8	
2	486	1443	1929
expected	449.12	1479.9	
3 or more	366	861	1227
expected	285.68	941.32	
Totals	1566	5160	6726

Chi-square = 54.921 Df = 2 p < .0001.

(Manly 1990:28; Tatsuoka 1988:82-84). Average weight per flake by size grade was computed for the debitage from both sites and used in the test (Table 5). The overall test was significant at $p=.0302$, meaning on average, the Pitts debitage is heavier than the Lockarts Chapel debitage. This supports the above results from the test on facet count. The hypothesis is further supported by the greater number of cores at the Pitts site ($n=36$, Lockarts Chapel $n=8$) the recovery of cores evidencing use as battering tools at the Pitts site and the lack of these tool forms at the Lockarts Chapel site.

Thermal alteration was a part of the reduction sequence at both sites. A comparable percent of debitage from both the Pitts (15.7%) and Lockarts Chapel (14.9%) show evidence of intentional thermal alteration (exhibiting increased luster and color change). While the percent of modified chert artifacts exhibiting thermal alteration prior to final modification was greater for the Lockarts Chapel site (33.3% compared to 22.1% at the Pitts site), the small sample size for the Lockarts Chapel site ($n=21$) was too small for statistical comparisons, therefore no comparisons were made between the two sites. When the samples from the two sites were combined, the following percentages of thermally altered modified chert artifacts were seen: 10% ($n=2$) hard/soft hammer bifaces; 21.1% ($n=8$) soft hammer bifaces; 25.3% ($n=24$) soft hammer/retouch bifaces; 45% ($n=27$) PPks; 18.5% ($n=5$) drills; 100% ($n=2$) perforators on PPks; and 9.1% ($n=3$) indeterminate

Table 5. Average weight per Flake by Size Grade.

Size Grade	Pitts	Lockarts Chapel
2	0.33	0.31
3	1.78	1.48
4	5.94	4.34
5	22.94	13.45
6	94.22	68.8

Average weight in grams

biface fragments (Table 6). No evidence of use was observed on 22 of these specimens. Of the Merom cluster PPks, 24 (53.3%) were intentionally thermally altered prior to final modification.

Debitage exhibiting hoe polish was recovered from both sites. In addition, three of the cores exhibited heavy grinding along two margins similar to that exhibited on several large bifaces evidencing hoe polish. This is possible evidence of hoes being reused as cores. Scavenging of earlier site material was also evidenced from the recovery of thirteen bifacial implements that exhibited differential patination on one or both faces and the recovery ofdebitage exhibiting differential patination.

Micro-wear analysis of the modified chert artifacts indicated that both sites contained comparable percentages of cutting, projectile, hoe, and scraping implements. The main difference in the two sites is in the addition of boring and battering tools at the Pitts site and the exclusion of these implements at the Lockarts Chapel site.

The observed differences between the two sites may be due to differences in site function, different activities taking place at the sites, or the result of sampling bias due to the disturbed nature of the Lockarts Chapel site.

Functional Analysis

The results of the functional analysis of implements from both sites were combined and are presented together in this

Table 6. Technological/Morphological Class by Thermal Alteration

Class	Count	Percent
Hard/Soft Hammer Biface	2	20
Soft Hammer Biface	8	21.1
Soft Hammer/Retouched Biface	24	25.3
PPk	27	45
Drill	5	18.5
PPk/Perforator	2	100
Indeterminate Biface Fragment	3	9.1
Total	71	22.9

section. Only those implements exhibiting modification other than initial removal from a parent piece were included in the micro-wear analysis. A total of 310 implements was examined. Of this total, 164 functional units were defined on 118 implements exhibiting micro-scarring that could be attributed to use. Attributes that defined the use-wear were combined to determine motion of the implement (e.g. cutting, scraping, etc.) and resistance of the worked material (soft, medium, hard). Motion and resistance were combined to form the functional classes (e.g. scraping hard, boring medium) used in this analysis. A summary of these classes is presented in Table 7.

Variability Within Functional Classes

Variability can be demonstrated with regard to the various morphological/technological forms represented in each functional class (Table 7). Functional classes battering hard, projectile, and hoe are represented by only one or two technological/morphological classes while boring, cutting, and scraping are represented by several. Some classes (e.g. hard hammer biface) exhibit only one functional class (hoeing). Other classes, such as PPk and soft hammer/retouch biface, are represented in several functional classes (i.e. cutting hard, cutting soft, etc.).

Variability can be also observed in the differential use of thermal alteration in the functional classes. A chi-square test of independence (Table 8) showed significant differences

Table 7. Functional Class by Technological/Morphological Class.

Morphological/Technological Class														
Functional Class	Indeterminate Biface Frag	Hard Hammer Biface	Hard/Soft Hammer Biface	Soft Hammer Biface	Soft Hammer/Retouch Biface	PPk	Drill	Drill/Pk	Perforator/PPk	Cobble	Core	Uniface	Micro-Tool	Totals
Boring Soft	0	0	0	1(0)	4(0)	2(0)	11(2)	1(0)	1(1)	0	0	0	2(0)	22(3)
Boring Medium	0	0	0	0	0	0	0	1(1)	0	0	0	0	0	1(1)
Boring Hard	0	0	0	0	0	0	1(0)	0	0	0	0	0	1(0)	2(0)
Cutting Soft	4(0)	0	2(1)	4(1)	27(8)	25(11)	1(1)	0	1(1)	0	1(0)	2(0)	0	67(23)
Cutting Medium	1(0)	0	0	1(0)	7(3)	5(3)	2(0)	0	0	0	0	0	0	16(6)
Cutting Hard	0	0	0	0	1(1)	4(4)	1(0)	2(0)	1(1)	0	0	0	2(0)	11(6)
Scraping Soft	1(0)	0	1(0)	0	4(1)	2(1)	0	0	0	0	0	0	1(0)	9(2)
Scraping Hard	0	0	0	0	0	0	0	0	0	0	0	0	2(0)	2(0)
Scraping Indeterminate	0	0	0	0	0	0	0	0	0	0	0	1(0)	0	1(0)
Hoe	0	3(0)	0	0	0	0	0	0	0	0	0	0	0	3(0)
Battering Hard	0	0	0	0	0	0	0	0	0	1(0)	7(0)	0	0	8(0)
Projectile	0	0	0	0	1(0)	19(17)	0	0	0	0	0	0	0	20(17)
Totals	6(0)	3(0)	3(1)	6(1)	44(13)	57(36)	16(3)	3(0)	4(4)	1(0)	8(0)	3(0)	8(0)	162(58)

Total Functional Units (Functional Units Thermally Altered)

Table 8. Chi-square Table of Functional Class by Thermal Alteration.

Function	Thermal	Not Altered	Totals
projectile expected	17 7.6821	3 12.318	20
cutting expected	35 36.106	59 57.894	94
Boring expected	4 9.6026	21 15.397	25
Scraping expected	2 4.609	10 7.391	12
Totals	58	93	151

Chi-square = 26.11 Df = 3 p < .0001

($p < .0001$) in the frequency of thermal alteration between the functional classes. An examination of the chi-square table shows that thermal alteration is more common in the projectile class and less common in the boring class.

The variability observed in the functional classes is somewhat expected. Some of the functional classes are more generalized (e.g. cutting, boring, scraping) while others are more specific (e.g. battering hard, hoeing, projectile). More generalized, in this case, means that there are a number of prehistoric activities that could be associated with the functional class. For example, the cutting implements could represent tools that were used to cut hide, wood, bone, antler, or for butchering purposes. Many of these uses could be performed with the same tool or with several different tools. The opposite is true of the more specific functional classes. Implements used as projectiles have to conform to specific use related requirements. For example, these implements must articulate with other elements that make up the total functional tool projectile (e.g. foreshaft, shaft, method of propulsion). This includes having an area suitable for hafting, a sharp tip for penetrating the target, in addition to being weighted to counter balance the rest of the projectile. The same may be said of the other specific functional classes. Both the battering hard and hoeing classes must withstand large amounts of stress as the result of being used as hard hammer percussors or nutting stones

(battering hard) or for digging in the soil (hoe). Selection will therefore favor those implements that are better suited to performing a specific task. This process occurs over an extended period of time. Eventually, the functional classes should become quite homogeneous in the implements that are represented by a specific function.

Selective Elements

In the preceding section, variability was observed within both functional and technological/morphological classes. It was hypothesized that selection would act on this variability, and therefore, over time, specific implements or specific attributes would become associated with a specific function. In the context of the present study, selection may only represent a specific choice made by the user of the implement. A more extensive time depth and a greater understanding of the environmental conditions that played a role in the selective processes than that represented by this analysis would be necessary to demonstrate selection in the evolutionary sense. However, it may be possible to determine what elements might be undergoing selection.

It can be hypothesized that specific technological and/or morphological attributes or combinations of attributes were selected for specific functional requirements. If this were the case, then these attributes could be used to separate the functional classes. This hypothesis can be tested through the use of canonical discriminant analysis. This multivariate

statistical technique uses a linear combination of the variables to separate the groups as much as possible (Manly 1990:88; Tatsuoka 1988:235). The canonical discriminant analysis defines several canonical variables that are uncorrelated with each other and summarize the between class variation.

For the canonical discriminant analysis, the functional classes were collapsed into 6 classes: boring, cutting, hoeing, projectile, scraping, or battering, based on the motion of the worked piece. A series of seven variables was examined. Weight and edge angle were continuous variables. On projectiles, edge angle was measured at a point as close to the location of use as possible because damage at the location of use did not allow for this measurement. Therefore, on projectiles, edge angle was measured at a point as close to the location of use as possible. The remaining variables: artifact class, haft modification, blade modification, and edge shape, were turned into dummy variables (1=present, 0=absent), thus a total of fourteen variables was used in the analysis.

The distance matrix (Table 9) shows the results of the Mahalanobis distances calculated between the pairs of groups. Multivariate distance measures are used to examine distances between sample observations or populations of observations (Manly 1990:42). The distance matrix gives an indication of how well the groups separate and where the main similarities

Table 9. Distance Matrix for Functional Classes.

	Boring	Cutting	Hoe	Project.	Scraping	Batter.
Boring	0					
Cutting	96.3451	0				
Hoe	171.8889	81.2121	0			
Projectile	8.26682	104.8839	182.096	0		
Scraping	90.52852	3.12011	82.631	104.067	0	
Battering	308.4938	213.779	168.036	319.839	214.347	0

and differences, in terms of technology/morphology, between functional classes exist. For example, hoe and battering classes exhibit large distances from the remaining classes. Scraping and cutting are relatively close as are boring and projectile. This is indicative of similar technological responses to specific functional requirements.

The overall test was significant at $p < .0001$ and indicates that the groups can be separated relatively well using linear combinations of attributes. The individual F-tests showed that the first three canonical variables were significant at $p < .0001$ and accounted for 97.6% of the variation (Table 10). Figures 9-11 are plots of the canonical variables for the implements used in the analysis. As can be seen in these plots, the functional classes separate reasonably well. It can also be seen that the functional classes form relatively homogenous clusters. This gives independent evidence that the micro-wear analysis was quite consistent in defining the attributes of wear.

An examination of the canonical coefficients (Table 11) is useful in determining the variables that best separate the groups. The groups differ most on the linear combination

$$\begin{aligned} &.0026216 * \text{weight} - .9780546 * \text{microtool} - 1.876402 * \text{biface} - \\ &2.525311 * \text{uniface} - .204835 * \text{thermal alteration} - .1977651 * \text{basal} \\ &\text{grinding} + .0048532 * \text{unthinned base} - 1.069116 * \text{serrated blade} \\ &+ .3492207 * \text{bevelled blade} - .0693689 * \text{retouched blade} + \\ &1.59828 * \text{excurvate shape} + 1.523346 * \text{straight shape} \end{aligned}$$

Table 10. Eigenvalues and Variances for Canonical Variables.

Variable	Eigen.	Variance	Approx. F-value	P-Value
Canonical Variable 1	20.8221	0.633	31.7257	0.0001
Canonical Variable 2	10.1492	0.3085	17.9329	0.0001
Canonical Variable 3	1.1417	0.0347	7.1352	0.0001
Canonical Variable 4	0.6507	0.0198	4.8637	0.0001

Total Variance Accounted For: .996

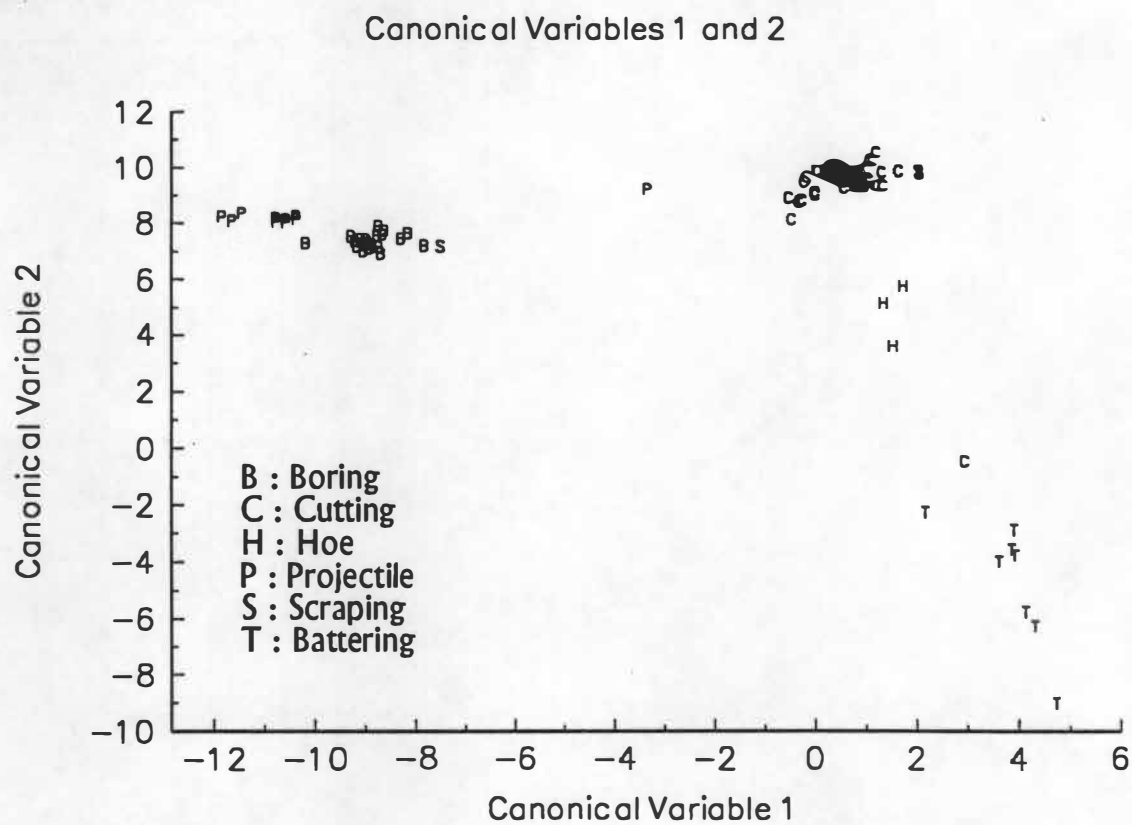


Figure 9. Plot of Canonical Variables 1 and 2.

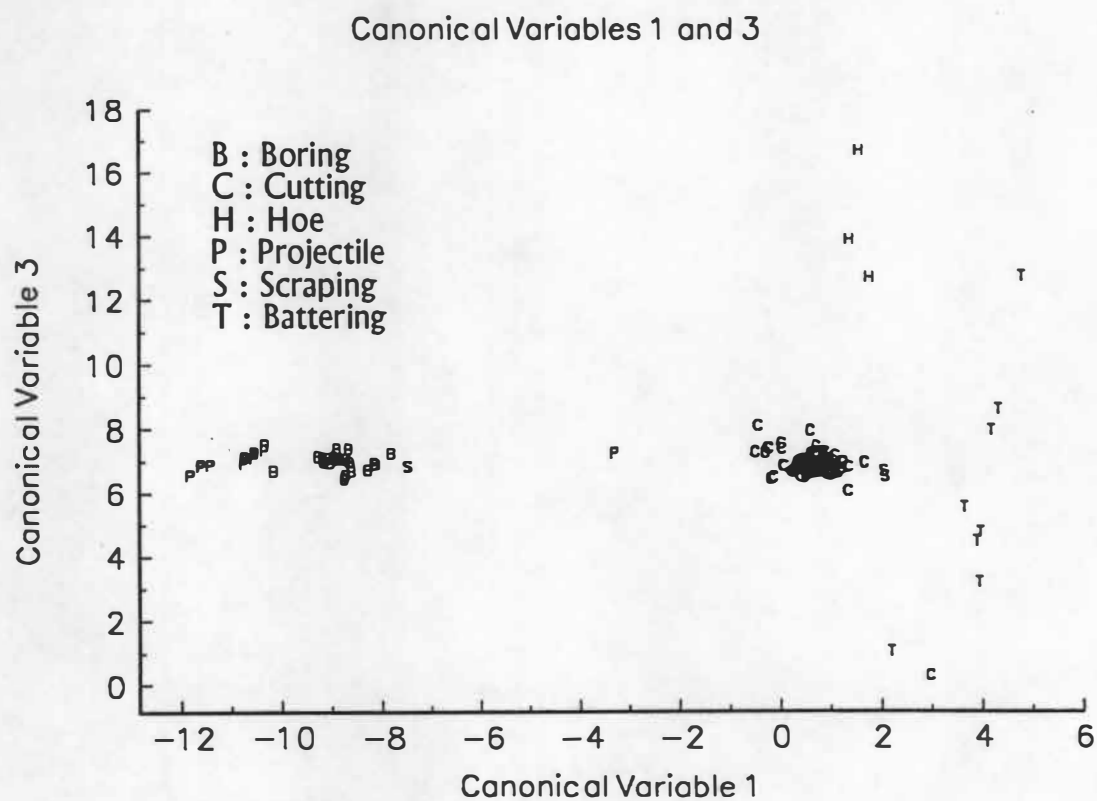


Figure 10. Plot of Canonical Variables 1 and 3.

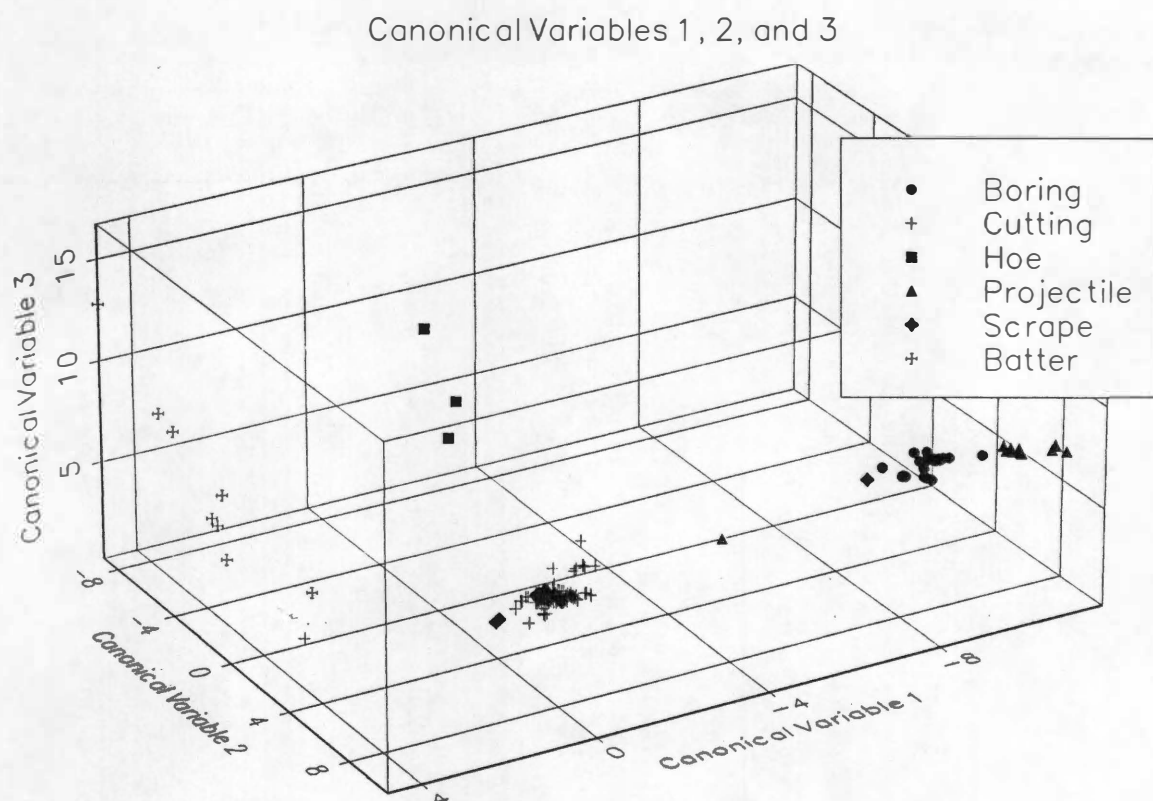


Figure 11. Three Dimensional Plot of Canonical Variables 1, 2, and 3.

Table 11. Canonical Coefficients.

Variable	Can. Variable 1	Can. Variable 2	Can. Variable 3	Can. Variable 4
Weight	0.0026216	-0.0225608	0.0355753	-0.0054901
Micro-tool	-0.9780546	9.646849	7.707897	2.49775
Biface	-1.876402	9.359308	7.927591	1.363309
Uniface	-2.525311	10.21667	6.465247	0.6282417
Thermal Alteration	-0.204835	-0.1546628	-0.1979859	-1.428728
Basal Grinding	-0.1977651	0.0660534	-0.1875048	-0.6445467
Unthinned Base	0.0048532	-0.1059228	-0.3002948	-0.7551108
Serrated Blade	-1.069116	0.0619951	-0.4128948	-1.402785
Beveled Blade	0.3492207	0.4767837	-0.5269616	1.102513
Retouched Blade	-0.0693689	0.3026226	0.0558259	2.129441
Shape, Excurvate	1.59828	1.317368	-0.9307059	1.908966
Shape, Straight	1.523346	1.27393	-1.089265	1.703307
Shape, Pointed	-8.512839	-1.014605	-0.7316489	1.379265
Edge Angle	0.0204509	-0.0141961	-0.0022925	0.0495267

-8.512839*pointed shape + .0204509*edge angle.

The between canonical weights are the correlations between the original variables and the canonical variables and are useful for determining what each of the canonical variables is describing (Table 12). Canonical variable 1 is highly correlated negatively with edge shape pointed. A moderate positive correlation with weight and the edge shapes excurvate and straight is also seen. The variables biface, haft grinding, serrated blade, and edge angle show a moderate negative correlation. Implements that show a high score on this axis can be characterized as being heavy, with either an excurvate or straight edge and usually lacking haft grinding or serrated blades, and a low edge angle.

Canonical variable 2 is negatively correlated with weight and edge angle. Moderate positive correlations are seen with bifaces and straight edges. Low negative correlations are with excurvate and pointed edges, and a low positive correlation with thermal alteration. Implements that have high scores on this axis are those with low weight and edge angles, are often bifaces with straight edges, and are rarely thermally altered.

Canonical variable 3 shows a moderate positive correlation with weight and a low positive correlation with biface. Implements that show high scores on this axis are usually large bifacial implements.

An examination of the means for each functional class on

Table 12. Between Canonical Structure.

Original Variables	Can. Variable 1	Can. Variable 2	Can. Variable 3	Can. Variable 4
Weight	0.30481	-0.80829	0.48014	-0.02277
Micro-tool	-0.05875	0.04109	-0.01968	0.37978
Biface	-0.20075	0.58388	0.20593	-0.26972
Uniface	0.07638	0.06295	-0.02378	0.07021
Thermal Alteration	-0.17685	0.15201	-0.10037	-0.61427
Basal Grinding	-0.18667	0.07203	-0.05675	-0.31618
Unthinned Base	0.06457	0.0529	-0.0213	-0.03088
Serrated Blade	-0.19742	0.0074	-0.02613	-0.35829
Beveled Blade	-0.07516	0.0561	-0.03063	0.23854
Retouched Blade	-0.12855	0.0059	-0.00983	0.25243
Shape, Excurvate	0.46744	-0.16021	0.04311	-0.04139
Shape, Straight	0.4282	0.32922	-0.0088	0.00686
Shape, Pointed	-0.98024	-0.15503	-0.00509	0.09767
Edge Angle	-0.1523	-0.61599	-0.05856	0.46989

each of the canonical variables provides the key to determining which of the canonical variables are discriminating the groups (Table 13). Variable 1 discriminates the boring and projectile classes from the other classes; variable 2, battering from the other classes; and variable 3, hoeing from the other classes. As an additional test, a K-sample test was computed using the canonical scores to test for significant differences between class means for each of the classes (Manly 1990:89). The K-sample test is a multivariate statistical test that is used to test for significance in the overall differences among several sample centriods (Tatsuoka 1988:90). The Scheffe method was used for the comparisons to keep the experimentwise error rate to .05 for the family of tests. This method is useful for all pairwise comparisons when a large number of comparisons are being made (Ott 1988:459-460). On canonical variable 1, no significant differences were observed between the hoe and cutting, hoe and scraping, and cutting and scraping classes. On canonical variable 2, no significant differences were observed between cutting and scraping and between projectile and boring. On canonical variable 3, significant differences were observed between hoe and all the other classes. No significant difference was observed for the remaining pairs of comparisons.

To summarize, a canonical discriminant analysis was relatively successful in separating the functional classes

Table 13. Class Means on Canonical Variables.

Functional Class	Can. Variable 1	Can. Variable 2	Can. Variable 3
Boring	-6.9353	-0.7853	0.0269
Cutting	2.526	1.4114	-0.1458
Hoe	3.4485	-3.2504	7.5099
Projectile	-7.367	-0.8	-0.0447
Scraping	2.2449	1.2784	-0.106
Battering	5.7487	-12.8282	-0.916

based on technological/morphological attributes. This indicates that there is selection of specific attributes for functional requirements. Selection in functional class battering was for heavy implements that exhibited excurvate edges and a high edge angle, and were manufactured on cores. Selection in functional class projectile was for thermally altered, bifacially worked implements that exhibited low weight and edge angles, and were pointed. Selection in functional class hoe was for large, bifacial implements that had low edge angles, excurvate edges, and grinding in the haft area. Selection in functional class boring was for bifacial or micro-tools that exhibited high edge angles, a pointed tip, low weight, and a retouched or beveled blade. Selection in functional class cutting was for bifacial implements with straight or excurvate blades, low edge angle, and low to medium weight. Selection in functional class scraping was for bifaces or micro-tools that exhibited excurvate or straight edges, a high edge angle, low to medium weight, and a beveled or retouched blade.

Wells Creek in a Regional Perspective

The lithic component of the Wells Creek sites has been presented. It is now beneficial to examine similarities and differences between this assemblage and other contemporary assemblages in the Interior Low Plateau and surrounding areas.

As was discussed in the Background Chapter, Late Archaic lithic technologies common in the Interior Low Plateau are

characterized by large bifacial implements. Many of these large bifacial forms were the product of bifacial removals from unprepared nodules or blocks of chert (Amick 1984:228, 1985b:148; Cridlebaugh 1983:132). Another aspect of Late Archaic lithic technology is an apparent discrete staging of biface manufacture that is not affected by proximity to the source (Amick 1985b:148; Faulkner and McCollough 1974:224-225; Fogarety et al. 1985:25; Johnson 1981). Fort Payne chert also is extensively utilized in this region and is often transported over distances of greater than 25 kilometers from the source location (Amick 1985b:148).

In contrast to this, the majority of the Wells Creek implements are small bifacial forms that were probably produced on flakes detached from cores. Local raw materials are extensively utilized for chipped stone tool manufacture. Anslinger (1986:298-299) notes that Riverton lithic implements from the Wint site in Indiana are small and often unrefined with little evidence of long-term maintenance or curation and are predominantly manufactured on flakes. These tools often exhibit waterworn cortex and local cherts are the predominate source of raw material (Anslinger 1986:296). Winters (1969:23-25) noted a similar pattern of raw material utilization for the Riverton sites in the Wabash Valley.

Other aspects of Riverton lithic technology are the scavenging of earlier site materials and the use of thermal alteration. Both of these patterns were observed for the

Wells Creek lithic assemblage. Almost 24% of the Riverton lithic implements from the Wint site exhibited thermal alteration (Anslinger 1986:238, Table 26). At the Pitts and Lockarts Chapel sites, 22% and 33%, respectively, of the lithic implements were thermally altered. Just over 53% of the Merom PPks were thermally altered. Higginbotham (1983:203) noted that a distinctive feature of the Riverton points from the lower Wabash area of Indiana was that close to 100% were thermally altered.

Thermal alteration of chert is also a part of Ledbetter and Wade lithic technologies. However, the utilization of thermal alteration is not as extensive as seen on Riverton and Wells Creek sites. Excavations at the Baker's Knoll, Oldroy, and Fattybread Branch sites in the Shelby Bend area evidenced a high of 14.3% and a low of 3.8% for thermal alteration of Ledbetter and Wade material (Amick 1985a:361; Herbert 1985a:122; 1985b:141). At the Penitentiary Branch site, Cridlebaugh (1983:202) reports that only 12% of the assemblage was thermally altered. The largest percentage of thermal alteration (19.7%) was on PPks (Cridlebaugh 1983:168). At the Phillips site in Giles County, Tennessee, only 4.4% of the Wade tools and 6.5% of the debitage exhibited thermal alteration (Bradbury n.d.). At the nearby Hyatt site, 5.5% of the debitage and none of the tools from Late Archaic features were thermally altered (Bradbury n.d.). The above assemblages were all dominated by Fort Payne chert.

Minor differences between Riverton and Wells Creek were observed in some aspects of the lithic artifacts. Merom PPks from the Wells Creek sites were compared to those from Riverton sites (data from Winters 1969:152 Table A) and the Wint site (data from Anslinger 1986:134 Table 12). The data are summarized in Table 14. The range in measurements for the Wells Creek Meroms overlap with those from both the Riverton and Wint sites. However, Hotelling's T-square tests comparing Wells Creek to Riverton, and Wells Creek to Wint indicate that the means are significantly different for both comparisons ($p < .0001$). On average, the Wells Creek forms are slightly larger than the Riverton and Wint forms. The other main difference in the lithic technologies was the presence of cortex on a large number of Riverton (Winters 1969:23-24) and Wint (Anslinger 1986:296) modified chert artifacts and the lack of cortex cover on most of the Wells Creek modified chert artifacts. These differences are most likely the result of the available chert resources. Chert nodules in the Wells Creek area are much larger than those available around the Riverton and Wint site areas. The larger size of the raw material would lead to lower percentages of implements with cortex cover. Other reasons for the differences may be due to geographic variation.

The above discussion has shown that Wells Creek lithic technology is quite distinct from other contemporary groups in the same area. Not only are the lithic implements distinct,

Table 14. Ranges for Merom Projectile Points/Knives.

	Wells Creek	Riverton	Wint
Length	23.88-56.16 (41.55)	19-36 (26)	19-45 (28)
Blade Width	15.39-22.28 (18.38)	11-20 (16)	10-20 (15)
Thickness	5.42-8.99 (7.15)	4-8 (6)	2-8 (5)
Shoulder Width	15.39-22.28 (18.35)	11-20 (16)	NA
Stem Length	7.16-13.91 (10.9)	4-10 (6)	NA
Neck Width	9.7-13.67 (11.22)	6-11 (8)	NA
Base Width	9.22-17.69 (14.23)	7-17 (12)	NA

Measurements in millimeters (average)

but the entire lithic reduction system is also different for the two groups. Riverton lithic technology is quite similar to Wells Creek. Similarities are seen in the small size of the implements, heavy use of local raw materials, extensive use of secondary deposits for raw material procurement, utilization of thermal alteration, and reuse of earlier site materials.

Language Group Hypothesis

In her 1983 article, Wiessner demonstrated that the !Kung groups she was studying could separate projectiles made by their group from other surrounding groups. Furthermore, the !Kung could determine which projectiles were manufactured by members of other groups that shared their language and those that were manufactured by groups that were foreign to them. In Chapter 4, I hypothesized that the Wells Creek assemblage represented the material remains of a separate language group than that of other contemporary groups (i.e. Ledbetter and Wade) in the area. It is recognized that it would be impossible to determine if these groups do indeed represent separate language groups. However, significant differences in material culture remains of contemporary groups should be indicative of groups that represent separate evolutionary histories. The hypothesis that Wells Creek represents a different evolutionary history than other contemporary groups in the area is examined below.

The Wells Creek lithic assemblage is quite distinct in

comparison to other contemporary groups in the area and may represent a separate language group. This hypothesis can be tested with canonical discriminant analysis of PPks for groups that precede, and that are contemporary with, Wells Creek.

Metric measurements of 207 projectile points/knives from the Wells Creek sites and from various sections of the Middle Tennessee area were taken. These measurements were: maximum length, blade width, blade thickness, shoulder width, stem length, stem width, and base width. All implements were typed according to traditional named types in the Southeast; Benton, Ledbetter, Claymine, Wade, Big Sandy, and Merom. Type names are based on morphological attributes of the implements. Implements recovered from Normandy, Columbia, and Barkley Lake reservoirs, several sites from Giles and Jackson counties, the Wells Creek sites and several counties (Benton, Humphreys, and Stewart) surrounding the Wells Creek area were included in this study. Differences in implement form due to raw material constraints should not be a factor as similar raw material sources were available to the makers of all implements.

Two assumptions are made in relation to the hypothesis being tested: 1) because these implements represent functional tools, changes in tool form will occur slowly through time due to the articulation of this implement with other parts of the total functional form (i.e. foreshaft, shaft, method of delivery); and that 2) the teaching of the methods of manufacture are passed down from generation to generation;

therefore, any change in stylistic attributes will also occur slowly through time. If these assumptions hold, then groups that share the same evolutionary history should be more similar in form than those that do not share this history. For these reasons, it is expected that in the canonical discriminant analysis: 1) the distance matrix should show a general increased distance through time for the groups that are related; 2) mean scores on the canonical scores should be closest for related groups; and 3) plots of the canonical scores should show some clusterings of those groups that are related.

This morphological class of implements was chosen for study for several reasons. These implements exhibit the greatest variability through time. This may be due to the importance of hunting in these pre-agricultural societies. As would be expected, implements that were used in the acquisition and/or processing of food items would be under greater selective pressure than other tools. Increases in efficiency would be of great advantage. Thus changes in these forms occur more rapidly than would be seen in other forms. It is also recognized that these implements will contain attributes that are purely functional, purely stylistic, and others that exhibit both functional and stylistic requirements in addition to technological considerations. These attributes should all be group specific. Thus by grouping the implements by similar morphological form, no distinction of functional or

stylistic traits is necessary.

Of the 207 specimens measured for this study, only 71 were complete. The measurement missing from the majority of incomplete specimens was maximum length. At this point there were several possible alternatives for this data set: 1) use only those specimens that were complete; 2) exclude maximum length from the analysis and use the remaining attributes; or 3) develop a method for estimating length, and use all measurements in the following analysis. The later alternative was chosen for several reasons. Implements used for different activities (e.g. projectile vs. cutting) are likely to exhibit differential breakage. The exclusion of a portion of the sample based on completeness could bias the sample by under-representing a specific functional class and also excludes a certain amount of variability from consideration. Length of the implement is also an important attribute and is important in relation to the other attributes. In view of the above considerations, it was decided to use multiple regression techniques to estimate maximum length.

Multiple regression analysis is a statistical technique that uses measurements obtained from several independent variables to estimate a single dependant variable (Ott 1988:469). In the present study, maximum length is the dependant variable and the remaining metric measurements are the independent variables. The assumption of normality was checked for each variable and type and could not be rejected

for any measurement at $p < .1$. Specimens were separated by type and separate regressions were computed for each. Using the SAS system, a stepwise regression procedure was computed using both linear and quadratic terms in the regression model. The regression equations for Benton, Merom, Ledbetter, and Wade are shown in Figure 12. No regression was attempted for Claymine as there were only four specimens in the sample (3 were complete). No variables were significant at $p < .15$ in the regression procedure for the Big Sandy forms, thus no further attempt was made to estimate length for these specimens. The regression equations allowed for the inclusion of 100 specimens in addition to the original 71 complete specimens (Table 15). A total of 171 specimens was used in the analyses that follows.

In the next stage of the analysis, a principal components analysis was undertaken. Principal components analysis is a method that finds linear combinations of variables that maximize the variability between each observation in the data set (Johnson and Wichern 1992:356-357; Manly 1990:59; Stevens 1992:375-376). The principal component analysis was conducted for several reasons: 1) to examine how well the 'types' actually grouped together; 2) to examine underlying dimensions in the data and how this related to each 'type'; and 3) as an exploratory examination of the data. In addition, plots of the component scores should show some general time trends for the groups that are related.

Wade

R-square = .668

$$(1.50690017*\text{blade}^2)-(1.49502775*\text{shoulder}^2)+38.43889$$

Benton

R-square = .959

$$(1.912633*\text{stem}^2)-(.100514*\text{neck}^2)-(31.747121*\text{stem})+217.521786$$

Ledbetter

R-square = .6635

$$(.22246386*\text{shoulder}^2)+(.05034178*\text{neck}^2)-(15.18492292*\text{shoulder})-(2.13988263*\text{base})+346.29419216$$

Merom

R-square = .6287

$$(-4.33578871*\text{thick}^2)+(2.59323959*\text{neck})+(68.49307355*\text{thick})-251.53964558$$

Figure 12. Regression Formula for Projectile Point/Knives.

Table 15. Projectile Points/Knives Used in Analysis.

Type	Total Measured	Used in Analysis
Benton	51	49
Big Sandy	18	6
Claymine	4	3
Ledbetter	58	58
Merom	51	32
Wade	25	23
Totals	207	171

The principal components and their corresponding eigenvalues are listed in Table 16. The first three components are retained and account for 88.3 % of the total variation in the original data set (Table 17). Examination of these three components can also be revealing. Component 1 loads positively on all measurements and is a general index of overall size. Approximately 61.4 % of the total variation in point form is due to size differences. Implements that score high on this component are those that are large.

Component 2 loads high on base width, moderately on neck width, and negatively on stem length. This component can be viewed as an indication of the size of the base area. Almost 16.4 % of the total variation in point form is accounted for by this component. Implements that score high on this component have wide, short basal elements.

Component 3 loads highly on stem length and base width and can be considered a general measure of the size of the haft area. This component accounts for 10.5 % of the total variation in point form. Implements that have high scores on this component are those that have long, wide hafting areas.

Scatter plots of these components (Figures 13-16) are useful for examining how well the 'types' cluster. In the scatter plot of components 1 and 3 (Figure 13), two main groupings can be observed; a group in the center consisting of Benton, Ledbetter, Claymine, and Wade, and a group in the upper left consisting of Big Sandy and Merom. Within the

Table 16. Eigenvalues of the Correlation Matrix.

	Eigenvalue	Difference	Proportion	Cumulative
Prin1	4.29567	3.15046	0.613667	0.61367
Prin2	1.14521	0.40719	0.163602	0.77727
Prin3	0.73802	0.34608	0.105431	0.8827
Prin4	0.39194	0.10236	0.055991	0.93869
Prin5	0.28958	0.15307	0.041368	0.98006
Prin6	0.13651	0.13344	0.019501	0.99956
Prin7	0.00307	.	0.000439	1

First Three Components Retained For Further Analysis

Table 17. Eigenvectors of the Components Retained for Analysis.

	Prin1	Prin2	Prin3
Length	0.408001	-0.215977	-0.115595
Blade	0.456778	-0.03013	-0.198081
Thick	0.376161	-0.242209	-0.188059
Shoulder	0.455075	-0.039191	-0.196167
Stem	0.219883	-0.509295	0.813724
Neck	0.414157	0.377945	0.023301
Base	0.237541	0.700015	0.459201

Components 1 and 3

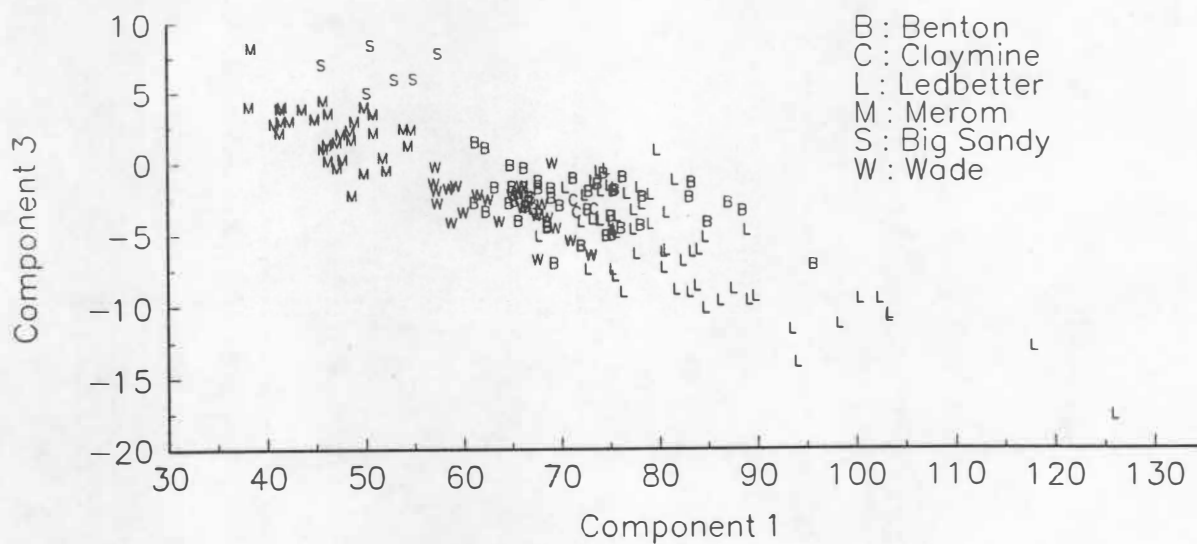


Figure 13. Plot of Principal Components 1 and 3.

Components 1 and 2

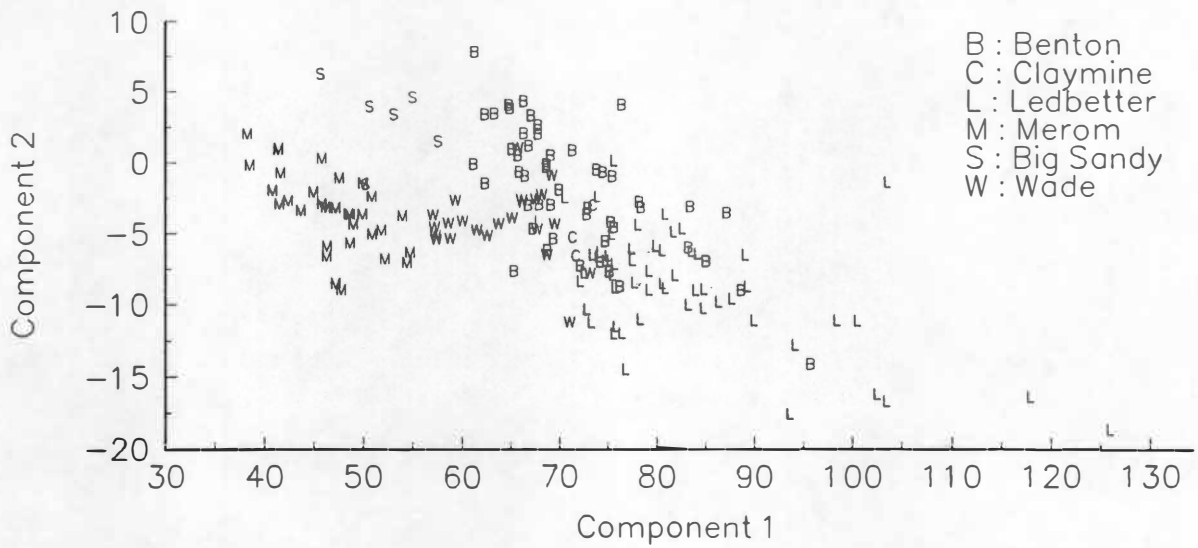


Figure 14. Plot of Principal Components 1 and 2.

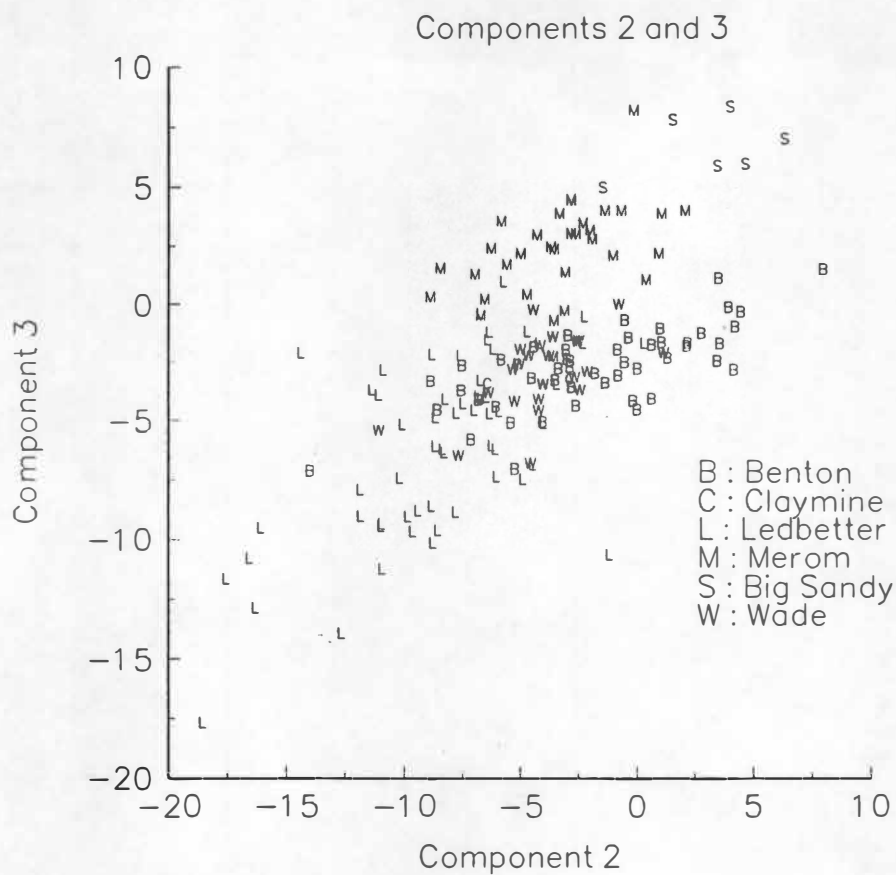


Figure 15. Plot of Principal Components 2 and 3.

Components 1, 2, and 3

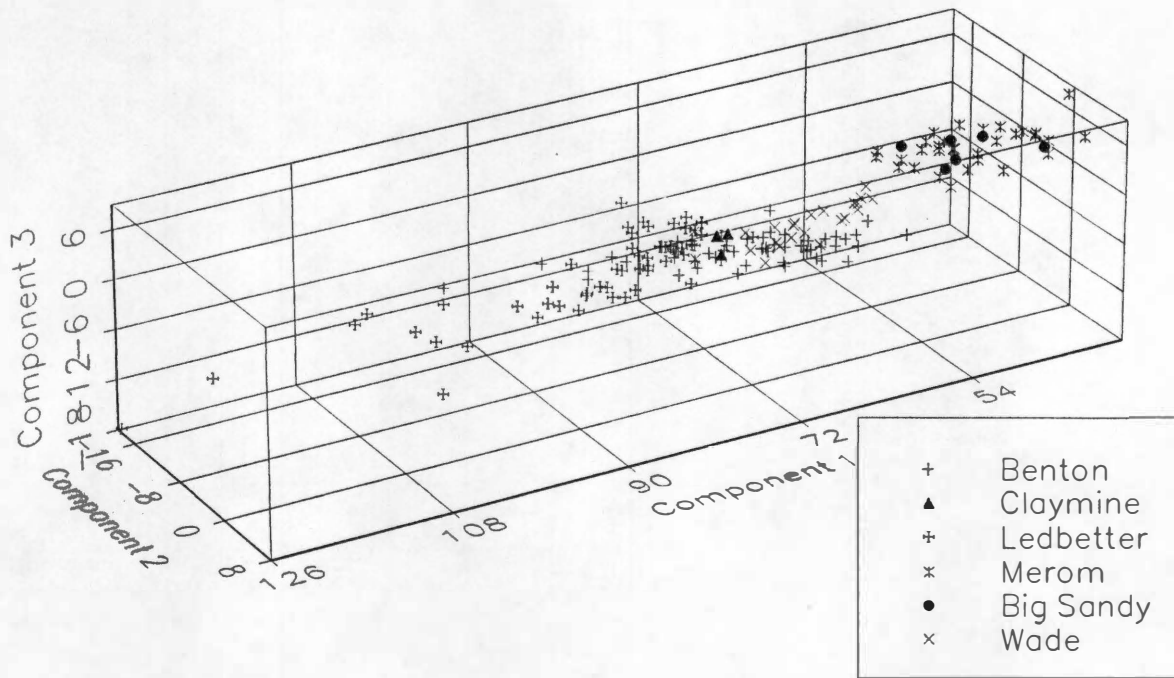


Figure 16. Three Dimensional Plot of Principal Component Scores.

center grouping there is also a general trend of a decrease in time depth from the left side to the right side of the plot. This trend is also observable in the upper left of the plot with an increase in time depth as one moves up the plot. The only anomaly is the presence of Benton scattered throughout the center of the plot. A similar pattern is present in the plot of components 1 and 2 (Figure 14) and components 2 and 3 (Figure 15). The main difference is the clearer separation of Big Sandy II and Merom. The same general time trend is also observed.

An examination of the mean component score for each type (Table 18) gives an indication of similarities or differences in the overall morphology of the implements. For example, Merom and Big Sandy score low on component 1, while forms such as Ledbetter, Claymine, and Benton score high. Big Sandy scores highest on component 2 while the remaining forms score low (negative scores). Both Merom and Big Sandy score positively on component 3 while the other forms all score negatively. Big Sandy and Merom are generally short forms with large haft areas (relative to size). Big Sandy also exhibits a wide base. The other forms are generally large forms with short narrow haft elements (relative to size).

The same specimens that were used in the above principal component analysis were used in the canonical discriminant analysis. The overall test was significant ($p < .0001$) and indicates that the groups can be separated using linear

Table 18. Mean Component Scores.

	Prin1	Prin2	Prin3
Merom	46.8091	-3.3252	2.2755
Ledbetter	82.4709	-8.4054	-5.9403
Wade	63.9488	-4.1615	-2.9614
Big Sandy	51.9937	3.0839	6.7039
Claymine	72.0982	-4.8302	-3.0378
Benton	71.3806	-1.7131	-2.6907

combinations of the variables. The first two canonical variables were also significant ($p < .0001$) and account for approximately 88% of the variation in the data set (Table 19).

An examination of the distance matrix (Table 20) gives an indication of how well the groups can be separated and how similar or different the groups are. Examination of the distance matrix is useful for other purposes. For example: 1) if the groups represent a single evolutionary continuum, then there should be a general increase in distance from the earliest forms to the latest forms; or 2) if these forms represent more than one group, then there should be a separation between the groups in addition to a general increased distance through time.

As seen in Table 20, there is a general progression of increased distance through time from Wade to Claymine to Ledbetter and finally to Benton. This supports the traditional view in the Southeast of Benton, Ledbetter, Claymine, and Wade being a cultural continuum. Merom and Big Sandy, however, are quite separate from this group. This lends support to the hypothesis proposed here that Wells Creek represents a separate language group from other contemporary groups in the area. It would be impossible to determine from material remains if these groups actually spoke different languages. However, from the material remains, it is certain that Wells Creek and Ledbetter/Wade represent two different and separate evolutionary continuums.

Table 19. Eigenvalues and Variances for Canonical Variables.

	Eigenvalue	Proportion	Approx. F	p-value
Canonical Variable 1	3.6578	0.5963	671.2824	0.0001
Canonical Variable 2	1.7338	0.2826	559.3834	0.0001
Canonical Variable 3	0.4317	0.0704	444.8515	0.0001
Canonical Variable 4	0.2658	0.0433	324	0.0001
Canonical Variable 5	0.045	0.0073	163	0.0659

Table 20. Distance Matrix for Projectile Point/Knife Data.

	Benton	Led.	Clay.	Wade	Big Sandy	Merom
Benton	0					
Ledbetter	1.0314	0				
Claymine	0.1473	0.4953	0			
Wade	0.1683	0.91131	0.1004	0		
Big Sandy	2.4817	6.1878	3.2315	2.6854	0	
Merom	1.3397	3.4079	1.4503	0.9248	1.005	0

Based on radiocarbon dates, Wells Creek is contemporary with late Ledbetter and early Wade components. While separated in time by approximately 1000 years, Merom and Big Sandy are relatively close together and somewhat distant from the remaining forms. It is also interesting to note that forms similar to Big Sandy (i.e. Godar and Raddatz) are common in the Wabash area prior to the presence of Merom forms. In the Wabash area there appears to be continuum from Godar/Raddatz to Matanzas and finally to Merom.

The between canonical weights indicate on what variables the canonical variables are loading (Table 21). Canonical variable 1 loads high on length, shoulder and blade width, thickness, and neck width. Implements that score high on this axis are those that are large in size. Canonical variable 2 loads high on neck and base width. Implements that score high on this axis are those that have relatively wide haft areas.

The canonical coefficients indicate the linear combinations that are separating the groups (Table 22). The groups differ most on the linear combination: $-0.061852 \times \text{length} + .2778171 \times \text{blade width} + .1764432 \times \text{thickness} - .071135 \times \text{shoulder width} + .0357888 \times \text{stem length} + .1924042 \times \text{neck width} - .1841935 \times \text{base width}$. A plot of the canonical scores for each implement (Figure 17) is useful for determining how well the groups separate. Canonical axis 1 shows a good separation between the Big Sandy/Merom and Benton/Ledbetter/Claymine/Wade groups. Canonical axis 2 separates these main groups. The

Table 21. Between Canonical Structure.

	can1	can2
Length	0.7845	0.15182
Blade	0.973	0.07005
Thick	0.77262	-0.15922
Shoulder	0.96913	0.04561
Stem	0.36372	-0.30686
Neck	0.77058	0.5749
Base	0.24512	0.76323

Table 22. Canonical Coefficients.

	can1	can2
Length	-0.0061852	0.0413412
Blade	0.2778171	0.4056507
Thick	0.1764432	-0.3576899
Shoulder	-0.0711350	-0.531009
Stem	0.0357888	-0.2431286
Neck	0.1924042	0.2623553
Base	-0.1841935	0.2703821

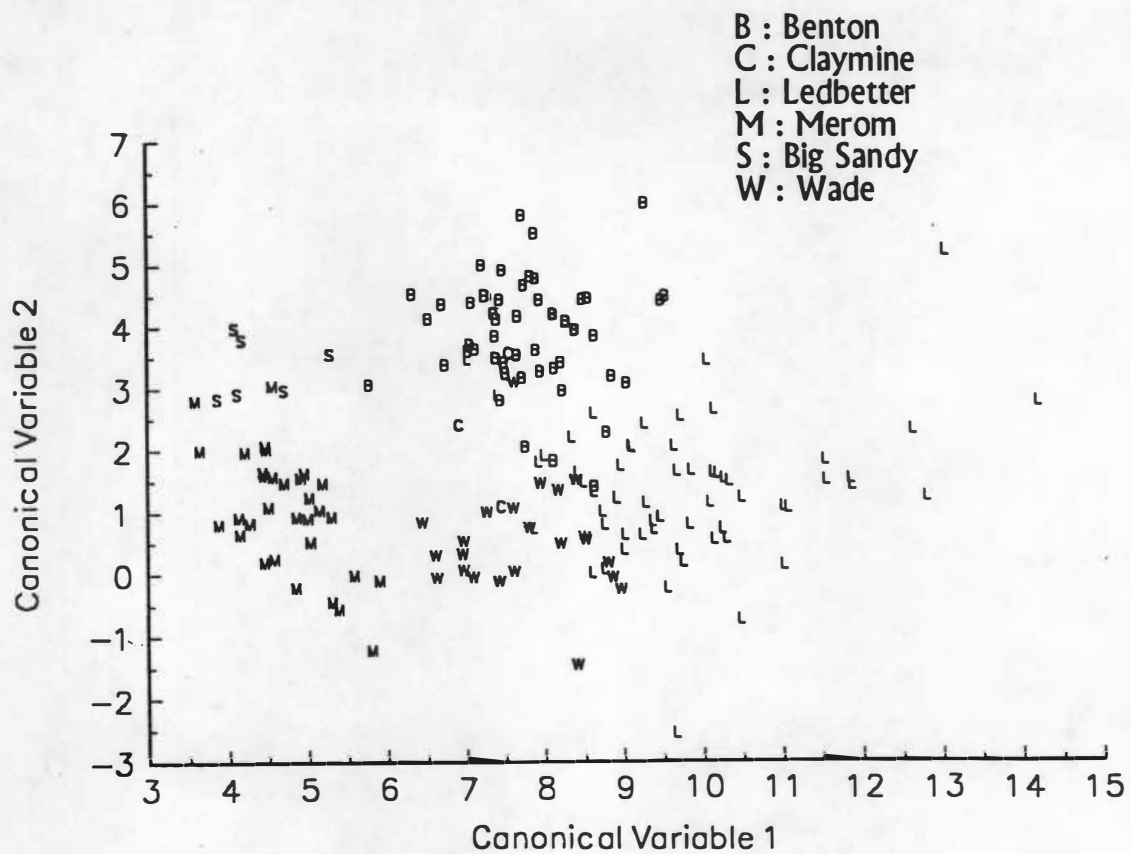


Figure 17. Plot of Canonical Variables 1 and 2.

plot also shows a general time trend from Benton to Ledbetter and to Wade. This same trend is exhibited in the Big Sandy and Merom group. It is also interesting to note that the Big Sandy and Benton groups are relatively equal on canonical axis 2 and the Merom, Ledbetter, Wade, and Claymine groups are also relatively equal on axis 2. Big Sandy and Benton are roughly contemporaneous. Merom overlaps with late Ledbetter and early Wade. These indicate a possible evolutionary trend in the reduction in overall point size and haft area for both groups.

The above trend can be more closely examined. The mean canonical scores for each type are listed in Table 23 and shown graphically in Figure 18. To test whether the mean scores are significantly different, a K-sample test was computed. Pairwise comparisons were made using the Scheffe approach to keep the experimentwise error rate to .05 for the family of tests. The pairwise comparisons between Benton and Wade, Benton and Claymine, Wade and Claymine, and Merom and Big Sandy were not significant on canonical variable 1. On canonical variable 2, Claymine was not significantly different than any of the other forms; Benton and Big Sandy, Ledbetter and Merom, and Wade and Merom were not significantly different.

Examination of the Differences

Some of the differences between the Merom and Ledbetter/Wade group may be related to functional differences. Data that could support or reject this hypothesis are scarce.

Table 23. Mean Canonical Scores.

	can1	can2
Benton	0.0315623	1.875926
Big Sandy	-3.390713	1.334074
Claymine	-0.4574519	0.3594602
Ledbetter	2.032494	-0.6143673
Merom	-3.032433	-0.991026
Wade	-0.0294229	-1.46335

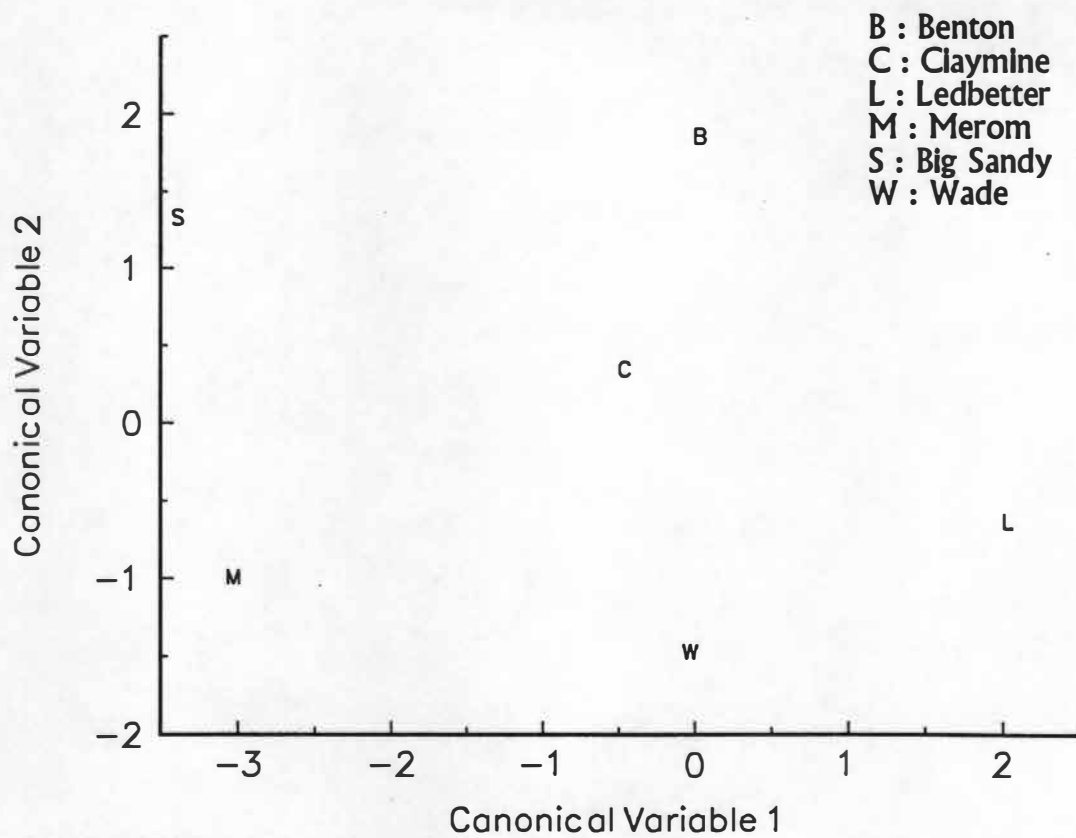


Figure 18. Mean Scores for Canonical Variables.

However, some preliminary discussion is still possible.

Yerkes (1989) conducted a high power micro-wear analysis of Archaic and Mississippian lithic artifacts from the Labras Lake site in Illinois. Merom PPks were recovered from the site and dates between 1650 B.C. and 1400 B.C. were associated with this occupation. Preliminary studies of the Merom PPks indicated that impact fractures were the only use traces observed on the tool class, thus no further analysis of these implements was undertaken (Yerkes 1989:190).

A review of the literature regarding use-wear analysis of Ledbetter or Wade assemblages revealed no such analysis has yet been undertaken. However, forms morphologically similar to Ledbetters were analyzed by Ahler (1971) from the Rogers Shelter in Missouri. Ahler's descriptions (1971:46-48,108) of use-wear on his categories 12-14 (morphologically similar to Ledbetter) included only wear on the blades and no indication of impact damage.

Thomas (1978) used a discriminant function analysis to separate projectile points from known context into arrow points and dart points. Using the discriminant function, an 86 % success rate was achieved in separating arrow and dart points. Applying the formula given by Thomas (1978:470), I examined the implements presented in the above analysis. The results are summarized in Table 24. As can be seen from the table, a possible functional difference exists between the Benton/Ledbetter/Claymine/Wade and Big Sandy/Merom groups.

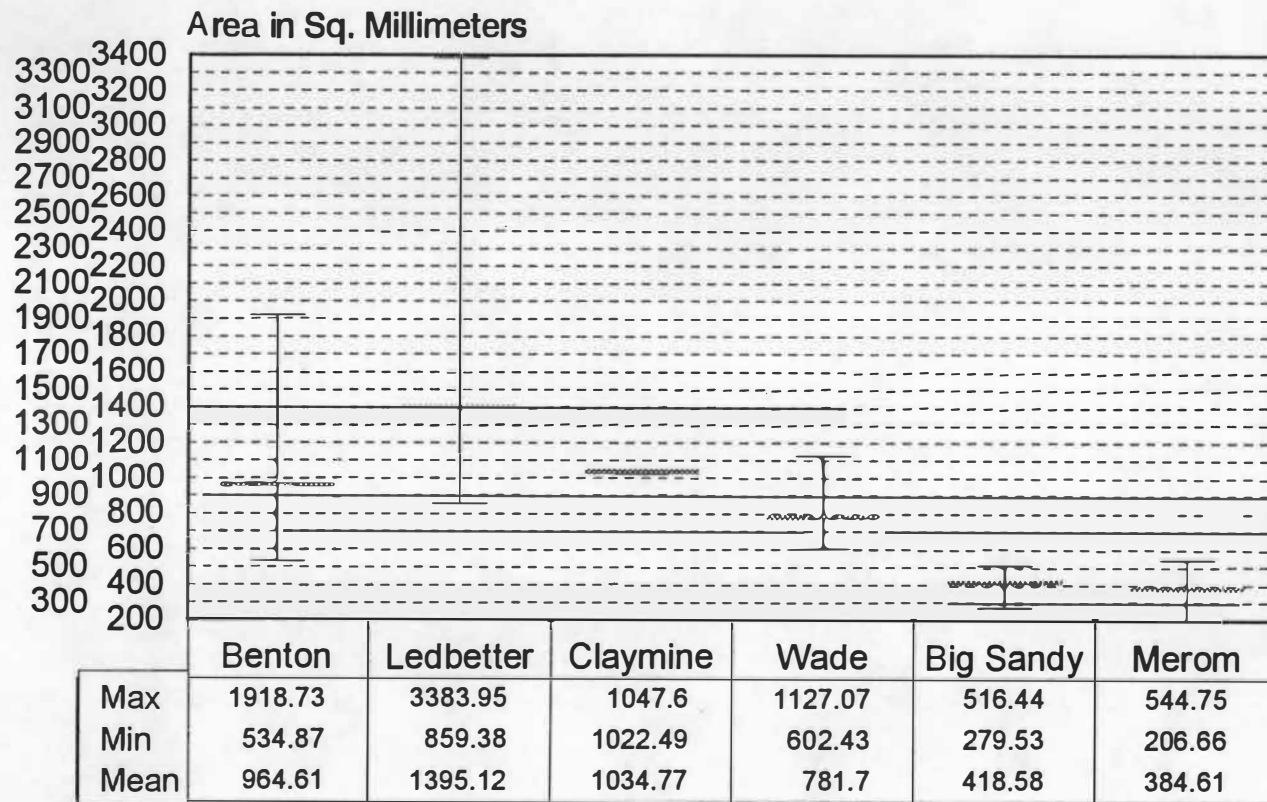
Table 24. Results of the Discriminant Function Criteria.

Type	Dart	Arrow	Total
Benton	49	0	49
Big Sandy	3	3	6
Claymine	3	0	3
Ledbetter	58	0	58
Merom	12	20	32
Wade	23	0	23

Based on the discriminant function equations, all of the Benton/Ledbetter/Claymine/Wade implements were determined to be darts. Half (n=3) of the Big Sandy II and 62.5 % (n=20) of the Merom were determined to be arrow points based on this formula. Of the Merom PPks determined to be arrow points based on the discriminant function, 11 evidenced damage indicative of use as a projectile.

To further examine possible functional differences in PPk form, blade area was calculated using the formula $1/2(\text{length} \times \text{width})$ (Boyd 1986:44). There is an increase in average blade area from Benton to Ledbetter, then a decline from Ledbetter through Wade (Figure 19). To determine if the observed differences were significant, a one-way Analysis of Variance (ANOVA) was computed. ANOVA is a statistical test for determining if the means from a number of groups are equal (Ott 1988:403-404). Comparisons between the groups was made using the Bonferroni method to keep the experimentwise error to .05 for the family of tests. The overall test was significant ($p < .0001$) indicating that there is a significant difference in blade area for the groups. The pairwise comparisons showed that Claymine was not significantly different than any of the other groups; however, the small sample size of Claymine may be a cause of bias in the analysis. For the remaining groups, Ledbetter was significantly different than each of the other groups, and no significant difference was observed between Benton and Wade,

Figure 19. Blade Area for Projectile Points/Knives.



Big Sandy and Wade, and Big Sandy and Merom. These differences may be indicative of functional differences. A large blade area would be advantageous for implements that were used predominately for non-projectile functions. The increased blade size would allow for the implement to be used for various tasks (e.g. cutting, scraping, etc.) and to be resharpened many times. The increased size would not be advantageous for implements used as projectile points. The larger form would be harder to balance with the rest of the projectile and would tend to cause the projectile, as a whole, to be less effective.

From the above discussions several hypotheses can be presented that are testable with the gathering of additional data. Differences between Wells Creek and other contemporary PPks may be due, in part, to functional differences. Both the Wells Creek PPks and those examined by Yerkes (1989) show damage indicative of use as projectiles. Impact damage was not observed on forms similar to Ledbetter by Ahler (1971). It is possible that the Ledbetter forms functioned mostly as knives while the Wells Creek forms served several functions. This would explain some of the size differences seen between these two forms. If the results obtained from Thomas' (1978) discriminant function are correct, then this is an indication of the use of the bow and arrow much earlier in Southeastern prehistory than previously believed. Odell (1988:350) has also suggested that Riverton PPks were used as arrow points.

Further work along these lines is necessary before the above hypotheses can be taken as more than testable hypotheses.

Chapter VII

Summary and Conclusions

The goal of this thesis was to develop an evolutionary framework for the analysis of prehistoric lithic artifacts. The principles of evolutionary theory were presented and then extended to lithic artifact analysis. Methods were developed based on the theoretical framework. Lithic artifacts recovered from two Terminal Archaic Wells Creek phase sites in Houston County, Tennessee were used as a case study to demonstrate the utility of such an approach. Variability was demonstrated with respect to morphology, technology, and function of lithic implements. Elements that may represent attributes under selective pressure were examined. No definite evidence for selection could be demonstrated as the examination of these elements over a deeper time depth than that presented here is necessary to examine such questions.

The lithic material recovered from the two sites was shown to be quite distinct from other contemporary Archaic groups in the area. It is suggested here, based on similarities in both morphological form and technology, that Wells Creek is related to Riverton and similar entities known from archaeological remains recovered from sites north of the study area. Radiocarbon dates for Wells Creek overlap those of Riverton and other similar groups.

The lithic technology utilized by the Wells Creek knappers is similar in many respects to the Riverton lithic

technology. Both industries are geared toward the production of small sized implements, exhibit heavy reliance on locally obtained raw material, make greater use of secondary deposits (i.e. river gravels) for raw material procurement, utilize thermal alteration, and scavenge for earlier site materials. These aspects of the lithic technology are distinct from other contemporary groups in the area.

In the Wabash area, lithic resources were of small size. This factor "imposed limitations on the actual expression of the range of variability possible within the technological aspect" (Winters 1969:24). A raw material survey in the Wells Creek area indicated that this area could be characterized as a raw material rich area. Large nodules of Fort Payne chert could be obtained from natural outcrops in close proximity to either site. River gravels were also easily obtainable and of good quality. The Wells Creek knappers were not constrained by raw material limitations like their northern counterparts. However, there does not appear to be any major differences between the lithic technologies of the Wells Creek phase and Riverton culture. The lithic technology of Riverton was an adaptation, in part, to the small sized raw material. The continued use of this technology by the Wells Creek people was not maladaptive, thus no major changes in the lithic technology were necessary.

Some differences were seen in that the size of the Wells Creek PPks were, on average, larger than those of Riverton.

This may be the result of geographic variation. Limitations imposed by raw material size in the Wabash Valley area were not seen in the Wells Creek area. Another possibility is functional differences. Many of the Wells Creek forms evidenced damage other than impact fractures. Forms examined by Yerkes (1989) evidenced only impact damage. Obviously, larger samples will be needed to resolve this issue.

Similarities in morphological form can be the result of many different factors. However, similarities in other aspects of lithic technology should be an indication of possible group relationships. The manufacture of stone tools is a process that is passed down from generation to generation, can be constrained by raw material limitations, and is geared towards the production of functional implements. Some stylistic elements are also possible, but are not easily recognized. All the above tend to be group specific as they are governed by variability and selection that is specific to each group.

It was originally suggested that Wells Creek was the result of people migrating into the area and was not the result of an indigenous development (Bradbury 1992c). Part of the difficulty in testing this is the incomplete nature of the archaeological record in the area. Few sites in the Houston County area have been professionally excavated. It is still unclear what preceded Wells Creek in the Cumberland Valley. It is possible that people who were ancestral to both Wells Creek and Riverton were the original migrants. Whatever the

case may be, I am quite certain that if the direct movement of people was not taking place, there was a good deal of contact between Wells Creek and the northern groups. I would also argue that these groups developed along the same, or a very similar, evolutionary line and are descendants of the same ancestral group. This hypothesis would be difficult, if not impossible, to test just using material culture remains. However, an examination of skeletal populations of these groups could hold the key to answering this question.

Dunnell (1992:218, 1989:46-47) has argued that we can make no significant progress towards understanding evolutionary phenomena until we make wholesale changes in the way we collect data. This thesis represents a step, though an admittedly small step, in that direction. Lithic material recovered from the Wells Creek sites was analyzed using a classification system that allowed for the examination of variability in technological and functional attributes. The examination of case studies, such as that presented here, are important steps in the construction of a large data base that will allow for the explanation of higher level changes. The focus of such studies must be on the examination of variability and a determination of what elements are undergoing selection. These studies should be guided by a well developed evolutionary theory. It is only through continued research along these lines that we will achieve the ultimate goal of archaeology, the explanation of culture

process.

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Appendix
Lithic Coding Formats

Modified Chert Artifacts

Morphological and Technological Attributes

Dimension 1: (Material Class)

- 1: Unmodified lithic
- 2: Modified lithic

Dimension 2: (Technological Class)

- | | |
|-----------------------------|---------------|
| 01: debitage | 06: cores |
| 02: fire cracked rock | 07: microtool |
| 03: ground and pecked stone | 08: uniface |
| 04: biface | |
| 05: cobble tool | |

Dimension 3: (Technological/Morphological Class)

- | Classes 201, 207
and 208 | Class 204 | Classes 106
and 206 |
|-----------------------------|----------------------------|------------------------|
| 01: blocky | 01: hard hammer | 01: tested cobble |
| 02: complete | 02: hard/soft hammer | 02: core frag |
| 03: PRB | 03: soft hammer | 03: core |
| 04: flake fragment | 04: soft hammer/retouch | |
| 05: complete, lipped | 05: PPk | |
| 06: PRB, lipped | 06: PPk, reworked | |
| 07: | 07: | |
| 08: shatter | 08: drill | |
| 09: | 09: PPk/drill | |
| 10: retouch | 10: PPk/scrapper | |
| | 11: PPk/perforator | |
| | 12: Indeterminate fragment | |

Dimension 4: (Raw Material)

- | | |
|-------------------|------------------|
| 015: Fort Payne | 040: chalcedony |
| 020: Ridley | 055: quartzite |
| 021: Carters | 070: vein quartz |
| 022: Bigby Cannon | |
| 025: Brassfield | |
| 026: St. Louis | |

Dimension 5: (Thermal Alteration)

- | | |
|---------------------------------|---------------------------|
| 01: no evidence | 07: pot-lids |
| 02: dull both faces | 08: crenulations, crazing |
| 03: partial dull, partial gloss | 09: partial alteration |
| 04: gloss both faces | |
| 05: possible alteration | |
| 06: incipient pot-lids | |

Dimension 6: (Cortex Type)

- 0: none present
- 1: matrix/residual
- 2: waterworn cobble
- 3: patination

Dimension 7: (Cortex Presence)

Classes 201, 207 and 208		Class 204	Classes 106, and 206
1: none present		1: none present	1: absent
2: < 50% dorsal cortex		2: cortex on one face	2: present
3: > 50% dorsal cortex		3: cortex on two faces	
4: 100% dorsal cortex		4: cortex on base only	
5: platform only cortex			

Dimension 8: (Flake Orientation, classes 106 and 206)

01: indeterminate	06: multidirectional
02: unidirectional	07: bidirectional
03: bifacial	
04: bipolar	
05: unidirectional subconical	

Dimension 8: (Type of Retouch, classes 201, 207, 208)

00: no retouch
01: unifacial only
02: some bifacial, mostly unifacial
03: bifacial
04: alternate unifacial

Dimension 8: (Portion, class 204)

01: Indeterminate fragment	07: facial
02: complete	08: basal fragment
03: proximal	09: tip missing
04: distal	10: partial stem and base missing
05: medial	11: medial/lateral
06: lateral	12: partial base missing
	13: basal/lateral

Remainder of attributes for class 204 only. 0 coded for all other classes.

Dimension 9: (Failure Type)

01: none	09: impact
02: hinge	10: transverse hinge
03: incipient fracture	11: lateral hinge
04: edge collapse	12: haft snap
05: lateral snap	13: post-depositional
06: perverse	14: indeterminate
07: overshot	
08: thermal	

Dimension 10: (Haft Modification)

01: indeterminate	05: basal cortex
02: none	06: basal burination
03: haft present, no modif.	07: basal bevelling
04: basal grinding	08: unthinned base

Dimension 11: (Blade Modification)

01: indeterminate	07: serrated, alternate bevel
02: none (bi-convex)	08: alternate unifacial retouch
03: serrated	09: unifacial retouch
04: alternate bevel	10: bifacial retouch
05: one edge bevelled	11: serrated, unifacial retouch
06: unifacial bevel	

Dimension 12: (Blank Type)

- 1: indeterminate
- 2: core
- 3: flake
- 4: tabular block
- 5: river gravel

Metric Measurements:

- Maximum length
- Maximum blade width
- Maximum blade thickness
- Maximum shoulder width
- Maximum stem length
- Maximum neck width
- Maximum basal width

Functional Analysis Codes

Dimension 1: (edge shape)

- | | |
|---------------------|-------------|
| 0: NA/indeterminate | 3: pointed |
| 1: excurve | 4: straight |
| 2: incurve | |

Dimension 2: (wear pattern)

- | | |
|---------------------|--------------------|
| 0: NA/indeterminate | 3: facial |
| 1: bifacial | 4: bifacial/facial |
| 2: unifacial | |

Dimension 3: (scar form)

- | | |
|---------------------|------------------|
| 0: NA/indeterminate | 4: snap |
| 1: feather | 5: snap and step |
| 2: scalar | |
| 3: step or hinge | |

Dimension 4: (scar size)

- | | |
|---------------------|-----------|
| 0: NA/indeterminate | 2: medium |
| 1: small | 3: large |

Dimension 5: (scar pattern)

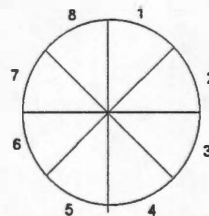
- | | |
|---------------------|------------------|
| 0: NA/indeterminate | 3: discontinuous |
| 1: alternating | 4: random |
| 2: continuous | 5: isolate |

Dimension 6: (other edge modifications)

- | | |
|------------------|------------------------|
| 0: none | 5: edge abrasion |
| 1: edge rounding | 6: post-depositional |
| 2: nibbling | 7: crushing |
| 3: burination | 8: burination/crushing |

Dimension 7: (location of wear)

- 0: NA/ indeterminate
all other numbers cooresponding to polar coordinate of used portion are recorded



Eight polar coordinate grid.
After Odell (1977, 1979).

Dimension 8: (edge angle)

- in degrees to nearest whole degree.

VITA

Andrew Phillip Bradbury was born in Chelmsford, England on April 12, 1963. His family immigrated to the U.S. in January of 1970. As no one else would take him, Andrew was packed along with the rest of the family's furniture and belongings and shipped to the U.S.. The family settled in Greensburg, Pennsylvania. Andrew attended obedience school in that city and was graduated in June, 1981.

In September, 1981, Andrew began his undergraduate education at The University of Tennessee. During summer breaks he worked on various field projects in the Middle Tennessee area. He graduated in June 1986 with a major in Anthropology.

After graduation, Andrew spent two years working on various field projects in Tennessee, Illinois, Pennsylvania, Delaware, New Jersey, and North Carolina.

In January 1988, Andrew began taking graduate courses part time at The University of Tennessee. The following year he began working full time directing CRM projects for the Transportation Center. In January 1992, he was excepted into the graduate program at The University of Tennessee and began taking classes on a full time basis towards a Master's degree. During this period, he continued to work part time with the Transportation supervising small CRM projects and analyzing lithic material from various sites throughout the Middle Tennessee area. Andrew graduated with a Master of Arts

degree in Anthropology in May 1994.

In his spare time, Andrew enjoys fishing, flintknapping, playing the electric bass, and bashing two bricks together. Andrew's only regret in life is that the laws of evolution make it illegal for him to actually evolve past his present primordial state.