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University of Washington PH.D. 1984

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Late Pleistocene Human Adaptations in Eastern North America

by

DAVID JEFFREY MELTZER

A dissertation submitted in partial fulfillment
of the requirements for the degree of

Doctor of Philosophy

University of Washington

1984

Approved by ______________________________
(Chairperson of Supervisory Committee)

Program Authorized
to Offer Degree Anthropology

Date May 14, 1984

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Date May 14, 1984

University of Washington

Abstract

LATE PLEISTOCENE HUMAN ADAPTATIONS IN EASTERN NORTH AMERICA

by David Jeffrey Meltzer

Chairperson of the Supervisory Committee: Professor Robert C. Dunnell
Department of Anthropology

Late Pleistocene human adaptations in eastern North America have long been treated as essentially homogeneous and like the highly specialized adaptive strategies practiced by contemporary Paleo-indian groups on the southern High Plains. Yet a brief review of the relevant archaeological and paleoecological data demonstrates that a pan-eastern specialized hunting adaptation is unlikely theoretically and any claims to such are unwarranted empirically.

The origin of the view of Paleo-indians as specialized big-game hunters is rooted in the resolution of an important chronological debate in American archaeology that began in the mid-19th century. The persistence of this view in eastern North America, in the absence of empirical support, is rooted in perceptions of the way the archaeological record should appear, rather than the way the archaeological record does appear.

Examination of the late Pleistocene environmental record for eastern North America shows that a specialized hunting adaptation was ecologically improbable in the complex forests of the southeast, and that the subsistence strategy there was a more generalized one. By contrast, specialized hunting was quite possible in the low diversity tundra of the high latitudes.

This is supported by analysis of two classes of archaeological data, sites and isolated fluted points. Sites exhibit significant differences in tool technology, raw material use, subsistence and settlement patterning which conform with differences in their environmental setting. The fluted points exhibit stylistic differences across the region as well, certain types of points being restricted both spatially and temporally. Those stylistic classes are useful in developing an internal chronology for the fluted point period. Moreover, the wide distribution of isolated fluted points in the eastern forests suggests the existence of a non-site settlement organization which also corresponds with hypothesized patterns of adaptation.

This alternative view of late Pleistocene human adaptations in eastern North America has significant implications for the analysis and interpretation of Paleo-indian in the eastern United States.

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ACKNOWLEDGMENTS

I would like to express my gratitude to my Advisor, Professor Robert C. Dunnell. He catalyzed this study, then supported it with aid and advice. His intellectual contributions to this work are manifest throughout its pages.

The members of my Committee, Professors Jean-Paul Dumont, Donald K. Grayson, George I. Quimby, Matsuo Tsukada, and Robert Wenke deserve my thanks for giving freely of their advice and their libraries. I am especially grateful to Professor Grayson, who was always willing to advise and instruct me on the fine points of historical and paleoenvironmental interpretation. My knowledge of eastern Paleo-indian has benefited from discussions with William M. Gardner (Thunderbird Museum), Albert C. Goodyear (University of South Carolina) and Henry T. Wright (University of Michigan).

A number of friends and colleagues have offered sage advice or otherwise helped along the way. My thanks to Charlotte Beck, Jane and Oscar Goodman, Dennis Lewarch, R. Lee Lyman, Don Means and Joan O'Connor, Barbara Paquette, David Rhode, Eric Smith, Patrice Teltser, and especially Robert Leonard and George T. Jones.

Financial support for the dissertation research was provided by a Predoctoral Fellowship from the Department of Anthropology, Smithsonian Institution; a Grant-in-Aid from Sigma-Xi, The Scientific Research Society; a Graduate Student Research Travel Grant from the Department of Anthropology (University of Washington); and an Annual Fund Dissertation Fellowship (University of Washington). The aid of all these Institutions is gratefully acknowledged.

Finally, without the support of Suzanne Siegel, my wife, and Stephen and Florence Meltzer, my parents, this dissertation surely would not exist. I dedicate this work to them.

CHAPTER 1

INTRODUCTION

A recurrent theme in discussions of the late Pleistocene human adaptations in the New World is the Paleo-indian as specialized big-game hunter, stalking the mammoth and mastodon throughout the frozen periglacial northern landscape, out across the western grasslands, and into the eastern forests. The image, based on archaeological excavations on the southern High Plains (at sites such as Folsom and Clovis, New Mexico), is applied wherever the characteristic "fluted point" is found (Willey 1966). And fluted points are found in most states of the Union, from Florida in the southeast (Purdy 1981), to Maine and beyond in the Northeast (Gramly 1982; MacDonald 1968), as far west as California (Davis and Shutler 1969), and as far northwest as Washington and Alaska (Dumond 1980; Meltzer and Dunnell, n.d.).

Yet while fluted points are widely distributed, actual evidence of specialized big-game hunting is not. Consider, for example, the late Pleistocene human and faunal remains found east of the Mississippi River. Over 6000 fluted points (Brennan 1982; Seeman and Prufer 1982), and nearly 1000 Pleistocene proboscideans (e.g. Dreimanis 1967, 1968; Hay 1923) have been recovered in the eastern woodlands. Oftentimes these remains are found in the same region or on surfaces or features of similar age (Martin 1967; Mason 1958; Quimby 1965; Williams and Stoltman 1965). Yet, despite this overlap there is no direct evidence that the fluted point groups in the Eastern United States were specialized big game hunters (Dincauze 1981). The two classes of remains are never physically associated.

East of the Mississippi there are no kill sites, as at Lehner (Haury 1953) or Murray Springs (Haynes 1970); no purported bone tools as at Dutton and Selby (Stanford 1979); no meat caches as at Colby (Frison 1976). There is nothing in the archaeological record to indicate that fluted point groups in the eastern United States were specialized big-game hunters, or even exploited the Pleistocene megafauna.

Despite the lack of firm archaeological evidence, eastern Paleoindians are nonetheless perceived as having an adaptation tied to specialized big-game hunting (e.g. Mason 1981; Stoltman 1978; Willey 1966). These populations are claimed to be highly mobile in their seasonal and annual movements, and with adaptations so tightly tied to the exploitation of the Pleistocene megafauna that they were able to subsist throughout the complex environments of late glacial eastern North America. As Mason (1981) expresses the argument, eastern fluted point groups "had specialized just enough in migratory big-game hunting to allow them to selectively ignore and override ecological differences from region to region" (Mason 1981:107).

The inference that these eastern fluted point groups were highly mobile, specialized big-game hunters is borrowed, directly, from interpretations developed of the western fluted point groups (Dragoo 1976; Stoltman 1978). In effect, the lack of firm archaeological evidence for big-game hunting has been ignored in favor of the application of an interpretation from analogous material. But how good is the analogy? Probably not very good at all.

Take, for example, the ecological and environmental settings within which the adaptations in these two parts of the country were played out. North America at the end of the Pleistocene was characterized by an extremely complex set of environments and biotic communities. In eastern North America these ranged from low-latitude tundra in the north to near-tropical mesophytic forests in the south; in the west humid grasslands were dominant. The most notably similar feature of these markedly dissimilar environments was their instability: the postglacial retreat of the ice sheets caused the appearance of large and hitherto uncolonized regions in the east, and changing climatic regimes and the migration of many plant and animal species in the east and the west (Graham 1979). Extinction was taking its toll throughout both regions. Some 32 genera of megafauna, along with many more species of birds and other mammals disappeared by around 10,000 years ago (Grayson 1977; Martin 1973; Meltzer and Mead 1983). Given the climatic flux and ecological diversity, there is good *a priori* reason to doubt whether the continental-wide distribution of fluted points marks a uniform specialized adaptive strategy, one that could somehow cross-cut ecological zones (Dunnell 1978).

Moreover, in drawing an analogy between Clovis and eastern fluted point occupations, one is faced with the conspicuous facts that Clovis is represented by well over a dozen sites demonstrating the physical interaction of Paleo-indian groups and some extinct species of megafauna (Haynes 1966, 1970), while in the eastern states there is compelling negative evidence against any hunting of the Pleistocene megafauna. There is also evidence that Clovis and later Folsom groups were highly mobile (Hester and Grady 1977; Judge 1973). In the eastern states, evidence for long-distance mobility is clearly lacking in particular regions (e.g.

Gardner 1977). Finally, the Clovis occupations are tightly restricted in time, having fallen between 11,750 and 11,250 B.P. (Haynes 1970). By contrast, the fluted point occupations of the eastern states potentially have a greater absolute age, and longer duration (Griffin 1977).

The lack of evidence for specialized hunting, and the real as well as potential disparity between the archaeological and paloecological records of the eastern and western United States, should effectively preclude application of interpretations from one occupation (Clovis) on the data from another (the eastern States). In effect, the lack of evidence for big-game hunting may not be a vagary of the archaeological record for eastern North America, however depauperate that archaeological record may be (Dragoo 1976; Haynes 1983).

Yet despite all this, the Clovis interpretation is routinely applied to the data from eastern North America. Indeed, it is rare that alternative views of the adaptive strategies of eastern fluted point groups are entertained. For that matter, this has never been the case where we have competing theories vying for empirical support or refutation.

The goal of this dissertation then is to provide an alternative view of the adaptive strategies of these eastern fluted point groups, and in the course of the work demonstrate that continued reliance on the Clovis interpretation of eastern fluted point data is actually unnecessary. Despite the stated and quite genuine inadequacies of the eastern archaeological record (e.g. Dragoo 1976; Haynes 1983), it can be used to answer significant chronological, historical and processual questions about late Pleistocene human adaptations, given that the questions being posed are answerable within the frame of data we have. It was with this goal and these cautions in mind that the analysis and synthesis of the eastern fluted point materials was undertaken for this dissertation.

To accomplish my stated goal, I have structured this dissertation around three broad analytical questions:

(1) What historical factors account for the creation and subsequent generalization of the archaeological myth of Paleo-indians as specialized big-game hunters?

(2) Why is such an adaptation unlikely given the floral and faunal record for late and postglacial eastern North America; what kinds of adaptive strategies might have taken place within these environments?

(3) What kinds of variation is evident in the archaeological record of eastern fluted point materials, and does that variation inform us on the spatial/temporal distribution and adaptive strategies of eastern fluted point groups?

Obviously three major classes of data are relevant to this analysis: historical data on the development of Paleo-indian studies; environmental data on the ecological variation in eastern North America during the time of fluted point occupation; and archaeological data from sites as well as isolated fluted point materials.

More specifically, this dissertation is in five parts: Chapter 2 summarizes contemporary views, facts and inferences commonly made about eastern fluted point groups. This review expands on some of the points made in this introduction, highlights differences in opinion, identifies poorly understood issues, and isolates some unsolved problems. Three topical areas - chronology, subsistence and settlement - are examined in detail. Following this, I discuss the kinds of data needed to resolve some of these contentious issues, and at the same time outline an alternative model of eastern fluted point adaptive strategies.

The chapter that follows traces the historical development of Paleo-indian studies from their roots in the mid-nineteenth century to the discovery of the Folsom site in 1927. The resolution at Folsom of a longstanding debate on chronological issues had a significant impact on archaeology generally (Meltzer 1983a), as well as on perceptions or "myths" (Binford 1981:1-2) of Paleo-indian subsistence and settlement strategies. Exploring the history of this issue is more than a "search and seizure" of past data and ideas. Rather, the investigation illuminates the context within which contemporary views of all Paleo-indian adaptive strategies are ground. As Binford (1981) has argued,

> the past deeds that we criticize need not be seen so much as misdeed relative to our contemporary frame of reference but as important contributions necessary to the genesis of the point of view from which our criticism derives (Binford 1981:4).

Chapter Four reviews the ecological evidence derived from the pollen and faunal records, and reconstructs the environmental setting of late Pleistocene eastern North America. The ecological data are used to set the adaptive constraints on these late Pleistocene fluted point populations: while their particular adaptive strategies are obscure in the archaeological record, knowledge of the settings in which they were played out provides some understanding of their limitations and challenges. It is apparent from this analysis that with the exception of an area of tundra immediately bordering the ice sheets, the periglacial and unglaciated regions of the eastern States were characterized by complex boreal-deciduous forests. The complex forest and low diversity tundra set particular and quite different adaptive constraints on the human inhabitants.

Chapter Five is an analysis of the data from fluted point sites. It is evident, from the analysis, that there is a significant difference between archaeological sites and assemblages of the glaciated versus unglaciated regions of eastern North America. This results from differences in aboriginal land use of these two areas.

In effect, it appears that adaptations in the glaciated regions - on or near the periglacial tundra - were fundamentally different from adaptations in the complex boreal/deciduous forests of the southern latitudes. These differences are manifest in site situation, settlement mobility, apparent subsistence strategies, and the tool kits of the sites themselves. The groups occupying the lower latitudes were likely adaptive generalists ("diffuse" in Cleland's [1966, 1976] terms); the fluted point groups of the northern and northeastern tundra were likely ecological specialists, colonizing a fairly homogeneous environment (deglaciated tundra), exploiting the singlemost available resource (caribou). Much greater settlement mobility and commensurate variation in the tool kit (high curation, tool reuse and reliance on "exotic" raw material) is evident in the archaeological record of the glaciated region.

The sixth chapter presents the analysis of the isolated fluted point data. Fluted points, since their discovery at Folsom in the late 1920s, and their first recognition in the states east of the Mississippi River in the 1930s (Shetrone 1936), have been collected, measured and photographed with what occasionally approaches a religious fervor. This is a large data set in a readily accessible form that has been used for statewide typological and distribution studies (Mason 1958; Prufer and Baby 1963), but never for pan-regional analyses.

The inital discussion in Chapter Six focuses on the technological and functional aspects of these tools, which in turn provides a basis for the development of a stylistic classification of fluted points. The application of this classification to a sample of isolated fluted points demonstrates that the normative category of "fluted point", has a great deal of internal variability and heterogeneity. Further, it is evident that that variability informs on the age and distribution of the fluted point groups in eastern North America. In fact, variation in the point styles appears to conform to hypothesized historical relationships between the eastern fluted point groups.

The final Chapter summarizes my findings and conclusions, addresses some long-standing anomalies in interpretation of eastern fluted point adaptive strategies, and specifies some of the implications this study has for the analysis and interpretation of late Pleistocene human adaptations.

CHAPTER 2

THE EASTERN FLUTED POINT OCCUPATIONS: PROBLEMS AND AVENUES TO SOLUTIONS

A comment was recently made by David Brose that, taken at face value, the archaeological record seems to indicate that eastern fluted point groups "ate nothing and lived as isolated individuals" (Brose 1978:729). The remark, while made in jest, nonetheless highlights how little is known of this late Pleistocene human occupation. The current view of their lifeways and adaptive strategies is a patchwork of fragmentary data and borrowed interpretation, and one very much subject to debate.

This chapter summarizes what is known and what is thought to be known about the chronology, subsistence system and settlement pattern of eastern fluted point groups. The goals of this brief review of the literature are twofold: to sort carefully actual data from inference and assertion derived from the western Clovis model, and to identify the kinds of data and analysis necessary to resolve, or at least illuminate, contentious issues and shore up weak inferences.

The chapter itself is in three sections. The first specifies some basic definitions. The second summarizes the essential facts, borrowed inferences and salient unsolved problems in eastern fluted point studies. In keeping with the specified themes, the discussion is in three parts: chronology, subsistence and settlement. The last section introduces the historical, environmental and archaeological data sets used in this dissertation to resolve some of the debates and unsolved problems.

Definitions

In order to clarify what kinds of cultural materials I am dealing with in this chapter and the dissertation, I begin with some definitions. While fluted points are the hallmark of the Paleo-indian tradition (Willey 1966), not all Paleo-indian groups used fluted points. Some, especially those on the western High Plains, are termed Paleo-indian though they utilized large, unfluted lanceolates (e.g. Frison 1978:149-191). Others, such as Clovis and Folsom groups, utilized fluted points, but these were different types of points that were part of different kinds of adaptive strategies.

In order to avoid any ambiguity, Paleo-indian is defined here as both fluted and non-fluted late Pleistocene and initial Holocene occupations in North America. Clovis and Folsom are defined as fluted occupations characterized by these respective point types; these are occupations that existed on the southern and western Plains between 11,750 B.P. and 10,000 B.P. Eastern fluted point groups or occupations is used here as a reference to ALL FLUTED POINTS AND ASSOCIATED MATERIAL EAST OF THE MISSISSIPI RIVER. No assumptions are made, at this juncture, of the temporal limits of this occupation or its association with Clovis or Folsom.

This distinction between eastern and western Paleo-indian groups might seem unnecessary. After all, many authors have commented on the remarkable similarity of fluted points across the continent (Willey 1966:48; Ritchie 1983:30). Eastern fluted points share certain morphological and technological attributes with western fluted points, particularly those from Clovis sites (Mason 1958:7). But as a matter of strategy, it is better not to refer to eastern fluted points as Clovis. For by doing so, one implies a shared stylistic pattern, which in turn implies roughly contemporaneous ages of occupation and a shared adaptive system. Lest there be any doubt that such implications are commonly drawn, note:

> although still lacking associated faunal remains, if the Michigan series equates with Clovis, we are obliged to view them as a Great Lakes manifestation of the widespread Llano complex ... and to infer that the people who used such weapons were likewise hunters of such Pleistocene mammals as the American proboscideans (Mason 1958:44; see also Dragoo 1976; Ritchie 1983).

The position in this chapter and the discussion and analyses that follow is to treat eastern fluted point occupations as an entity independent of Clovis or any other western or non-fluted Paleo-indian groups. I have adopted this tactic because it helps establish guidelines for analyzing and understanding the eastern fluted point groups proper. Too often the eastern fluted point occupations are discussed in terms of the Clovis model. This might be a suitable procedure, but only if it could be demonstrated that Clovis and eastern fluted point groups are highly similar to one another. And since they are not, it is not. The main goal of this dissertation is to show what eastern fluted point materials look like once removed from the long shadow cast by Clovis.

One final definitional matter: it is Clovis rather than, for example, Great Basin or California Paleo-indian occupations, that routinely serves as the "western" analog for the eastern model. In fact, no distinction is made in the eastern Paleo-indian literature between "western Paleo-indian" and Clovis. The two terms are synonymous. This, of course, obscures real and potential differences between the Great Basin/ California and Clovis occupations, and highlights the tendency to treat Paleo-indian throughout the continent as homogeneous. In conformance with the eastern Paleo-indian literature, I restrict my discussion of Paleo-indian west of the Mississippi River to Clovis, but do so explicitly and with the caveat that western Paleo-indian and Clovis are not identical.

Facts, Inferences and Issues

Chronology

The essential facts relating to the chronology of the eastern fluted occupations can be summarized as follows: eastern fluted point groups are Pleistocene in age (Mason 1962:235). All fluted points occur south of the region glaciated as recently as 10,000 years ago, but they could be much older (Griffin 1976, 1977; Seeman and Prufer 1982). There are very few radiocarbon dated sites (Haynes 1980); of those dates, some are obviously anomalous (e.g. dates falling in the Late Prehistoric period). Where stratigraphic successions appear, there are no cultural occupations below fluted material (MacDonald 1971).

In the absence of many stratified sites or radiocarbon or geochronological age determinations, the eastern fluted point occupation is frequently dated on "the basis of morphological characteristics [of the fluted points] and comparison with finds elsewhere" (Gardner 1974:36). The comparisons referred to here are, of course, with fluted points from well-dated Clovis sites.

It is generally assumed that eastern and Clovis fluted point groups are contemporaneous, or that eastern fluted point occupations are derived from - and are thus younger than - Clovis (Forbis 1962; Haynes 1980; Willey 1966; but see Mason 1962, 1981). Quite clearly these inferences rest on whether "true" Clovis points occur in the east (Gardner 1974:36). Those who see Clovis forms in the east accept some sort of "ethnic unity" or a rapid spread of fluted point users across the continent (Fitting 1975:31; Gardner 1974; Mason 1962; Ritchie 1983). The apparent identity between Clovis points and eastern forms is accepted as evidence of relatedness, and the apparent identity of the points makes the relations quite close.

But just how similar are eastern and Clovis fluted points? Or, more broadly, how significant is the continent wide spread of the fluted form? Fluted points are similar across the continent insofar as they share a technological attribute: a common hafting technique (Bryan 1977b:358). This makes their "uniformity" no more remarkable than projectile points of a later period that share a hafting technique - such as notching - on a continental scale. One never hears the argument that notched points in the Great Basin and eastern woodlands are the same age or, for that matter, demonstrate a shared adaptive strategy (Bryan 1977b).

In order to understand the temporal variability in eastern fluted points, one cannot assume that fluted points mean the same things everyplace, however much they appear alike. For example, Griffin (1976) has argued that the

> large number and variety of fluted point forms over much of the eastern United States ... implies that these populations were in the east as early as they were in the better documented western areas (Griffin 1976:15).

It is equally plausible that the eastern fluted point groups are older than the Clovis groups (Griffin 1977:5), or that they lasted longer (Haynes 1977; Forbis 1962). The fact remains that there is sufficient stylistic variability to suggest spatial and temporal differences (Haynes 1980; Ritchie 1957; Snow 1980), and from that follows the conclusion that eastern fluted point occupations do not have the restricted chronology characteristic of Clovis groups (Cox 1972). Gardner's (1974:36-38) observation that Clovis-like forms occur stratigraphically below other fluted forms at the Thunderbird site is important for detailing stylistic sequences within the east, but not for determining whether the eastern and western forms are coeval.

Three classes of data are valuable for more fully developing the chronology of the eastern fluted point occupation: these are radiocarbon dates, geochronological dates, and projectile point styles. In recent years it has become apparent that there are a number of factors that effect the reliability of a radiocarbon determination, including the nature of the material being dated and its association with the target event - the occupation of the site (Meltzer and Mead 1983). The radiocarbon dates from eastern fluted points cannot be accepted at face value, but instead must be screened for these biases.

Geochronological dates, based on the association of fluted point material with geological features of known age, are practical only in northern regions, where fluted point occupations can be related to well dated glacial features such as morainal systems or proglacial lakes (e.g. Mason 1958, 1962; Prufer and Baby 1963; Quimby 1958). Moreover, these kinds of associations are not straightforward, since they are affected by aboriginal land use and subsistence strategies. Use of this data has to take into account whether fluted point materials were physically associated with the glacial features at the time those features (such as lakes) existed, or whether the association was with extinct landforms or topographic remnants.

There are broad patterns in the distribution of fluted point styles, but as yet these are only roughly related to temporal variation. This is, by far, the most complex of the three sources of information on chronology, as it requires careful sorting and identification of the stylistic attributes of the points themselves. On the other hand, this class of data has great potential for yielding useful information, since fluted points are spatially distributed throughout the eastern states. Owing to the scale of these data, this particular aspect of the chronological problem is treated in a separate chapter (Chapter 6).

Subsistence

There are few unequivocal facts about the subsistence strategies of eastern fluted point groups. In a positive vein, a few sites have yielded organic remains. These include carbonized seeds from a variety of berry species, charred fish bone, and the bones of caribou, Rangifer sp. (Funk et al. 1969; Grimes 1979; McNett et al. 1977). In a negative vein, two classes of evidence are notably absent from eastern fluted point occupations. First, there is no evidence that these groups specialized in the hunting of proboscideans, as is characteristic of Clovis sites (Haynes 1966; Dincauze 1981). Second, there is no evidence for tools commonly associated with the processing of wild plant foods (Mason 1981; Ritchie and Funk 1973; Snow 1980).

One cannot rely too heavily on negative evidence, as it may reflect collection or other biases rather than meaningful prehistoric patterns. On the other hand, if it can be shown that the effects of the biases are minimal, then the evidence takes on some importance. Consider, for example, the lack of cultural remains in association with the remains of proboscideans. Were either cultural remains or proboscidean remains rare, or were sites containing these remains routinely overlooked, then the absence of an association between the two would not be significant.

But there are well over 600 occurrences of mastodon alone in only the glacial and periglacial region of the eastern United States (Dreimanis 1968). They are found in regions abundant in fluted point groups and the mastodon were contemporaneous, and occupied the same areas. Yet their remains are never physically associated as they are in the better known Clovis localities (Ford 1974). In this instance the negative evidence seems compelling.

Less compelling, however, is the absence of plant processing materials. Certainly plant processing tools of the type commonly found thousands of years later in Archaic and Woodland sites are lacking (Mason 1981:98). But then there is reason why they should be. After all, the adaptations represented by these later groups are quite different. Until the specific uses of the eastern fluted point tool kit is better understood, it would be premature to infer anything about the subsistence strategy from this bit of negative evidence (save, perhaps, that their tool kit differed from the one used by later groups). In effect, there may be biases in our abilities to recognize plant processing tools (Dunnell 1972:81), and this makes the negative data insignificant. For this reason, I am unconvinced by Snow's (1980) argument that the absence of food grinding tools indicates that wild plant foods were unpredictable, and therefore that the eastern fluted point groups could not and did not practice a generalized subsistence strategy (Mason [1981:98] makes an argument similar to that made by Snow).

Almost in spite of the facts (positive and negative) that would seem to preclude specialized proboscidean hunting as either a viable strategy - or one practiced by eastern fluted point groups - an imposing edifice of inference has been built around that very notion. Many maintain that eastern fluted point groups were like their Clovis counterparts in pursuing a specialized hunting strategy, exploiting the mammoth or mastodon (Fitting 1970; Gardner 1976; Funk 1977; Kraft 1977a; Seeman and Prufer 1982; and Stoltman 1978 are some of the more recent references).

In the absence of evidence supporting this position, and in the face of a good bit of evidence denying it, this inference derives from analogy with the Clovis model and a hefty bit of circumstantial (and weak) evidence. Those who argue that eastern fluted point groups were specialized hunters have pointed to the continental spread of 'Clovis' points as indicative of the continental spread of the Clovis adaptation (Funk 1976; Haynes 1980; Stoltman 1978). But, recalling the arguments just made, the fact that eastern and Clovis Paleo-indian groups shared a hafting technique is not convincing evidence that they shared an adaptive strategy as well (Bryan 1977b).

Others argue that a spatial correlation in the distribution of fluted point sites and localities of extinct megafaunal remains indicates their past physical interaction (Haynes 1966; Martin 1967; Mason 1962, 1981; Quimby 1965; Stoltman and Williams 1965). Yet this correlation is restricted to a very small area - the lower peninsula of Michigan - and is not apparent throughout the remainder of the eastern United States and Canada (Seeman and Prufer 1982).

Vast numbers of mastodon remains are found in areas lacking fluted points and vice versa. Where abundant remains of each are found in the same area, they are never physically associated. In all likelihood, the correlation seen between the distribution of fluted points and proboscidean remains is better explained by the fact that these remains were deposited and subsequently exposed on surfaces of like age: after all, they were contemporaries. This is a more parsimonious explanation than Mason's comment that the relationship manifest in the co-occurring remains had to be more than "platonic" (Mason 1981:98).

Finally, whether or not they accept Martin's (1967) specific model of Pleistocene extinction caused by human overkill, many have pointed to this episode in faunal history as evidence of widespread specialized hunting (Mason 1962:243, 1981:107; Salwen 1975). The timing of the extinction process, which is said to correlate precisely with the Clovis occupation, is marshalled in support of this argument.

Yet a critical analysis of the relevant radiocarbon record highlights the flaws in this argument. Mead and I (Meltzer and Mead 1983, In press), have a sample of 375 radiocarbon dates run on 23 genera of extinct mammals. Our analysis demonstrates that extinctions were complete across all genera by 10,000 B.P. (Meltzer and Mead 1983: Figure 1), and thus were contemporaneous with the Clovis Paleo-indian occupations (Haynes 1970). The analysis also reveals that the radiocarbon record is strongly biased by a disproportionate number of dated Clovis sites (Table 1).

TABLE 1. Radiocarbon dating and association of late Pleistocene megafauna

	Associated with human remains	Not associated with human remains	Total
Radiocarbon dated	17	92	109
Not radiocarbon dated	4	396	400
Total	21	488	509

Chi-square = 46.093, significant at 0.001

Adjusted residuals by cell: 6.78 -6.78
-6.79 6.80

The upshot is that whether a site is dated and whether it has associated human remains are not independent variables. The chronological correlation between extinctions and human hunting is more apparent than real. Moreover, the fact remains that little is known of the population dynamics of extinctions. The process could well have started thousands of years before the appearance of the Clovis hunters, making any chronological correlation irrelevant.

It seems, and this is a speculation on my part, that the continued support of the notion that eastern fluted point groups were specialized proboscidean hunters is rooted in a desire to produce formal prehistoric units or culture-historical periods with precise boundaries (e.g. Stoltman 1978). By their very nature these schemes require internally homogeneous units. Glossing over the variability in Paleo-indian materials east and west allows one to fulfill these requirements; or, at very least, it makes it possible to construct prehistoric periods and stages (Cleland 1976; Stoltman 1978; Willey 1966).

An alternative inference of the subsistence strategy of eastern fluted point groups holds that these groups practiced a more generalized foraging strategy (Bryan 1977b; Dincauze and Curran 1983; Gardner 1977; Griffin 1977; Milanich and Fairbanks 1980). This inference is supported by the meager evidence of organic remains from sites like Shawnee-Minisink (McNett et al. 1977), and the lack of evidence for systematic specialized hunting.

Quite obviously the intra- and inter-assemblage variability of the toolkits at these sites is an important source of data for analyzing inferred subsistence strategies. The kinds, frequencies and diversity of the tool classes monitor differences and similarities in adaptive strategies. But tool kit variation in fluted point sites is not well understood. As was the case with fluted points, it has long been assumed that the tool kit associated with Paleo-indian groups was uniform or standardized. It has been claimed, for example, that the basic Paleo-indian tool kit "was essentially the same except for minor local components, whether in the eastern or western parts of the continent, regardless of the environment" (Haynes 1980:119).

Most archaeologists, in speaking of materials from eastern fluted point sites, have also remarked that these assemblages appear to be uniform (e.g. Byers 1954; Cleland 1976; Dincauze and Curran 1983; Funk 1972, 1976; Mason 1981; Ritchie 1957; Snow 1980; but cf. Gardner 1977). The standard tool kit contains "almost universally ... biface knives, biface preforms, endscrapers, side scrapers, flake knives and other unifaces" (Funk 1978:17; see also Mason 1981:85-86; Ritchie 1983:30; Snow 1980:125-127).

Oddly enough, the standard tool kit that allegedly occurs across vast distances (Mason 1981) and diverse environments (Eisenberg 1978), supports both sides of the debate over subsistence strategies in eastern fluted point groups. Many attribute the uniformity of the tool kit to "a highly conservative way of life, attuned to the requirements of a specialized subsistence pattern dependent on the ubiquitous megafauna (Funk 1978:17; identical arguments are found in Byers 1954; Cleland 1966, 1976; Jackson 1983; Mason 1981; and others). At the same time, Dincauze and Curran (1983; see also Dincauze 1981:76) argue that

> the standardization of the tool kit existed not to serve repetitive, special functions but to maximize flexibility and to reduce risk as procurers moved across space and utilized resources as available. Standardization ... allowed these people to exploit diverse environments ... (Dincauze and Curran 1983:7).

A similar argument is made by others (e.g. Bryan 1977b; Eisenberg 1978).

Yet both of these arguments are premature, since each derives from faulty or questionable evidence. Since the early 1950s, when eastern fluted point sites were first uncovered, archaeologists have been repeating the dictum that the tool kit is standardized. It may even be true. But since it has never been demonstrated, in anything but a superficial fashion, and since even a cursory look at the data would suggest otherwise, then it behoooves us to take a closer look at the alleged uniformity.

With few exceptions, the inference that the tool kit is standardized is based only on an observation of the kinds of tools present at the different sites. One routinely reads the statement that "with the exception of [Tool X], every major tool type known from other eastern sites was present at [Site Y]" (Dragoo 1973:52; in this case, X are pieces esquillees, Site Y is Wells Creek). Little attention has been paid to whether these tool classes are differentially represented at the various sites, or whether they are indeed distributed evenly at each site (Gardner 1977).

The fact that the tool kit is standardized in terms of the presence of a set of tool classes is important; but so too is the manner in which tool classes within that standard tool kit vary in frequency at individual sites; the degree that the tool kit is curated or expended at individual sites; and the variation in the technology used to produce the tool kit (Bryan 1977b). Looking only at the presence/absence of tool classes at these sites ignores variability in the assemblages.

I am not suggesting that it is impossible to test subsistence strategies using tool kit data: far from it. Rather, I am arguing that any test has to examine in detail the variability in the tool kit, and go beyond the simple presence of tool classes. Among other sources of data, information is necessary on the raw material, technology, diversity and abundance of these assemblages. As is careful screening for biases related to the recovery and collection of archaeological materials. It is necessary to demonstrate whether the sample of artifacts is, indeed, representative of the assemblages at the site.

In order to place interassemblage tool kit variability in an adaptive context, it is necessary to analyze late and postglacial environmental settings. The palynological and paleontological records for eastern North America are quite extensive, and the information from those records can be analyzed to reconstruct the major biotic communities within which the adaptations were played out. In recent years, models of foraging theory have become popular in anthropology (e.g. Winterhalder and Smith 1983), and with the aid of environmental data these have been applied in archaeological settings (e.g. Keene 1981; Lewis 1979). It is not my purpose to use the environmental data in this manner. Valid application of the foraging models requires more information than is retrievable in the paleoecological record. Rather, it is valuable to analyze the paleoenvironmental record to determine a priori what kinds of constraints, if any, were imposed on human adaptations in the area during the late and postglacial.

Additional data useful in the reconstruction of subsistence strategies are site location and recovered organic remains. Regarding the former, it is useful to analyze settlement location for topographic patterning or for the kinds of microenvironments being exploited. With this class of data it is necessary to screen extraneous factors that influence either the placement, or chance of recovery, of archaeological materials (Bryan 1977a). These include factors like soil deposition and modern day land use (Goodyear et al. 1979; Lepper 1983a,b).

Organic remains, as mentioned earlier, are rare at eastern fluted point sites. Unlike the absence of associated human and megafaunal remains, this scarcity probably does not represent the absence of an activity, so much as it represents a set of biases that destroy the record.

Settlement

Discussion of the settlement pattern of eastern fluted point groups entails two aspects: the settlement system, whether mobile or non-mobile, and the settlement type, whether nucleated or dispersed. I deal with each of these separately, beginning with the settlement system.

Settlement system

It was long ago suggested that the settlement system of Paleo-indians, and this included the eastern groups, was one that entailed great mobility (Roberts 1939). This was codified in the mid-1950s by the "Seminars in Archaeology" group (Beardsley et al. 1956). They listed seven types of community patterning, the first and simplest of which was called "Free wandering", defined as frequent movement without restriction, movement conditioned only by the local abundance and mobility of big game species (Beardsley et al. 1956:135). This type was manifest in the archaeological record by a "wide distribution of artifact types that are simple in nature and limited in variety" (Beardsley et al. 1956:136). Paleo-indian groups in North America were given as examples of this type.

This should come as no surprise, for this type of community patterning was defined by the Seminar group almost entirely on the basis of archaeological data derived from Paleo-indian sites (not unexpected, given the composition of the group). This being the case, assignment of Paleo-indian groups to the "Free wandering" category is something of a tautology. For that matter, Steward (1960) questions on ethnographic grounds whether this stage ever existed, and Parsons (1972) argues that the scheme has little practical utility.

These criticisms notwithstanding, the scheme produced by the Seminar group is still used, although in recent years it has become customary to read that eastern fluted point groups actually practiced a "Restricted wandering" rather than a "Free wandering" pattern (Eisenberg 1978; Gardner 1977; Ritchie and Funk 1973; Snow 1980). As is frequently envisioned, the colonizing eastern fluted point groups were free wanderers who, once they had become familiar with an area, began to establish themselves within broad and loose territorial limits, and so developed a restricted wandering pattern (Funk 1976:223-224; Ritchie and Funk 1973:7; Snow 1980:50). Some authors would emphasize greater restrictions and less wandering (Eisenberg 1978; Gardner 1977), while others would put the emphasis on less restrictions and greater wandering (Goodyear 1979; Mason 1981).

There are three lines of evidence on which inferences of mobility are based: two of these rely heavily on an analogy or homology with Clovis. For example, those who accept the notion that eastern fluted point groups were specialized hunters like their Clovis counterparts, argue that they had to be mobile and far ranging in order to follow the megafauna, and ultimately cause their extinction (Mason 1981; Salwen 1975; the most extreme form of this argument is in Martin 1973). Specialization on the late Pleistocene megafauna allowed these groups to "selectively ignore and override ecological differences from region to region" (Mason 1981:107), but forced them to adopt a highly mobile settlement system (Mason 1962:245). How the prey "overrode" such differences is obscure, and makes one question the premise of this argument.

Similarly, high mobility of the settlement system is also inferred on the explicit assumption that true Clovis forms occur in the east, and on the implicit assumption that stylistic differentiation takes time. If the projectile points are identical east to west, then it indicates little elapsed time, which in turn implies rapid movement. The number and distribution of points "sustains the inference of a wide range of movement" (Ritchie 1956:72). As summarized by Mason (1962),

> the near continental distribution of the highly sophisticated Clovis fluted point and its accompanying tool kit seems ... to argue for the spread of their makers in a relatively short time (Mason 1962:245; see also Fitting 1975:30-31).

The weakness inherent in these inferences are clear. Undemonstrated assertions about (1) the subsistence strategy of eastern fluted point groups, or (2) the identity of their projectile points and tools with Clovis forms, are not compelling evidence on which to base conclusions about settlement mobility.

A third measure commonly employed to assess settlement mobility is the amount of "exotic" raw material at a site. Exotic is taken to mean stone that occurs at a site but not naturally in the surrounding region (Gramly 1980:828; Ritchie 1965:6). On the assumption that the exotic stone had to have been carried into the site by its occupants, the presence of the stone becomes a "measure of the mobility scale of the adaptation" (Binford 1979:261; see also Funk 1976; Goodyear 1979).

Most eastern fluted point sites contain elements of exotic raw material (Funk 1976). In some cases, the raw material of the site comes from sources that outcrop 200 or more miles away (Cox 1972; Ritchie 1957; Simons et al. 1983). If one assumes that this raw material is a by-product of the settlement system, then this is impressive evidence for wide ranging movement and mobility (Goodyear 1979:7).

But the situation is actually more complex than the apparently straightforward equation of exotic raw material equals mobility. There are other factors that can account for the appearance of raw material at a site (or in a region) away from an actual outcrop. These include the movement of stone by means of gift giving or trade (Cox 1972; Eisenberg

1978; Funk 1973; Goodyear 1979; Miller 1982; Snow 1980) and the movement of stone by glacial action (Eisenberg 1978) or other geological processes (Gardner 1974; Miller 1982). If either of these processes took place, the result would be stone brought into a site without any necessary movement on the part of the inhabitants. Let me then examine the evidence for glacial/geological action and trade as these affect the distribution of lithic raw material.

Certainly there is ample proof that natural agencies, but most especially glaciation, had a significant impact on the distribution of siliceous cryptocrystalline material, both within the glaciated region and in areas where the glacial fields drained. In these regions, stone is moved in bulk and over great distances. Onondaga chert, for example, which outcrops in New York and Pennsylvania (Lavin and Prothero 1981), has been found in terraces of the Ohio River near Ashland, Kentucky (H.T. Wright, personal communication, 1983). In fact, because siliceous cryptocrystalline materials are among the hardest common materials in the environment, they often constitute a disproportionately large component of tills and moraine gravels. By and large, the variety of cherts in till is quite complex, since the transported material is gathered over a large area.

Therefore, before a lithic raw material at a site is designated as exotic, it is necessary to demonstrate that the outcrop is outside the region and that cobbles of the material are not locally available in secondary deposits of glacial till. Unfortunately, this is uncommon in studies of raw material use (Lavin and Prothero 1981; Wray 1948), although the testing is rather simple. To screen the effects of glacial action requires first mapping areas where the possibility exists for secondary lithic raw material deposits; this includes both glaciated regions proper, and areas with major rivers and streams draining the glaciated region. This sets the spatial boundaries of the area within which the processes take place, and therefore where the source data must be examined closely. Two attributes of the lithic raw material at sites within these areas must be examined: the nature of the cortex flakes, and the diversity of the raw material types. When combined, these attributes provide a key for sorting the use of secondary cobble deposits from the use of an outcrop source (Meltzer 1983b). The specifics of this test are developed in detail in the fifth chapter.

Glacial ice had an undeniable effect on the distribution of siliceous stone in glaciated and associated unglaciated regions. If eastern fluted point groups used cherts from cobble sources, and there is no good reason to suppose they did not, then the picture of settlement mobility as measured by so-called exotics requires careful analysis (along the lines just sketched). But what if trade, in addition, was responsible for transporting raw material within and between regions? The issue of mobility as measured by lithic exotics would become even more clouded. Is there evidence for trade?

It has been asserted that "gift exchange ... was primarily responsible for the conveyance of exotic cherts that appear in most Paleo-indian sites" (Snow 1980:152, emphasis mine). While others might not share this view of the importance of trade, a number feel it might have occurred (Cox 1972; Eisenberg 1978; Funk 1976; Miller 1982).

However, the claim that trade took place, or was responsible for the presence of exotic cherts in most sites - is exceedingly difficult to test. To demonstrate that trade took place requires knowing the location of the stone source, demonstrating that eastern fluted groups were territorial, locating the territory in relation to the stone source and other group's territories, knowing the extent/mobility of the settlement system of these groups, and demonstrating that the material does not occur within the territory or boundaries of the settlement system and would therefore had to have been traded in (and could not be carried in). There is little knowledge of any of this crucial information.

Snow's claim that eastern fluted groups were territorial and traded is not well supported. It is based on the inference that these groups were specialized hunters (Snow 1980:150-152). More to the point, Snow ignores the possibility that the "exotic" material in these sites was brought in by glacial action, a telling omission given that the sites with which he deals are in glaciated areas.

Webb (1974) has suggested that the identification of an exotic source for some material or artifact

> does rather conclusively prove that the item moved at some time from source to destination, [but] it does not of itself necessarily indicate anything very much about the manner in which the movement in question took place (Webb 1974:360).

Given this, and the nature of the data at hand, there is no ready test to disconfirm trade as a mechanism causing the appearance of exotic raw material at these eastern fluted point sites. But at the same time I would speculate, and it is no more than a speculation, that trade was neither routine nor of "primary" importance (Goodyear 1979; Moeller 1980). For this reason the focus of my analysis is on what can be examined: how much of the variation in raw material can be accounted for by movement of material by natural processes. When additional theoretical/substantive evidence appears to indicate trade occurred or could be tested, then the evidence here will have to be reevaluated.

Determining settlement mobility among eastern fluted point groups entails the analysis of four classes of data. The primary source of information is raw material source and use, screened for the effects of natural transport by ice or other facts. In Chapter 5 a key for determining the source of raw materials at a site is presented, along with the analysis of the specific sites in the data set.

An additional source of information comprises tool attrition and wear data. These variables provide a measure of the uselife of an assemblage. Taken together with patterns of the raw material diversity, these data indicate distance (temporal/spatial) from the source of the stone to the site.

Projectile point styles are another source of data on mobility. Sites within the same mobile settlement systems will have similar - if not identical - projectile point styles. Given sufficient variability, mapping these will determine the system scale.

Finally, data on use and reuse of particular sites is valuable, insofar as it indicates periodic abandonment/return - and thus movement. It is critical in evaluating data of this sort to separate sites caused by the buildup of successive occupations from those caused by an intensive, single occupation.

Settlement type

Settlement type refers to the way in which the population is aggregated in space, whether nucleated or dispersed. If nucleated, then the local population aggregate or settlement represents the entire community, and is of sufficient size to survive most stochastic fluctuations of mortality, fertility and sex ratio to reproduce itself (Wobst 1974:172-173). By contrast, with the dispersed type the local population aggregate is a fraction of the entire community. The community breaks into smaller units, by family or along other social/functional lines, and those units are distributed across the landscape on a seasonal or annual basis. Those dispersed units regroup at intervals in order to insure the cultural and biological reproduction and survival of the community.

Little is known of the settlement types of eastern fluted point groups, save that some of their sites are quite large, some are very small, and all appear to vary in complexity (as measured by the number and kind of activities represented). As a consequence of this lack of direct evidence, discussion of settlement types takes one of two approaches: inference from archaeological data and patterns (e.g. Gardner 1977; Gramly 1982); and, inference from ethnographic analogues, with occasional doses of Service's (1962) ethnographic models (e.g. Fitting 1970; Funk 1976; MacDonald 1968; Ritchie and Funk 1973; Snow 1980).

As an example of the first approach, Gramly (1982) analyzes data from four eastern fluted point sites - Bull Brook, Debert, Vail and Whipple. His conclusion that the sites were seasonally occupied led him to suggest two alternative views on settlement patterning. One view argues that the groups using these sites were nucleated year-round, but moved between major summer and winter camps. Associated small camps are seen as "mere way-stations in the round of transhumance" (Gramly 1982:75; this is analagous to the situation described by Winters 1969).

Alternatively, he suggests that dispersed family camps were the common mode of settlement, with nucleation taking place only at kill-associated sites on a seasonal basis. According to this view, small camps were occupied for long periods, perhaps during the cold season (Gramly 1982:75-77; like the Shoshone case - Steward 1938). Gramly persuasively argues that these small camps - if they represent dispersed settlements - should be fairly abundant. By his count, they are not, and he therefore favors the view that small camps are simple way stations between nucleated settlements (Gramly 1982:78).

Gramly is well aware that this kind of test assumes that there is a valid sample of small camps, and that they are found in representative numbers. Further, he acknowledges the fact that neither of these assumptions is well-founded (Gramly 1982:78). Given this, his conclusions cannot be firmly supported, at least not without subsequent tests (Gramly 1982:76). Yet the importance of Gramly's analysis is not the specific conclusions he reaches, but the fact that he provides a means of testing his arguments.

A second approach to the settlement types of eastern fluted point groups is evident in the discussion of Funk (1976; see also Ritchie and Funk 1973). He begins his argument with the suggestion that there are strong analogies between eastern fluted point groups and the Tuluaqmiut band of the Nunamuit Eskimo (Funk 1976:226). Oddly enough, he calls attention to the fact that Fitting (1970) and MacDonald (1968) have used other analogs (the Barren Ground Eskimo and Montaignais-Naskapi, respectively) to explain the very same data, but does not justify his selection of an additional analog, or comment on theirs.

Campbell's (1968) analysis of Tuluaqmuit settlement pattern is the basis for Funk's discussion. Campbell (1968:15-17) divided Tuluaqmuit settlements into six types. Of these, only the Type I or "central base" is nucleated, the remainder are settlements dispersed along various lines (by season and by activity primarily). Nucleation occurs to exploit the seasonal caribou migration: "the major Tuluaqmuit encampments were mainly predicated upon the habits of the caribou" (Campbell 1968:15).

Funk offers the caveat that it is unlikely that these ethnographic patterns can be applied to eastern fluted point groups in "a simple and uncritical way" (Funk 1976:227). But because he feels it is very likely that the caribou played a central role in the subsistence strategies of the fluted point groups, and because "many aspects of Tuluaqmuit life ... seem to have something familiar about them" (Funk 1976:228), he proceeds to apply these specific ethnographic patterns to eastern fluted point sites. He suggests that Bull Brook and Debert may have been much like Campbell's (1968) Type I settlements, that Potts and Davis may be examples of Campbell's (1968) Type II settlements, and so on (Funk 1976:227-228).

The result of Funk's analysis is a set of inferences about archaeological settlement types based on and adjusted to categories that are neither universally true nor theoretically defined, but are instead a description of one particular ethnographic group made by one particular ethnographer. Confidence in Funk's analysis must therefore rest on the belief that this particular ethnographic group represents typical or general behavior among caribou hunters. Unfortunately, one cannot place a great deal of faith in this assertion.

In some respects the Tuluaqmuit are very similar to, for example, the Montaignais-Naskapi, in that both nucleate on a seasonal basis to exploit caribou, then disperse their populations for much of the remainder of the year (Fitzhugh 1972; MacDonald 1968). Despite these similarities, there is no reason to expect that the six, very detailed settlement types specific to the Tuluaqmuit are also characteristic, in detail, of the settlement types of either the Montaignais or Naskapi. And, in point of fact, they are not.

The Type I or central base of the Tuluaqmuit is occupied intermittently and by various groups of the community throughout most of the year; all members of the community occupy the site during the caribou migrations in April and May, and August through October (Campbell 1968:16). The site itself exists and is utilized independent of whether the entire community is there or not. By contrast, among the Montaignais-Naskapi groups there evidently were no core sites utilized throughout the year by either the full community or units thereof (Fitzhugh 1972:47-51).

If the six settlement types of the Tuluaqmuit do not match in detail the settlement types of other, contemporary caribou hunters of the tundra and tundra/forest edge, then it is unreasonable to argue that they somehow match the settlement types of purported caribou hunters of 10,000 years ago. Such an argument can only be made after the relevant conditions of the adaptive strategies of these Late Pleistocene groups have been determined independent of any recourse to the ethnographic models.

Nonetheless, when applied in a more general sense ethnographic data, whether from the Tuluaqmuit or Montaignais-Naskapi, are quite useful for delineating the systemic or dynamic conditions under which nucleation and dispersion occurs. Nucleation and dispersion are adaptive strategies, aimed at adjusting the population size of the local group to the amount and distribution of the available resources (Hayden 1981). Among ethnographic hunter-gatherers, dispersion commonly occurs when resources are low in abundance but evenly spaced (Dyson-Hudson and Smith 1978; Harpending and Davis 1978). Where the resources are highly abundant and clumped, nucleation or aggregation is possible and, depending on the subsistence strategy, highly advantageous (Heffly 1981; Wilmsen 1973).

Because animal and plant resources fluctuate in their availability over the course of a season or year, or even across space, then the degree of aggregation and the timing of aggregation must become a flexible part of the adaptive system. Groups may aggregate seasonally to exploit more effectively a highly abundant resource, then disperse when that resource is no longer abundant. As Conkey (1980) has suggested, nucleation may be highly variable in its duration, location, cyclicity, extent, personnel and activities.

Differentiating sites representing entire communities (nucleated) from sites representing parts of communities (dispersed) thus takes on some importance. For it provides an additional insight into the underlying subsistence strategy, and the way that strategy was operationalized.

Return, for example, to the case of human groups living on the tundra. This is an environment of low species richness, but with high numbers of individuals per species. The tundra food chain relative to human beings is very short, consisting of caribou who eat lichens. Other animals, such as the Yellow-cheeked vole, are incapable of sustaining human life for any prolonged period (Fitzhugh 1972:179). But the caribou is a spatially incongruous resource, and thus human hunting groups must be mobile and have a fluid social system, one capable of aggregating and dispersing elements of the population in relation to peaks and valleys of resource abundance (Heffley 1981; Smith 1978). While the specific settlement systems of the Tuluaqmuit, Montaignais-Naskapi, Caribou-eater Chipewyan or Caribou Eskimo are not be directly applicable to late Pleistocene caribou hunters, seasonal population nucleation almost surely is (Heffly 1981). If eastern fluted point groups exploited caribou, then one expects to see nucleation, at least on a seasonal basis.

There are various lines of evidence that inform on nucleation and dispersion. In her analysis of aggregation among Early Magdalenian groups in Cantabria, Conkey (1980) isolated diversity, particularly assemblage evenness, as a key indicator (Conkey 1980:612). Based on evidence from ethnoarchaeological studies (Yellen 1977), she concludes that activity diversity increases as aggregation increases, and that this is reflected in the archaeological record in increased tool kit and assemblage diversity. Put simply, the larger the crowd, the "more likely it is that any specific (and compatible) activity will take place there" (Conkey 1980:620). There are some difficulties with Conkey's assumptions, that the number of people is proportional to the number of activities and to the number of tools, and these are addressed in Chapter 5.

Regardless, this kind of analysis requires, aside from careful attention to the kinds of units employed, a determination as to whether an occupation represents a single event, or a series of multiple events. For this reason, data on assemblage diversity can be complemented by additional sources of information, namely data on seasonal occupation and reoccupation of particular sites.

Further, site size is a useful variable here, although it must be treated with caution, since site size is not proportional to the degree of nucleation or dispersion. Regardless, site size, both in areal extent and in terms of the amount of material present, when treated as an ordinal variable (large versus small sites) can indicate when, for example, nucleation did not occur. The biases effecting this measure are strong, for the vagaries of preservation, which tend to break up sites, and the vagaries of recovery, the tendency to locate only large sites, result in the collection mostly of larger sites.

Some thoughts on the issues

The preceding review of data and inferences about eastern fluted point groups was not meant to be a comprehensive identification of individual positions on specific issues. Rather, the aim was to highlight differences in thought and opinion within three broad areas: chronology, subsistence and settlement. There are striking differences in those areas.

Eastern fluted point groups are variously perceived as having been coeval with Clovis, older than Clovis, younger than Clovis, or having lasted longer than Clovis (Forbis 1962; Gardner 1974; Griffin 1977; Haynes 1977, 1980; Mason 1962, 1981; Willey 1966). Their subsistence strategy is traditionally seen as one of specialized proboscidean hunting, but alternatives include specialized caribou hunting, generalized foraging, or a combination of generalized foraging and specialized caribou hunting (Bryan 1977b; Dincauze and Curran 1983; Funk 1976; Gardner 1976; Gramly 1982; Seeman and Prufer 1982; Stoltman 1978).

Some argue these groups were highly mobile, while others suggest their mobility was restricted around a central base, possibly related to a stationary resource such as stone (Eisenberg 1978; Funk 1976; Gardner 1977; Mason 1981). Finally, some suggest these groups were nucleated year round, while others liken their settlement pattern to one of seasonal shifts between nucleation and dispersion (Funk 1976; Gramly 1982; MacDonald 1968).

It is equally evident that there are different ideas of what constitutes relevant data or valid lines of inference. To take the most obvious example, different authors attach different emphasis and importance to the Clovis model. For some, it is relevant data to be utilized in developing interpretations about eastern fluted point groups

(Mason 1981; Stoltman 1978). Others would altogether exclude the Clovis model from discussion of eastern fluted point occupations (Bryan 1977b; Dincauze and Curran 1983).

The differences of opinion over chronology, subsistence and settlement and, on a deeper level, the differences over what constitutes relevant data are rooted in at least two factors: historical inertia and the impoverished archaeological record for eastern fluted point groups. Historical inertia is a factor, insofar as the Paleo-indian occupation was first defined on the southern High Plains at Folsom and Clovis sites. As a consequence, when similar projectile points were recognized in the eastern United States, the Paleo-indian pattern of specialized hunters was extended there as well. The impoverished record is also a factor: were there more, well-dated sites with good organic preservation the situation would doubtless be improved. There would be no need for recourse to the Clovis model, and some of questions that now appear quite impossible to answer would be resolved.

But to attribute the lack of consensus over substantive matters to historical factors and poor data, or complex differences about relevant data, partly begs the issue. For many of the questions being asked can be resolved by the data at hand. The obstacle preventing that resolution is the fact that these issues have not been addressed in the proper frame. Determining patterns and pan-regional adaptive strategies requires an analysis of data on a region-wide basis.

Yet, traditionally, the "overviews" of eastern fluted point materials include a detailed look at one specific site with which an author is familiar, coupled with a cursory examination of data from other sites: the "View from ______" approach. This generally involves only a nominal description of interassemblage variability (e.g. Funk 1978; MacDonald

1971, 1983; Mason 1981; Snow 1980).

To resolve these problems, and some of the issues I have discussed in this chapter, this dissertation analyzes three kinds of data: historical data, relevant to the origin and development of Paleo-indian studies; environmental data, relating to the Pleistocene biotic communities within which these human adaptations were played out; and, archaeological data, in both the site and non-site context. Each of these is described in the section that follows.

Description of the data sets

Historical data

The development of Paleo-indian studies in North America began to take on its modern form in the mid-19th century. It was then that the antiquity of the human race was conclusively demonstrated in the alluvial valleys and caves of Europe, which in turn led to the ambitious application of the European Paleolithic/Neolithic scheme to this continent. Over the next 70 years, between 1860 and 1927, American archaeology was embroiled in a controversy over human antiquity on this continent. It was a controversy that was to have lasting implications for both American archaeology and studies of Paleo-indian adaptations.

In order to understand the origin and subsequent tenacity of the myth that eastern fluted groups were specialized proboscidean hunters, this history must be analyzed. For it reveals why the sites on the southern High Plains, kill sites all, were so very important in solving the chronological issues, and why that resolution had such a tremendous impact on Paleo-indian studies.

In the chapter that immediately follows, I examine the literature on this controversy, as well as the relevant literature on American archaeology and society in the late 19th and early 20th century. My review and analysis of this material differs from other, similar attempts (e.g. Mounier 1972; Willey and Sabloff 1974; Wilmsen 1965), not only in its detail, but also in the nature of the source material. These works focus only on published sources, either because unpublished material was unavailable, or perhaps because it was believed that published sources alone could provide a sufficient record of the controversy, the evolution of thought, and the development of a consensus.

In my analysis of the long debate over human antiquity and its impact on Paleo-indian studies, I have relied on an extensive study of the relevant unpublished archival materials. This approach is quite valuable insofar as it complements the published record. For published documentation, particularly that which is contentious, is often a post hoc summary of what the participants of a debate feel should have transpired, and not what actually did transpire. Moreover, positions on an issue are often caricatured to facilitate drawing clear-cut boundaries. In effect, because the published record is laundered for public consumption, omitting uncertainty, false starts or wrong turns on the part of the author, the historian is faced with documentation with uncertain but potentially significant biases. Unpublished archival materials, such as letters, diaries and unpublished reports, can partly eliminate those biases, and provide a more detailed exposure of the evolution of thought and critical intellectual influences and machinations.

Paleoenvironmental data

The Holocene or Recent period is "abnormal" climatically, at least when contrasted with the typically cold climates of the last 2 million years (Davis 1976). Similarly, the modern floral and faunal patterns are markedly different than those of the Pleistocene (Wright 1976a), and for this reason are of limited utility in reconstructing the biotic communities facing fluted point groups in the eastern half of the continent.

Yet, historically, archaeologists have tended to use these modern environmental patterns as a basis for inferring the structure and changes in Pleistocene environments (e.g. Fitting 1968; Funk 1972; Ritchie 1965; Turnbaugh 1973). It is often implicitly assumed, further, that Pleistocene environments are monotypic in structure, much like those of the Holocene (Jochim 1980). And from this position one finds the assumption that humans adapt to the "zones" themselves, and not the variability within the zones (Winterhalder 1980).

With the developments in paleoecology in the last 20 years, it has become unreasonable to stereotype Pleistocene environments as quantitatively different although qualitatively alike those of the Holocene. In fact, the keyword describing the biotic communities of the Pleistocene is complexity, they differ in both kind and degree from the modern environmental communities. These communities exhibit the sympatry of species now allopatric (Graham 1976), with the attendant relatively high values of species diversity.

In Chapter 4, I analyze the relevant published data that bear on the reconstruction of the complex late Pleistocene environments. The analytic focus is on two classes of data: the palynological record and the paleontological record. Each is a different kind of data, subject to different biases, and providing different sorts of information. For that matter, there are many more pollen cores than there are sites with

Pleistocene faunal remains. By examining these two independent data sources, a more detailed picture of the complexity of the biotic communities is derived. This, in turn, enables certain conclusions regarding the adaptive potential of these environments for human subsistence, and thus suggests alternative models of subsistence for eastern fluted point groups.

Archaeological data

The archaeological record for eastern fluted point occupations has accumulated largely over the last 50 years. Isolated fluted points have been collected since the late 19th century (Beauchamp 1897; McGee and Thomas 1905; Moorehead 1910), but it was only after they were recognized as coming from an independent, late Pleistocene occupation were they reported with any regularity (e.g. Shetrone 1936). Similarly, it was only in the late 1940s and early 1950s that eastern fluted point sites began to be discovered and reported. Since that time, there have been discoveries of some three dozen sites that either have fluted point components or are assignable to a late Pleistocene occupation on independent evidence.

Fluted point sites and isolated fluted points are quite different kinds of data. Yet each is valuable. Earlier in this chapter I specified some of the kinds of information needed to resolve the contentious issues of chronology, subsistence and settlement. These included information such as radiocarbon dates, geochronological dates, subsistence remains, site setting and location, raw material usage and interassemblage variability.

The site data contributes to the resolution of these issues by providing data on setting, location, raw material usage, interassemblage variability, and possibly even age and associated subsistence remains. The isolated fluted point record is useful since it provides the potential for breaking up the normative category of "eastern fluted point".

Traditionally all fluted points have been lumped together in a single, broad typology. There are exceptions, such as the type categories "Cumberland" or "Ross County" (Mason 1962; Prufer and Baby 1963), but by and large these are ill-defined and have no clear spatial and temporal boundaries. In order to allow the ecological explanations I propose, it will be necessary to show that the point data, just like the site data, are not homogeneous.

My analysis focuses separately on the site data and the data for isolated fluted points. The sources for this data are (1) published reports on both isolated fluted points and sites with fluted components, and (2) unpublished site reports and a set of data I compiled on isolated fluted points.

Quite obviously, the published record, or any data reporting over which one has no personal control, will not always be in a form amenable to one's needs. Moreover, with the site record specifically, vagaries in recovery can introduce unwanted bias into an analysis. Recognizing this, I have elected to use the published record and the work of other researchers, for the simple reason that this remains the most practical strategy for examining data from large regions. Sites and isolated fluted points are scattered throughout the eastern States; the published record is the only means by which that data can be seen in its entirety and all at once. Nonetheless, it is important to recognize that this record is potentially biased, and screen the data accordingly.

My analysis includes over 1000 of the roughly 6000 isolated fluted points accounted for in the published literature (Brennan 1982; Seeman and Prufer 1982), and 22 of the 38 sites thought to represent fluted point occupations (see Table 2). The means by which these samples were derived, and some of their characteristics are discussed in the following subsections.

Eastern fluted point site data

Not all of the 38 sites that are thought to represent fluted point occupations can be used in an analysis of interassemblage variability. Some cannot be used at all, while others can be used but only partially or with stated conditions. The reasons for this vary, but revolve around the integrity of the assemblage, and the confidence with which it can be assigned to the fluted point occupation. The initial concern then is to sort the sites and identify those with poorly controlled or unuseable data.

Of the 38 sites, one can be readily omitted from analysis. The Carlson Annis site is an Archaic shell mound in which two fluted points were recovered (Webb 1950). The points were evidently brought into the site and reworked by its inhabitants. Three more sites are evidently late Pleistocene in age but lack diagnostic fluted point material. These are the Holcombe Beach (MI) site, Little Salt Spring (FL) and Meadowcroft (PA). The Holcombe site <u>purportedly</u> contains fluted points (Fitting et al. 1966:92-93), and was dated by geochronological methods to just prior to 11,000 B.P. (Fitting et al. 1966:133). But Griffin (1977:10) and others (Roosa and Deller 1982:4) have observed that the Holcombe points are not fluted, strictly speaking, but rather are basally thinned. Griffin, further, has questioned the association of the site with the glacial lake sequence (Griffin 1977:10). In the face of this, it is better not to include Holcombe among other, unequivocal fluted point sites.

Three more of the 38 sites are clearly eastern fluted point sites, but are as yet unpublished and in some cases unanalyzed and unexcavated. These are the Harney Flats (FL) site, the Munsungun Lake (ME) site, and the Whipple (NH) site. Information from these sites is utilized, insofar as it is available.

Finally, nine additional sites have mixtures of fluted and later materials: Banting (ON), Hi-Lo (MI), Hussey (ON), Parrish (KY), Pine Tree (AL), Plenge (NJ), Quad (AL), Stone Pipe (AL) and Wapanucket (MA) sites. The mixing of archaeological materials from different cultural periods at the same site poses significant problems, since the only diagnostic material of the fluted point occupation is the fluted point itself. The remainder of the tool kit can be - and is - duplicated in assemblages of later periods (Mason 1962, 1981; Morse 1976, 1978). It is therefore impossible to sort - in an absolute and unequivocal fashion - the tools of fluted and later assemblages.

The Plenge site, located in eastern New Jersey, is a good example of the problem as it is encountered. In the preliminary report published on the site in 1973, the artifact assemblages described are those gathered from private individuals who have surface collected at the site over the years (Kraft 1973). It is evident from this report that Plenge is by "no means a pure or closed component" (Kraft 1973:61). Nonetheless Kraft has argued that the problems of intermixing are ameliorated by the fact that the "lithic materials and technology" of the fluted point tools are "far superior" to the tools characteristic of the later groups occupying the site (Kraft 1973:61). This is an argument frequently made when dealing with mixed assemblages (e.g. Cambron 1955, 1956; Robbins and Agogino 1964; Soday 1954; Webb 1951).

This argument comes close to being tautological. It is assumed that fluted point tools will show the selective use of only high quality lithic raw material, and that later groups will not. Then this assumption is used to separate the fluted and non-fluted tool assemblages at the site. Subsequently the conclusion is reached that the later period tools - going back to the Plenge example - are manufactured on "shaly" material, while the earlier fluted point assemblages conform to the general expectation and are manufactured of jasper and other cherts (Kraft 1973:61-62; see also Rolingson and Schwartz 1966).

At Plenge there is independent evidence - a large number of fluted points - to suggest that some of the tools may well be from a fluted point occupation. But in the absence of actual counts of the suspected Archaic-age materials, or a sorting of the raw material by function (are all Archaic projectile points manufactured on "shaly" material?), it would be premature to accept that the 4000 plus artifacts are attributable to a fluted point occupation.

Nonetheless, at Plenge, as well as at the other sites with mixed assemblages, there is no mistaking the age or affiliation of the fluted points themselves. Thus, the fluted points at these sites can be used in an analysis of stylistic variability, to the degree that the information is reported.

Of the 38 sites then, some 16 cannot be used directly in analyses; of these, four (Carlson Annis, Holcombe, Little Salt Spring, Meadowcroft) cannot be used at all, while the remainder can only be used where information is available or where it is demonstrably related to the fluted point occupations.

The remaining 22 sites are listed in Table 2(a); the 16 just discussed are listed in Table 2(b). The sites in Table 2(a) are grouped together because they all have clearly defined fluted point components. These 22 sites are the primary focus of the analysis.

Data for each of the sites was compiled from primary sources, listed in Table 2(a). Where available, information was noted on recovery technique, site setting/location, site area, site structure (presence of features, activity areas, etc.), paleoenvironmental setting, proximity to lithic raw material sources, radiocarbon dates and geochronological age estimates, recovered organic remains, kind and frequency of artifact types, kind and frequency of lithic raw material types, kind and frequency of fluted projectile points, and the investigator's interpretation of site function. Given the period over which these sites were investigated, and the number of different investigators involved, it should come as no surprise that not all sites could provide the necessary information.

In some cases, this was because the data were simply unavailable. For example, the majority of sites lack radiocarbon dates and data on paleoenvironments. In other cases, the data were collected but not reported. Recovery techniques are not always discussed in sufficient detail. Insofar as these factors effect the analysis, they are discussed and their impact assessed. This insures that there is no confusion between negative data caused by, say, a recovery strategy, and negative data that reflects a genuine absence in the record.

It is generally true, however, that when data were provided they were provided in a straightforward manner compatible among investigators. Only in one instance was it necessary to transform data in the published record into a form compatible among investigators and thus suitable for analysis here. In compiling information on the frequency and kinds of artifacts in these assemblages, I was faced with the fact that artifact classes vary by investigator. To insure comparability across sites, the artifact types used in a report were lumped or split into a set of "generic"

TABLE 2. Eastern fluted point sites

(a) Sites included in analysis

Site (State)	Period worked	Recovery technique	Primary reference(s)
Barnes (MI)	1950s;1974	SC/EXC(S)!	Wright and Roosa 1966 Voss 1977
Bull Brook (MA)	1950s-1960s	EXC(S,US)	Byers 1954, 1955, 1959; Grimes 1979
Davis (NY)	1950s-1960s	SC(U)	Ritchie 1965; Snow 1980
Debert (NS)	1960s	EXC(S)	MacDonald 1968, 1971
Dutchess Quarry Cave (NY)	1960s-1970s	EXC(S)	Funk et al. 1969; Kopper et al. 1978
Fisher (ON)	1970s-1980s	EXC(S)	Storck 1983
Gainey (MI)	1979-1983	SC,EXC(S)!	Simons et al. 1983
Kings Road (NY)	1960s-1970s	SC(?)	Funk, Weinman and Weinman 1969; Weinman and Weinman 1978
Parkhill (ON)	ND	EXC(?)	Roosa 1977a, 1977b
Port Mobil (NY)	1960s-1970s	SC,EXC(U)	Kraft 1977a, 1977b
Potts (NY)	1960s	SC(U)	Ritchie 1965; Funk 1976
Reagen (VT)	1950s	SC(?)	Ritchie 1953
Shawnee-Minisink (PA)	1970s	EXC(S)!*	McNett et al. 1977; Eisenberg 1978
Shoop (PA)	1940s-1950s	SC(S,U)	Witthoft 1952; Cox 1972
6LF21 (CT)	1977	EXC(S)!*	Moeller 1980
Thunderbird (VA)	1970s-1980s	SC,EXC(S)!*	Gardner 1974, 1977
Twin Fields (NY)	1973-1974	EXC(S)!	Eisenberg 1978
Vail (ME)	1979-1980	SC,EXC(S)!	Gramly and Rutledge 1981; Gramly 1982
Welling (OH)	mid 1960s	SC,EXC(?)	Prufer and Wright 1970

Wells Creek (TN)	mid 1960s	SC(S?)	Dragoo 1973, 1976
West Athens Hill (NY)	1960s	SC,EXC(?)	Funk 1973, 1976
Williamson (VA)	1946-present	SC(U),EXC	McCary 1951; Benthall and McCary 1973

(b) Sites excluded from analysis

Site (State)	Reason for exclusion	Reference
Banting (ON)	Mixed component site	Storck 1979
Carlson Annis (KY)	Fluted material intrusive	Webb 1950
Harney Flats (FL)	Insufficient data	Daniel and Wisenbaker 1983
Hi-Lo (MI)	Mixed component site	Fitting 1963
Holcombe (MI)	Lacks diagnostics	Fitting et al. 1966
Hussey (ON)	Mixed component site	Storck 1979
Little Salt Spring (FL)	Lacks diagnostics	Clausen et al. 1979
Meadowcroft (PA)	Lacks diagnostics	Adovasio et al. 1978
Munsungun Lake (ME)	Insufficient data	Bonnichsen 1983
Parrish (KY)	Mixed component site	Webb 1951
Pine Tree (AL)	Mixed component site	Cambron 1956
Plenge (NJ)	Mixed component site	Kraft 1973
Quad (AL)	Mixed component site	Soday 1954
Stone Pipe (AL)	Mixed component site	Cambron 1955
Wapanucket (MA)	Mixed component site	Robbins and Agogino 1964
Whipple (NH)	Insufficient data	Dincauze and Curran 1983

SC= surface collection; EXC= excavation; (S)= systematic; (U)= unsystematic; != soil material screened; *= soil material floated morphological/functional categories. These classes are the "lowest common denominators," selected to be compatible with the widest range of sites and artifacts and thus underestimate variability. The basic set of classes was initially derived - and subsequently modified - from the Debert site report (MacDonald 1968). Selection of Debert as the model was deliberate: this report has served as an exemplar for the analysis of assemblages at many eastern fluted point sites. The artifact types used by MacDonald (1968) are frequently employed by others (e.g. Cox 1972; Dragoo 1973; Funk 1973, 1976; Gramly 1982; Kraft 1973). So for many sites conversion was unnecessary, and, in fact, extensive reworking of the published data was rare.

Another problem encountered was that in a few cases the number of items within an artifact class was not given. Where this occurs, it generally reflects an investigator's view of the importance or, better, unimportance of a particular artifact class. Certainly fluted projectile points are often carefully tallied and analyzed (e.g. Prufer and Wright 1970; Roosa 1977a,b). In fact, in commenting on the site report for Parkhill, MacDonald (1983) noted that a "preoccupation with the minutiae of fluting technology precludes a balanced overview of this assemblage" (MacDonald 1983:99). If projectile points are the one class generally overemphasized in discussion, then debitage is the one class routinely underemphasized. In some cases, debitage was not collected or only sampled (e.g. McCary 1951; Ritchie 1953). In other cases, it was collected but not counted - frequencies come in the form of estimates (e.g. Eisenberg 1978; Funk 1973). By and large these estimates appear to be quite reliable. In one case it was necessary for me to estimate debitage counts based on other evidence. The precise number of flakes at the Shoop site are not given in either of the primary sources (Cox 1972; Witthoft 1952). However, the ratio of flakes to tools is reported (Cox 1972:20), and by knowing the number of tools it was possible to derive the number of flakes. The actual data tables of artifact type and frequency are in Chapter 5, and since they form the basis of much of the analysis, I also address the effects of these vagaries in item counts.

More generally, all of the data from these 22 sites are tabulated and appear throughout Chapter 5. Again, where biases in recovery, analysis or reporting has a potential impact my analysis, those biases are screened. The effort is made to insure that patterns in the archaeological record are not obfuscated by idiosyncracies or vagaries in recovering and reporting that record.

Fluted projectile points

The sample of 1039 fluted projectile points analyzed in Chapter 6 comes from two sources: one compiled from a direct examination of a series of points; the other from published reports and surveys. There are differences in the quantity and quality of information available from these two sources, so each is discussed separately in the pages that follow.

The projectile points I examined directly are held in both institutional and individual (private) collections. The institutional collections are those of the Smithsonian Institution, Peabody Museum (Harvard University), Ohio Historical Society, and the Universities of Kentucky, North Carolina, South Carolina and Tennessee. The two individual collections are the property of avocational archaeologists, Mr. Phil Perkinson of Raleigh, North Carolina, and Mr. Beverly Burbage of Knoxville, Tennessee. My methods of data collection differed in these two settings.

My essential concern in compiling this data set was to isolate stylistic and functional variability in this widely distributed and potentially style rich class of artifacts. Thus the initial task was to generate a set of measurements that would faithfully replicate the size and shape properties of the points, and develop a series of nominal observations that would accurately describe their non-metric variation. There were a couple of factors guiding the selection of variable and attributes.

First, I realized early on in the planning stage that I would have access to only a limited number of points that could be examined directly. It was evident that the data set would ultimately be dominated by data from the published record. The published record, in turn, is rather limited, generally containing only the very basic descriptions and measurements of morphology and technology. Thus, the deliberate decision was made to pattern the variables I measured after the published record, in order to maximize comparability among the sources of data.

But I did want to include as much ancillary information as possible, in the event that the variables commonly used in the published record by themselves were insufficient. My second guiding factor then was to increase the level of detail in the measurements and descriptions I made, but avoid spending an inordinate amount of time making the measurements and descriptions. There were certain constraints, largely financial, that forced me to develop a system that could be implemented efficiently over large data sets and collections.

Briefly, four kinds of information were noted for each projectile point I examined. First, a series of metric measurements were taken to the nearest 0.05 mm with Helios dial calipers. Then, observations were made of the presence or absence of a series of attribute states, including basal morphology, basal grinding, bevelling, wear, reworking, lithic color and material. Third, information was taken on where the projectile point was found and where it is now located. In many of these collections, both public and private, locations of discovery are known only to the county level, a circumstance quite common throughout eastern North America (Moeller 1983). Finally, plan drawings and photographs were made of each projectile point. My justly uninspiring art work served to locate the extent of grinding, wear, fluting patterns, and breakage patterns. However poor the quality of the drawings, they nonetheless serve as a valuable supplement to the color photographs made of each point. Taken together, the drawings and photographs make a permanent record of point shape and attribute states.

Without exception, each of the institutions I visited provided me with laboratory space and darkroom facilities to enable me to examine and photograph the points. There were no constraints placed on my use of the collections, save those that were self-imposed. As a consequence I have complete data for the points I examined at the Institutions listed above. However there were some problems involved in the study of private collections.

Both Mr. Perkinson and Mr. Burbage were very generous in granting me access to their collections, but were understandably reluctant to let me remove those collections to nearby laboratories or offices for detailed study. Thus, in these cases I simply photographed all the projectile points, obverse and reverse (as was my general procedure), and noted where the point was found. This was done in full anticipation of my later drawing and measuring the points from the photographs.

This was only a partly successful strategy. While it was possible to draw these points from the slides, taking measurements was somewhat complicated. A detailed ruler was used in all photographs, and thus it was simple enough to scale the slide properly. Hence, two-dimensional plan measurements (e.g. length, width and the like) were easily taken from the photographs. Impossible to obtain in this manner were two other kinds of data: measurements related to three-dimensional variables (e.g. point thickness, fluting thickness), and information on certain edge and surface attributes (e.g. lateral and basal grinding). Breakage patterns are generally evident in the slides, although wear and reworking are often difficult to discern.

Fortunately, many of the points in Perkinson's collection are well documented in published records (Perkinson 1971, 1973) and from that source I was able to recover some of the missing information. While at Perkinson's I measured certain of the points for which he had published measurements, and found that his descriptions and measurements were reliable.

The fluted point collections at the Smithsonian and Peabody Museum (Harvard) are not dominated by points from any one state. On the other hand, the collections at the various universities and the Ohio Historical Society are predominantly from their respective states. As a consequence, the sample that I was able to examine directly was rather uneven in spatial coverage. In order to boost that data set, even out the spatial coverage, and derive a sample that roughly represented the frequency of points found in the various states, I turned to the published record for eastern fluted points.

Counting the number of fluted point finds in a state is a favored pastime in eastern Paleo-indian studies (for only the most recent examples of this, see Brennan 1982; Seeman and Prufer 1982; the ancestral form of this species of literature is Shetrone 1936). So is arguing over which state or area of the country has the most fluted points (Brennan 1982:45-46; Dragoo 1976:9; Mason 1962:235; Seeman and Prufer 1982:162; Williams and Stoltman 1965:674). One useful by-product of these studies are the fluted point surveys. These surveys, generally done on a state by state basis, generally include frequency and distributional data, and sometimes data and photographs of individuals points.

For the analysis in Chapter 6, data on isolated fluted points was compiled from the following state and regional surveys: the Delaware Valley (Mason 1959), the Susquehanna Valley (Kinsey 1958, 1959), Michigan (Mason 1958), New York (Ritchie 1957; Saxon 1973), North Carolina (Perkinson 1971, 1973), Virginia (McCary 1947a,b, 1948, 1949, 1952, 1953, 1954, 1956a,b, 1958, 1961, 1963, 1965, 1968), West Virginia (Dunnell n.d.; Hyde 1960); and Wisconsin (Stoltman and Workman 1969).

Use of published projectile point data was complicated by the same kind of factors effecting the use of the published site reports. The essence of the problem, again, was that information important to my analysis was not always provided. Nonetheless, I was routinely able to use the published information on fluted points whenever it included descriptions of the variables I used in my own analysis. Recall that the variables and attributes I selected for analysis were chosen with the published record in mind. There was no need to transform data; rather, there was a problem of missing data. The representativeness of this data set is addressed in Chapter 6.

CHAPTER 3

DEVELOPING AN ARCHAEOLOGICAL MYTH

Even a casual acquaintance with the literature on eastern North American paleoindians makes it clear that the interpretation of the fluted point materials has been influenced heavily by the data from the southern Plains and Arizona (Morse 1978). The fluted point groups of the east are thought to be economically specialized hunters, pursuing large herbivores, many now extinct, with technologically specialized fluted projectile points (Bryan 1977b:357). Yet it is evident (see next chapter) that the environmental complexity of the eastern forests during the late Pleistocene precluded specialized subsistence strategies. This is confirmed by the absence of sites east of the Mississippi linking fluted point hunters with the Pleistocene megafauna. But in spite of these lines of evidence, most archaeologists have never seriously questioned the model of eastern big-game hunters (Funk 1976; Stoltman 1978; Willey 1966). The tendency has been to assume that the presence of the fluted point throughout the eastern Woodlands indicates an analogous (and homologous) adaptation with the adaptation on the Plains.

The imposition and persistence of the "big-game hunting" myth on eastern fluted point material is rooted in the history and nature of archaeological explanation. In this chapter these issues are addressed, in order to provide the context for the discussions that follow on subsistence and adaptive strategies.

In an analysis of the source of the "big-game hunting" myth, Alan Bryan (1977b) discussed the tremendous influence of historical processes on the modern practice of archaeology. And he touched on what is known in formal logic as the "fallacy of initial predication." This fallacy occurs where a familiar characteristic of a phenomenon, or some characteristic known sooner than others, is taken as definitive of the phenomenon itself. In the case of Paleo-indian studies:

> Because of the historical accident that the first recognized early sites were kill sites containing...projectile points in association with the bones of large mammals, the generally accepted model has been that the early colonists were specialized big game hunters...(Bryan 1977b:355).

Bryan is no doubt correct in his identification of the historical source of the myth, however he errs in referring to the discovery of those early kill sites like Folsom and Clovis as "historical accidents." He compounds his error by arguing that were the Meadowcroft Rockshelter excavated before the discovery of Folsom or Clovis, then, "our whole conception of Paleo-indian would have been totally different" (Bryan 1977b:359).

Assume, for the sake of argument, that the Meadowcroft site was discovered before, say 1926 (the year before Folsom became public knowledge). What would have been the result? Recognize that Meadowcroft is a rather simple site: its importance is not rooted in artifact sequence, nor in a record of the association of hunters and extinct animals (there are no extinct animals at Meadowcroft; Guilday and Parmalee 1982). The importance of Meadowcroft lies in the admittedly striking column of radiocarbon dates. These dates are the backbone of the site and without them there is no independent evidence of its great antiquity. If the site was found in 1926, when the discoverer of the radiocarbon method was but 18 years old and over twenty years away from his discovery, it would have been ignored. Stripped of its ^{14}C dates, the site may as easily be 100 as 100,000 years old.

In fact, Bryan seems to have forgotten that fluted points were found in the East long before the discovery of Paleo-indian on the Plains (Beauchamp 1897; McGee and Thomas 1905; Moorehead 1910). None of these had an impact on our views of Paleo-indian before 1926.

The point to be made is that while Bryan has correctly identified the historical source of the Paleo-indian myth, he neglects a key ingredient in the importance of the Folsom finds. The Folsom discovery was anything but an "historical accident," as Bryan describes it. It was instead a necessary and sufficient condition for the demonstration of a Pleistocene-aged human occupation of the continent. In America at least, prior to the advent of radiocarbon dating, a kill site like Folsom was the only kind of site that could prove a deep human antiquity. Folsom represents time, and the independent measure of chronology. More to the point, the Folsom finds resolved one issue (a chronological one), and at the same time created another (Paleo-indian adaptations). The remainder of this chapter treats these two issues focusing primarily on the historical processes leading up to the Folsom discovery and the effects in archaeology of that discovey. Portions of this material were recently published (Meltzer 1983a).

The debate over human antiquity

Through the decades of the 1830's, 1840's, and 1850's, an increasing number of sites apparently exhibiting an association of human remains and extinct animals had been discovered in Europe (Oakley 1964). Yet, for a variety of reasons (see Grayson 1983), each case for contemporaneity was rejected fairly systematically. It was not until the late 1850's, following excavations organized by a committee of the Geological Society (London) at Brixham Cave in southwestern England, that evidence for the intermingling of man with the bones of extinct Pleistocene fauna was widely accepted (Gruber 1965). The work at this site led to a careful reexamination of previously reported discoveries, particularly those of the perennial champion of early man, Boucher de Perthes (who for years had been collecting specimens in the alluvial deposits of the valley of the Somme). And it also had the effect of catalyzing the discipline of prehistoric archaeology, triggering the analysis and excavation of cave sites and alluvial deposits linking man and the pre-biblical fauna (see summaries in the contemporary literature by Evans 1872, Lubbock 1865, and Lyell 1863).

The sequence of human history, as refined by Lubbock (1865), was no longer one of Adamite preceded by pre-Adamite but was instead a series of culturally defined periods, each characterized by a particular artifact class or association. Not surprisingly, the sequence was soon incorporated within the emergent evolutionary theory of Darwin. As Grayson observes, the Origin of Species:

> provided a theoretical framework within which a tremendous human antiquity could be understood...questions of human antiquity quickly became caught up in discussions of the larger issues of human evolution (Grayson 1980:28).

The significance of the discoveries in Europe was not lost on the American scientists, despite their preoccupation with the U.S. Civil War (Putnam 1889; but compare Wilmsen 1965).

It had long been suggested (by, among others, Thomas Jefferson and Benjamin Barton; see Wilmsen 1965), that there was ample nonarchaeological and geological evidence, such as linguistic and racial diversity, that seemed to demonstrate the great antiquity of the Indians on this continent (Haven 1856). With the impetus of the European finds, and with the belief that "there is exact synchronism (of geological beds) between Europe and America" (Whittlesey 1868:4-5), it became reasonable to anticipate finding ancient human relics here as well.

Skeletal material was resurrected from the closets of the profession and reexamined. Sir Charles Lyell himself metaphorically dusted off the Natchez (human) pelvic bone, alleged to have been found with the bones of an extinct Megatherium (Lyell 1863:203). Based on a variety of evidence, Foster was led to draw a chart depicting the "Parallelism as to the antiquity of man in the two hemispheres" (Foster 1873:79-81). For Foster, who took a more radical view than most of his contemporaries, these parallels reached back into the Miocene.

There were, however, those like Charles Rau and Sir Daniel Wilson (both trained in European prehistory), who were more sensitive to the apparent discrepancy between the records of the two continents. Rau correctly perceived that:

> we are not entitled to speak of a North American Paleolithic or Neolithic period. In the New World...the human contemporary of the Mastodon, it would seem, was more advanced in the manufacture of stone weapons than his savage brother of the European drift period (Rau 1873:397).

He further cautioned that while flint implements of the Paleolithic type were not scarce in North America, they could not as yet be referred to any particular period since they and other implements were in use among North American aborigines in historic times (Rau 1873:398). More to the point, Rau argued many of the American implements were found in context with more "advanced" cultural materials, and it was not entirely clear whether their primitive nature was due to their antiquity or to their being unfinished implements (Rau 1873:395). In the face of this, Rau chose to be circumspect in the application of the analogy between European and American implements and urged instead the further study and examination of caves and drift beds.

But what had become clear by the time Rau made his plea was that the archaeological and geological situation on this continent was different from that of Europe. Here there were no deeply stratified alluvial valleys or caves with human artifacts or remains mixed indiscriminately with Pleistocene-aged fauna (Wilmsen 1965). As a consequence, the definition of an American Paleolithic age became of necessity based on typological analogues. American researchers inferred from the work of Evans (1872), Lubbock (1865), and Lyell (1863) the idea that all morphologically "rude" objects were by definition Paleolithic in age (Noelke 1974:126) based on the assumption that the older the material, the more primitive its appearance. Identity between European and American implements would determine the antiquity of the latter. It was a position some Europeans challenged, but as Thomas Wilson, Curator of Prehistoric Anthropology at the United States National Museum and trained as a lawyer would later argue, "comparison is as good a rule of evidence in archaeology as in law" (Wilson 1890:679).

The catalyst for these comparative studies was Charles C. Abbott, who began archaeological studies on his ancestral farm near Trenton, New Jersey in the late 1860's (Cross 1956; Hart 1976). At first he held the notion that the artifacts being turned up were those of the precursors of modern indian groups from the region, but by 1876 he had become convinced they were instead the remnants of a different, probably Paleolithic race (Abbott 1876). Within two years he announced that the previous race was glacial in age (Abbott 1877, 1878).

With the support of Frederick Ward Putnam of the Peabody Museum (Harvard), geological studies by Nathaniel Shaler were undertaken at Trenton (Shaler 1876).

Abbott, however, relied more on morphological analogues with European Paleolithic tools than on geological studies: "whatever age the geologists may assign to them, be it inter- or post-glacial, these traces of man must possess a very great antiquity" (Abbott 1881:481). In part the reason for Abbott's reliance on the similarity between American and European Paleolithic tools was his belief that the records of the two continents exhibited homologies as well. The American Paleolithic race (the "River drift men") were descendents of the "Cave-men" of Europe (Abbott 1881:517).

Abbott's analysis of the relationship between the two continents concluded with the triumphant assertion that "the sequence of events, the advance of culture, have been practically synchronous in the two continents; and the parallelism in the archaeology of America and Europe becomes something more than "mere fancy"" (Abbott 1881:517).

That Abbott perceived such marked similarity, particularly when those who were more familiar with the European record (e.g. Charles Rau) could not, is due to the fact that like many American-born scientists of his time, he was anxious to place his work in the context of European scholarship (Sinclair 1979). And for that, he received a measure of recognition from the Old World: A.R. Wallace praised Abbott's work, and likened Abbott to Boucher de Perthes (Wallace 1887).

American geologists and archaeologists were also inspired. And shortly thereafter, Paleolithic implements began appearing in Ohio (Metz and Putnam 1886; Mills 1890), Indiana (Cresson 1890b), Minnesota (Babbitt 1890), Delaware (Cresson 1890a) and Washington, D.C. (Wilson 1889). On occasion these tools were found in a geological context that suggested great antiquity, but more often than not the age of the implement was determined by the "rude" form and grade of the tool. The geological situation was observed more for purposes of context than chronology.

As in the instance of the Trenton artifacts, the tools' Paleolithic identity was determined by comparison with known Paleolithic tools from England and France (Wilson 1890). At scientific meetings Paleolithic tools from Europe were placed alongside of American "Paleoliths," a similar strategy was used in publication. G.F. Wright, for example, argued that the New Comerstown (Ohio) implements was a a genuine Paleolith, as evidenced by its being a perfect representation of Figure 472 in Sir John Evans Ancient Stone Implements of Great Britain (Evans 1872; Wright 1890).

The similarity between European and American paleoliths confirmed the *a priori* belief in the geological antiquity of human groups on the continent, the divergence and convergence of human history and the psychic unity of mankind. In a larger sense, it solved the problem of both the origin and antiquity of man, although the focus was decidedly on the latter issue. By the end of the decade of the 1880's, for Abbott and his colleagues there was sufficient evidence to confirm man's presence here in glacial times; for many, the only question that remained was whether the antiquity of the American Paleolithic race might go back significantly farther (Putnam 1885, 1888).

The apparent consensus surrounding the American paleolithic, however, was short-lived; in the 1890's there was a major backlash against the paleolithic largely from scientists of the Bureau of American Ethnology (BAE). Archaeology as a separate study within the BAE was instituted officially some three years after the Bureau's founding (in 1879). By his own admission, John Wesley Powell (first Director of the BAE) had initially neglected the role of archaeology within his master plan for an American anthropology (Powell 1894:xl), and it took an Act of Congress to focus his and the Bureau's attention on this subfield.

The annual budget of the Institution for 1882 requested $25,000.00 for "continuing ethnological researches among the North American Indians." In open floor debate that was amended to read, "$5,000.00 of which shall be expended in continuing archaeological investigations relating to moundbuilders and prehistoric mounds" (Rhees 1901:363). With this amendment, the BAE began to channel its energy and resources into strictly archaeological matters. And those resources were considerable: by the turn of the century, scarcely 20 years after its founding, the BAE had spent approximately $820,000.00 on anthropological research - nearly $40,000.00

a year (Rhees 1901).

The proximate cause for the Bureau's involvement in archaeology was the Moundbuilder controversy, the question of whether the many apparently uninhabited mounds and earthworks of the Mississippi and Ohio Valleys were the products of the American Indian populations or, as was fashionable in the popular mythology of the time, the work of an extinct race of people (possibly the wandering Israelites or Atlantians) subsequently destroyed by the Indians. Sporadic research and surveys had been made of the mounds since the beginning of the 19th century, culminating in Squier and Davis' massive descriptive treatise on the earthworks around mid-century (Squier and Davis 1848). But as a number of historians have argued (e.g. Tax 1973, Hinsley 1981) these were innately inductive studies and it was apparent to all that they would likely never pass beyond the survey stage. Most of the theories that did surround the earthworks were thinly disguised speculations - and racist speculations at that. The idea that there was once a race of moundbuilders who had built magnificent cities out of earth and who were later exterminated by the native Americans became politically and socially very attractive (Silverberg 1968), particularly for those needing a rationale for the ongoing extermination of the indians of the west.

With the mandate from Congress, Powell, who was equally effective as an administrator and as a synthesizer, quickly incorporated the problem into his overall scheme for an anthropological science. As Bruce Smith has observed, the moundbuilder question was put within the larger context of the cultural development and the origin and antiquity of the historically described indian groups of the United States (Smith 1980).

The approach of Powell and the BAE to anthropology and archaeology was a blend of Lewis Henry Morgan's evolution and Powell's own unabashed uniformitarian geology. Like their counterparts in geology, BAE archaeologists began their interpretation of the past on the assumption that the prehistory of North America evinced the historical continuity of the pre-Columbian population, subject to known evolutionary laws. The approach was decidely against cataclysmic theories that postulated any intrusive or extinct races.

Their positions on the two major issues facing the archaeology of the late 19th century were thus almost foregone conclusions: they would not accept that there had once been a race of moundbuilders different from the contemporary indians, nor would they accept the efforts of others to see in the American archaeological record evidence of a comparable European-aged Paleolithic race. To accept that there had been a race of people on the continent that were non-Indian, or that apparently dated from Pleistocene times, but in neither case seemingly left no succeeding generations, would introduce a massive hiatus in the American prehistoric record (Thomas 1898). This was not only poor uniformitarianism - in its appeal to peoples not known in the present and its introduction of discontinuities into the record - but it also precluded the applicability of the ethnographic data in the explanation of archaeological phenomena.

The reasoning here went something like this. The methodological approach of the BAE archaeologists was typically uniformitarian: one worked from the known (ethnographic present) into the unknown (archaeological past). It was the forerunner of the direct historical approach; as A.V. Kidder described it, the "effort was directed toward identification of ancient sites with modern tribes" (Kidder 1936:145).

Disenfranchised races of moundbuilders and paleolithic peoples would effectively prevent drawing analogies between artifacts of say, the moundbuilders on the one hand, and the ethnographically known tribal groups on the other. If, however, one could merge the archaeological and ethnographic records:

> There would then be no more blind groping by archaeologists for the thread to lead them out of the mysterious labyrinth. The chain which links together the historic and prehistoric ages of our continent would be complete; the thousand and one wild theories and romances would be permanently disposed of; and the relations of all lines of investigations to one another being known, they would aid in the solution of many of the problems which hiterto have seemed involved in complete obscurity (Thomas 1894:21).

Underlying the Bureau's approach was an ideological position whose intent was to demonstrate that the native American race was unchanged and unchanging (Trigger 1980). Any apparent differences between the archaeological and ethnographic records were thought to be either the minor temporal changes expected from the few hundred years that probably separated the earliest and latest Native Americans or, more likely, the result of inter and intra-tribal variation so apparent among contemporary tribes. In the absence of apparent major societal evolution on the part of the New World tribes, the perception became that the indigenous populations were, in terms of cultural change, effectively static.

BAE scientists thus had a science that was broad and comprehensive in its sweeping vision of human history, and one that was firmly allied with the more visible and successful currents of nineteenth century science. And they were not unwilling to claim that they heralded the dawn of a new science of archaeology. As WJ McGee described it, their work would, "revolutionize American archaeology and give a definite basis for archaeologic science in this and other countries" (McGee 1893:August 27, 1893). Holmes claimed that the initial five years he spent on the paleolithic issue were the most important five years in the history of American archaeological research (Holmes 1932). Cyrus Thomas even used a phrase that is familiar to any who has followed the development of archaeology in the last twenty years: "I propose to give the people a taste of the New Archaeology (Thomas to Fowke October 31, 1881).

With this as a background, William Henry Holmes was called on to solve the great Paleolithic controversy. Holmes approached the issue much as Cyrus Thomas had dealt with the Moundbuilder problem. The demonstration that there was no previous Paleolithic (Moundbuilder) race required the demonstration that the artifacts of the indians and the artifacts of the Paleolithic (Moundbuilder) peoples were identical.

Under Powell's direction, Holmes began his archaeological researches into the Paleolithic at a quarry site in Washington, D.C. (a site located just off the 16th Street Bridge over Piney Branch Road; coincidentally, in the summer of 1981, Holmes' quarry site and Abbott's Trenton gravels were opened and reexcavated by crews from NYU and the Trenton Farm Commission). The reason Powell selected a quarry for the light it might shed on the Paleolithic issue was that for many years he had been wandering over the area looking at what were then believed to be "Paleolithic" tools (Powell 1895). He claimed later to have recognized them as "strangely like the forms found near the Shoshoni village sites," but had not felt the matter was worth pursuing until it became apparent that the gravels in which the tools were found belonged to the Cretaceous system (Powell 1895:4). At that point:

> the problem assumed still greater importance, for if these vestiges of the work of man were actually deposited in the gravels at the time of their formation as shore accumulations, then the age of man must be carried back to Cretaceous times (Powell 1895:4).

With a mandate in hand, Holmes began his work at Piney Branch in September of 1889. In an article for the January 1890 American Anthropologist he published his preliminary results. After an extended discussion of the site, quarrying, manufacturing, and the form of materials appearing in quarries, he drew in the Paleolithic problem. On the assumption that every implement must pass through the same stages of development (an assumption current in contemporary European circles, see Pitt-Rivers 1875, although Holmes made no connection), Holmes concluded that one could not use the relative "rudeness" of a tool to tell time (Holmes 1890:13). Further, he suggested that the so-called "turtle-backs", hallmarks of Abbott's Paleolithic age, were in reality rejects marking one of the stages of manufacturing. Turtle-backs were not themselves tools. Holmes' argument was couched in the theoretical framework of the BAE; he argued that the occupations were neither of great antiquity nor discontinuous (Holmes 1890:20), and that ethnic, chronolgical and cultural evidence all pointed to "the Indian as the laborer in these quarries" (Holmes 1890:25).

The literature in the decade after 1890 records Holmes' systematic examination of other quarry sites as well as all alleged Paleolithic sites in eastern North America, including Abbott's Trenton gravels (Holmes 1893a-d). In 1892, he published a more elaborate and detailed exposition of his quarry thesis (Holmes 1892). He began by restating his argument that all tools passed through a single sequence of manufacture, from the basic cobble in the quarry to the finished arrowhead, spear, drill or knife. In the process, the initially crude item became progressively more refined. If one found an object that had been rejected early on in the manufacturing process, it would by necessity appear "rude" and thus reminiscent of older European tools. Holmes, like many of his contemporaries in natural history, literature and education (see Gould 1977), was influenced by the dictum that ontogeny recapitulates phylogeny (see especially Holmes' [1894] article on what he termed the "natural history" of stone tools).

As Wilmsen (1965) observes, the reasoning here is dubious, but it meant one had to be careful in selecting the analogues for supposed American paleolithic implements:

> The critical observer will find...that this European-American resemblance is superficial, and that the rude tools have a much closer analogy with the rude quarry shop rejects of America (Holmes 1892:296).

Further, it was necessary to separate arguments on the grade of culture (savagery/barbarism/civilization) from arguments on the age of the materials. The extant stone age tribes demonstrated the fallacy of assuming that "rude" forms indicated great antiquity.

Holmes' arguments that the alleged Paleolithic tools were historic quarry refuse worked well on artifacts found on the surface, because the context seemed to indicate a recent deposition. For artifacts found in purported glacial gravels, Holmes and his colleagues (particularly WJ McGee, Thomas Chamberlin and Rollin Salisbury) argued that the objects had been on the surface in recent times but due to factors like slumping, the uprooting of trees, and rodent burrowing, they had been incorporated in older strata at greater depths (see Holmes 1893b, 1893d). In those instances where the geological context was unassailable, Holmes changed his strategy and cast aspersions on the collector or excavator (Holmes 1893c). The attitude among Holmes and his colleagues at the BAE and United States Geological Survey (USGS), and this held true through the first two decades of this century (see Holmes 1919; Hrdlicka 1907), was that if <u>any</u> possibility of instrusion existed, if there were any instances where modern indian material <u>could</u> have been incorporated into more ancient geological deposits, then the evidence had to be considered invalid.

As expected, the proponents of the American Paleolithic were unconvinced by the arguments and assertions of the federal scientists (see the discussion in Meltzer 1983a:22-23). They suggested in turn that scenarios of intrusion or redeposition of younger material into older strata were irrelevant in the absence of empirical evidence for that process. They further argued that analogies of indian artifacts with Paleolithic tools were inappropriate since they misrepresented the actual nature of the American Paleolithic artifacts. Finally, they took issue with the BAE approach, which Abbott saw as:

> something that must be <u>proved</u> at all hazards; or if not demonstrated, foisted upon the unthinking to secure the scientific prominence of a few archaeological mugwumps (Abbott 1893:122).

Because the defenders of the American Paleolithic were not about to back down, it is incorrect to suggest that "by the end of the 19th century the BAE and USGS views had been accepted" (Mounier 1972:64). Of those who supported glacial man prior to the 1890's, only a few changed their opinions as a result of Holmes' arguments. What transpired then, in the absence of sound empirical evidence for either side, was a heated and frequently acrimonious debate (Hart [1976] and Morison [1971] discuss the debate in detail).

The debate went beyond the realm of normal scientific discourse with the publication by G.F. Wright of Man and the glacial period (Wright 1892) and the volume's subsequent review by WJ McGee (McGee 1892, 1893). McGee's vituperative and libelous reviews were perceived by the supporters of the American paleolithic not simply as an attack on their archaeological views but a full-bore assault on their credibility as scientists and the role of non-federal workers in science. The current suspicion was that McGee's attacks were but another attempt by sanctioned government science to advance itself at the expense of local and private practitioners (Hart 1976). Powell, who was perceived as orchestrating the government position, was directly criticized in the midst of the spirited defense of Wright. The Paleolithic controversy was part of the growing pains of the discipline of archaeology and as such has importance in the movement toward professionalization then getting started (Hinsley 1976). And it initiated analysis and experimentation with stone tool analysis. But the ad hominem attacks serve to mark the fact that the differences between the two sides of the Paleolithic issue were largely irreconcilable. The proponents of each spent must of their time literally talking past one another (Spencer 1979).

The battles of 1890's were not decisive victories for the BAE camp. Rather, they introduced an element of caution to the previously unrestrained theorizing of the proponents of early man in North America. After the government outburst, it was no longer possible to accept unchallenged apparent morphological analogues between European and American implements as a basis for a common Paleolithic tradition. And, no longer was the description "material found in the drift" sufficient in and of itself to rectify claims of an object being Pleistocene in age. But because the BAE analogues between the American "Paleolithic" tools and indian manufacturing rejects were not recognizably more correct than the Paleolithic analogues, and because the glacial geology of the gravels and drift was still in flux, it was equally impossible to prove the absence of a Pleistocene-aged occupation. The basic ambiguity of the archaeological record in 1890, and the still unstructured state of the discipline, left the matter unresolved. It was in this state when Ales Hrdlicka arrived on the scene and addressed the Paleolithic question from the skeletal evidence.

The human skeletal evidence that was to figure in the early man debates of the 19th and 20th century began appearing in the 1840's (Hrdlicka 1907), but discussion of its bearing on the antiquity issue was initially devoted only to questions of context. Of primary importance was the demonstration that the bones were not intrusive in Pleistocene-aged strata. Thomas Wilson's early chemical tests of fossilization (Wilson 1892) and his pioneering use of the fluorine test to determine the contemporaneity of the remains of human and extinct animal species (Wilson 1895) are manifestations of this research (interestingly, Hrdlicka was aware of Wilson's use of the fluorine test, but because of his [Hrdlicka's] views on early man in the New World, he remained silent on the use of the tests throughout the Piltdown controversy, despite his belief that Piltdown was a fraud).

During the debates of the 1890's on the American Paleolithic, skeletal evidence was generally ignored or lost in the haggling about tool types and geological formations. With the appearance of human bones from various sites (including Trenton), and the discoveries then being made of early hominids in Java, the skeletal evidence took on greater significance.

The first major controversy was over the discovery of a site in Lansing, Kansas in the early 1900's. Human remains were found during excavation of a cellar tunnel on a farm (Holmes 1902). The bones were embedded in loess and, predictably, there were conflicting views on the source of the loess. Advocates of the American Paleolithic suggested that the loess was derived directly from the ice fronts in the valleys north of the site. The opposing camp, with Holmes, Chamberlin and R. Salisbury among their number, argued that the loess was secondarily deposited in recent times from older loess on neighboring slopes. Holmes also had the crania examined, and that seemed to reveal that there was a close correspondence "in type with crania of the historic Indians of the general region" (Holmes 1902:744).

Hrdlicka independently had examined the Lansing locality in 1902, and when he arrived at the Smithsonian Institution in 1903 he studied the human remains more closely. After an analysis using the comparative collections held by the Museum, Hrdlicka reached the same conclusion as Holmes: that the skeleton was typical of the large majority of the present indians of the middle and eastern states (Hrdlicka 1903:328; see also Wedel 1959:91-93 for a different evaluation of the skull).

While Hrdlicka's conclusions were similar to Holmes', his were bound up in a more sophisticated theoretical program. As Hrdlicka argued, in light of:

> present scientific views regarding man's evolution, the anthropologist has a right to expect that human bones, particularly crania, exceeding a few thousand years in age, and more especially those of geologic antiquity, shall present marked morphological differences, and that these differences shall point in the direction of more primitive forms (Hrdlicka 1912:2).

For Hrdlicka, human morphology was the result of the interplay between the potentiality of heredity and the environment. That interaction led to gradual but profound changes through time in body structure. In a general sense, for Hrdlicka morphological changes were the hands on the evolutionary clock. The responsibility to those who would claim great antiquity for human fossil remains was thus to demonstrate that the fossils were more distinct or of a lower grade than the recent or modern Indian remains (Hrdlicka 1907).

This theoretical stance has since been given the label "morphological dating" (Stewart 1949, F. Smith 1977). Hrdlicka refined his notions on morphological dating in the years after the Lansing analysis, and incorporated them in larger study of the skeletal remains found in all of North America (Hrdlicka 1907). Within his theoretical framework, claims for antiquity had to exhibit: (1) indisputable stratigraphic evidence; (2) some degree of fossilization of the bones; and (3) marked serial somatological distinctions in the more osseous parts (Hrdlicka 1907:13).

After having examined the 14 cases in North America that at that time purported to date to the Pleistocene, it was apparent to Hrdlicka that the last criterion was sufficient:

> It has been seen that, irrespective of other considerations, in every instance where enough of the bone is preserved for comparison, the somatological evidence bears witness against the geological antiquity of the remains and for their close affinity to or identity with those of the modern indian (Hrdlicka 1907:98).

By 1912, when Hrdlicka published his Early man in South America, he had expanded his criteria for establishing antiquity. In order to demonstrate that human bones were geologically ancient, one had to prove (1) that the specimens were found in geologically ancient deposits; (2) that the age of the deposits was confirmed by paleontological remains; (3)

that the bones presented evidence of organic as well as inorganic alterations; (4) that the bones showed morphological characteristics referable to any earlier type; and (5) that the human remains were not introduced in later times (Hrdlicka 1912:2). As might have been expected, the fourth criterion was the crucial test, since any human remains that did not present marked differences from those of modern human groups, would be regarded on <u>morphological grounds</u> as "insignificant geologically" (Hrdlicka 1912:3). As Abbott had 30 years previously, Hrdlicka ignored the geology when his analysis showed a solution.

With these prescriptions on his analysis of virtually all alleged evidence for great antiquity in both of the Americas, Hrdlicka reported that, without exception, no bones or artifacts were unequivocally glacial in age and none of the osteological materials was outside the range of the modern Native Americans (Spencer and Smith 1981:439). Hrdlicka concluded that the nigration from the Old World to the New World followed the Neanderthal phase of human evolution, and likely took place in Late Pleistocene or Early Holocene times (which he took to mean around 10,000 to 15,000 years ago; see Hrdlicka 1925).

Hrdlicka's conclusions are certainly not unreasonable, and later developments have proven him correct in many important respects. But there was continual ambiguity over the early man issue, particularly in the teens and twenties of this century. The ever increasing discovery of fossil hominids, compounded by the appearance of the incongruous Piltdown skull and jaw, left interpretations of human history open to debate. It was simply not clear what early human groups were supposed to have looked like, and what morphological changes took place over the millenia. Many, such as Hooton (1930) and Sir Arthur Keith (Spencer and Smith 1981) saw a great antiquity for the anatomically modern human form. Hrdlicka was in a decided minority in his advocacy of the relatively recent appearance of Homo sapiens, following an anatomically distinct Neanderthal phase. In the former instance, morphological data were irrelevant to the issue of early human groups in North America; in the latter, a crucial component of the argument and a reasonable expectation of the fossil record (F. Smith 1977).

Hrdlicka's views on human history left him in an ever-increasing minority. Those who disagreed with him, or did not accept the implications of his morphological arguments (see Hay 1918) were free to speculate with the evidence that linked human skeletal remains with Pleistocene aged fauna, and ignore the consequences of a mid-Pleistocene occupation and the attendant human somatype. One result of the ambiguities over the fossil record and its interpretation was that, as in the controversy 20 years previously, the two sides of the early man issue again found themselves talking past on another. The skeletal evidence was as unequivocal as the evidence from the artifacts.

It is important to note here that the debate over the possible Pleistocene occupation of the North American continent was being played out on at least two separate time scales. There was a European scale, with a deep human past characterized by significantly different morphotypes and artifact types, and there was an American scale, with an occupation possibly glacial in age but clearly not of the magnitude of the European sequence. Hrdlicka defined antiquity in terms of the European scale, and all his arguments against the American data were couched in those terms. American archaeologists and geologists had by this time abandoned the idea of a strictly Paleolithic age in North America, but maintained the likelihood that human groups had been on the continent for thousands or perhaps tens of thousands of years (Wissler 1916). All that was required was solid evidence, and that was provided within a decade at a site near Folsom, New Mexico.

Resolving the debate and creating a myth

The first of the evidence that appeared to show a clear association between artifacts and an extinct Pleistocene mammal came to light in 1925. In an issue of Science that appeared some two months after an attack by Holmes of the alleged Pleistocene aged occupations at Vero and Melbourne, Florida (Holmes 1925), Harold Cook published a preliminary report on the Lone Wolf Creek bison kill site (Cook 1925). Lone Wolf Creek was, of course, early Holocene in age, but it was kill sites like it although older that were finally to prove the existence of a Pleistocene occupation in North America.

In early 1926, Jesse D. Figgins and Cook were visiting a site near Folsom, New Mexico. Seeing in the site some potential to yield material similar to that found at Lone Wolf Creek, Figgins sent workers there with specific instructions to carefully monitor any signs of human antiquity. Evidence was not long in coming. Two points were found in immediate association with bison remains, a fragment of one directly associated with a rib bone (Figgins 1927:322). While no entire points were found in situ, the association of the artifacts was certain (Cook 1927). The following summer (1927), when a point was again found, it was left in the ground while telegrams were sent out to various eastern museums and universities to send representatives to examine the find.

Among those who responded to the call to verify the finds were the BAE archaeologist Frank Roberts, A.V. Kidder of the Peabody Foundation, and Barnum Brown of the American Museum of Natural History (Roberts and Kidder were then at the first Pecos conference). Roberts, after examining the site, reported to the head of the BAE that he had not the slightest doubt that the "buffalo" (bison) bones and the projectile points were contemporaneous; he concluded the points had entered the formation at the same time as the bones had (Roberts to Fewkes, September 13, 1927, BAE papers, National Anthropological Archives). Roberts was not alone in these conclusions: he reported that Kidder and Brown concurred (Roberts 1937).

As Roberts later recalled, he, Brown and Kidder reported on the Folsom finds at the Annual Meetings of the American Anthropological Association in December 1927. According to his recollections, despite the "convincing nature of the evidence, most of the anthropologists continued to doubt the validity of the discovery" (Roberts 1937:155, see also Wilmsen 1965). The published record of the meeting does not square with Roberts' account. In fact, the Association passed a favorable resolution regarding the finds, and called on the USGS to prepare a quadrant map of the site to aid research on the age of the deposits (Hallowell 1928). Roberts' memory of the reception of the announcement, written some ten years after the meeting, likely reflected his reception in Washington rather than at the Andover meeting (Roberts, after all, was an employee of the Smithsonian along with Holmes and Hrdlicka).

Hrdlicka had been invited to attend the Andover symposium and present a paper on his interpretation of early occupations of North America given the Folsom finds. He declined the invitation due to previous commitments

(Dixon to Hrdlicka November 27, 1927; Hrdlicka to Dixon December 2, 1927; Hrdlicka papers, National Anthropological Archives). The following spring Hrdlicka did have the opportunity to speak to the evidence at Folsom, at least indirectly, when he, Barnum Brown and Nels Nelson spoke at the New York Academy of Medicine. Hrdlicka reaffirmed his statement that there was no skeletal evidence in North America that exhibited great antiquity (in the European sense, mentioned earlier); he reiterated his position on the racial differentiation of the North American indians; he then closed by observing that a whole series of eminent men had looked for early man and found nothing prior to the Indian (Hrdlicka 1928). In Hrdlicka's opinion, the problem of early man seemed unresolvable, at least within his generation (Hrdlicka 1928:807).

Nelson, who followed Hrdlicka, disagreed and suggested the matter might easily be resolved after an hour or so of discussion (Nelson 1928:822). Barnum Brown, holding points from the Folsom site, would not even need an hour:

> In my hand I hold the answer to the antiquity of man in America. It is simply a question of interpretation (Brown 1928:824, emphasis in original).

Hrdlicka's reaction to Brown went unrecorded, but four days later after his return to Washington he wrote Brown asking for some slides and more information. Their exchange is most revealing (all in Hrdlicka papers, NAA):

> Hrdlicka to Brown, March 15, 1928: I would...be glad if you would give me your views as to how the artifacts may have come into association with the bisons (sic).

> Brown to Hrdlicka, March 16, 1928: There is absolutely no possibility of any introduction of the points subsequent to the natural covering over of the bison skeleton.

> Hrdlicka to Brown, March 19, 1928: There is only one additional point on which I should like your opinion and that is, the manner in which the arrow points or darts got into these places where they were found.
>
> Brown to Hrdlicka, March 21, 1928: It is my opinion that, at least, three of these points were embedded in some part of the flesh of the animals when the carcasses were entombed...Please write me further if I have not made the situation clear.
>
> Hrdlicka to Brown, March 22, 1928: Thank you for your supplementary letter which is very satisfactory.

It would be fitting to report that, after being unable to have Brown admit to possible intrusion at the site, Hrdlicka enthusiastically and wholeheartedly endorsed the Folsom evidence. Fitting, perhaps, but not historically accurate. All the same, neither he nor Holmes again went on the offensive against claims for early man. In part, this was due to the nature of the Folsom finds, which had a little something for everyone. For Hrdlicka, the dating was still sufficiently ambiguous that it could - and ultimately did - fit within his definition of geologically recent time. Moreover, the lack of skeletal evidence and any dependence on "rude" tools to date the site put Folsom beyond Holmes' and Hrdlicka's purview.

In terms of their specific arguments against the imposition of European models and sequences on the American data, both Holmes and Hrdlicka were correct and nothing in the Folsom site could prove them wrong. On the other hand, with Folsom they lost the larger battle over the presence of "glacial man" on the continent. Folsom exhibited an unequivocal association of man and extinct vertebrates and Holmes, likely recognizing that the time had come when a site had been found and approved by competent geologists and archaeologists, simply dropped the matter entirely (Meltzer 1981b; although when writing his 20 volume autobiography in the late 1920s and early 1930s his successes against the American

Paleolithic were proudly - and rightfully - listed as one of his major accomplishments. He neglected to mention the Folsom finds.) Hrdlicka similarly shied away from the issue but when confronted, spoke to the skeletal evidence (Hrdlicka 1937).

It is important to recognize that Holmes and Hrdlicka could take a fair share of the credit for the acceptance of the Folsom finds, at least indirectly. It was their dominance in the field for nearly 40 years, and their insistence on scientific caution, that led to the eventual acceptance of a set of agreed upon controls for determining authentic evidence for human antiquity in North America. With the Folsom finds their arguments had gone full circle. There was, in 1890, a problem to be solved, but no apparent means of reaching a solution and no idea of what the solution would entail. Arguments based initially on the institutional affiliation and authority of the individual making the argument soon gave way to a more clearly defined scientific discussion. After 30 years of debate on stone tool technology and typology, glacial geology, and the relevance of ethnology and analogy in archaeological research and reasoning, it was apparent what the solution to the early man debate had to look like. The rapid acceptance of the Folsom finds attests to this.

Here, then, are the reasons why the Folsom finds were not an "historical accident," as Bryan (1977b) portrayed them. They were the first, unequivocal finds clearly linking extinct faunal remains with artifacts of human groups. Unlike all previous discoveries, there was no room for ambiguity in interpretation or debate over meaning: the evidence was clear that human groups had been in North America during the Pleistocene. The Folsom finds solved the crucial chronological issue that all later developments in Paleo-indian studies followed. Its discovery had to come before the meaning of a site like Meadowcroft (in the absence of radiocarbon dating) was evident.

While the Folsom finds did not result in an antiquity comparable in depth to the deep past of Europe, it was obvious to most by 1927 that the American data would never provide that kind of prehistory. In spite of (or perhaps because of) this, American archaeologists had begun to channel their efforts into finer scale analyses of chronology. The European sequence and perception of change was replaced with a less epochal view, and with the introduction of the seriation method (Kroeber 1916, Spier 1917), the details of the cultural changes on this continent had begun to be worked out.

The Folsom finds had an important impact here in two ways. First, with the expansion of the prehistoric time scale, the applicability of the ethnographic data and analogues was restricted to only the latest segments of the prehistoric record. Second, with the American prehistoric sequence thus firmly anchored in the Late Pleistocene, the challenge became filling in the temporal details between the oldest and youngest materials. The chasm created by the Folsom finds left American archaeologists without a cultural historical sequence; it is not fortuitous that the first efforts at putting together time-space frameworks appear after the Folsom finds (Ford and Willey 1941; Griffin 1946).

The impact of the Folsom finds were also apparent on more substantive levels. Once it was evident that there was a Pleistocene aged occupation on the continent, efforts were made to determine the precise age of that occupation. It was initially believed that the Folsom materials were the oldest on the American continent, and represented a direct descent from an ancestral Asiatic group (Sellards 1952). Localities were being discovered that linked human remains with the extinct mammoth; the Dent site was reported on in 1933 (Figgins 1933), and excavations were begun at Blackwater Draw (the Clovis type site) in 1932. However the historical relationship between Folsom and Clovis remained unclear for some time. Estimates of the age of the Clovis materials ranged between 12,000 and 13,000 years ago (Antevs 1935); estimates of the age of the Lindenmeier Folsom materials ranged between 10,000 and 25,000 years ago, and in the opinion of the geologists involved, "the age must be much nearer 25,000 years than 10,000" (Bryan and Ray 1940:70).

With the initial recognition of fluted points as a class of artifacts, came the realization that there were a number of variants within the class. Generally two types of fluted points were formalized (Shetrone 1936; Roberts 1939): Folsom points proper and so-called Folsom-like (or Folsomoid, or simply Fluted blade). It was apparent that the true Folsom points had a limited distribution, being found along the western plains strip along the Rockies (Cotter 1937; Roberts 1939:543). Early explanations for the variety of fluted forms held that the differences were due to the Folsom-like points being an ancestral form to true Folsom, or, the reverse, that the Folsom-like points were a later, degenerate descendant form from true Folsom (Roberts 1940). Still another explanation - one still in use today - argued that the larger points (Folsom-like) were used for killing larger animals; the smaller points (true Folsom) used on smaller animals (Mason 1962).

It was not until the late 1940s that some of the terminological and cultural ambiguity was cleared up, and there was stratigraphic evidence of the historical relationship between Folsom and Clovis. As Sellards noted:

> Another culture, Llano (Clovis), is dated as yet only by its occurrence in the Blackwater No. 1 locality, New Mexico, at a level stratigraphically below Folsom culture. This culture...is not only older than Folsom, but is more widely distributed, occurring over much of the North American continent, and may be ancestral as well as antecedent to Folsom culture (Sellards 1952:149).

Despite debate over the precise antiquity of Folsom and Clovis, it was generally agreed upon early on that these Paleo-indian groups were hunters, who "depended entirely upon game - mainly bison, but occasionally the mammoth and a stray camel, deer and antelope - for his maintenance and sustenance" (Roberts 1939:541). One result of that subsistence strategy, it was argued, was mobility. The Paleo-indian groups probably did not settle long in one place but travelled wherever the animals moved in order to support themselves (Roberts 1939:541).

This interpretation for Folsom and Clovis on the western Plains was not unreasonable: after all, the only times when Paleo-indian materials were found on the Plains was when they were associated with paleontological remains of Pleistocene megafauna (remains that are highly visible archaeologically). It is rare, even today, to find Paleo-indian remains on the Plains independent of mammoth, bison or other large mammal remains.

Paleo-indian beyond the Plains

That interpretation, however, was soon extended beyond the boundaries of the Plains proper. In 1936, Henry Shetrone called attention to the appearance of fluted points in Ohio, as well as almost every state in the Union (Shetrone 1936:6). For Shetrone, the distribution of the Folsom points and Fluted blades indicated "the existence over a wide terrain of a common culture horizon" (Shetrone 1936:4). (The concept of a horizon, even prior to its formalization by Willey and Phillips in 1958, meant essentially what it does today: a pattern of culture occupying a great deal of space over a short period of time). John Cotter, in a publication a year later, expressed a similar view. He saw evidence of a widespread "sub-stratum" of the Folsom complex, or at least a general dispersion of the Folsom materials by diffusion or trade (Cotter 1937:35); he later called this a co-tradition (Cotter 1954). Frank Roberts appears to have been the first to argue that the widespread horizon was tied into a uniform pattern of subsistence (Roberts 1945:406).

Yet the evidence for the widespread distribution of Folsom and Folsom-like points east of the Mississippi River contained some apparent anomalies. It was obvious early on that true Folsom points were not being found (Cotter 1937), that the vast majority of fluted points found in the east were not associated with either burials or Pleistocene extinct faunal remains (Shetrone 1936). As a consequence, supporting evidence for their antiquity was lacking, and in a manner reminiscent of the arguments for the great antiquity of the American Paleoliths, it was asserted that the morphological identity between the Plains forms and the eastern forms indicated a comparable age (Shetrone 1936). It was evident to some that this kind of argument was not entirely trustworthy:

> The fact that the Eastern examples bear a striking resemblance to those in the West does not make them of equal antiquity. They may represent a survival of a highly specialized implement in later horizons (Roberts 1939:544).

In spite of these cautions, it was apparent that the fluted point materials were not being found associated with later cultural materials. And when the early period schemes for the eastern United States were written (Ford and Willey 1941; Griffin 1946), they included a possible

Paleo-indian cultural period as a "cultural ancestor" for later periods. W. Ritchie took a different approach; believing that the Lamoka focus was the oldest cultural period in New York, he suggested that the eastern fluted points represented "infiltrations from the Great Plains of the early hunters of mammals now extinct" or, perhaps, "secondary derivation from older deposits in the west, and perchance south, by later migrants to the area" (Ritchie 1944:312).

By the late 1940s, there was still no evidence in the eastern states of any fluted point sites. Fluted points had been found at sites in Kentucky (Parrish Village and Carlson Annis) but in both instances they were clearly not associated with the bulk of the (later) cultural material (Webb 1950, 1951). The absence of eastern sites changed in the early 1950s. The publication of the Williamson site appeared in 1951 (McCary 1951), and in rapid succession the Shoop (Witthoft 1952), Reagen (Ritchie 1953) and Bull Brook (Byers 1954, 1955) sites were reported. The appearance of these sites was taken as evidence of a cultural period underlying the known archaic era (Witthoft 1952), and Ritchie now admitted that there seemed "reasonable grounds for hypothesizing the presence, in a still undated period, of a thinly and widely scattered, mobile, early hunting population over much of the eastern United States prior to the appearance of the cultures classified as Archaic" (Ritchie 1953:249).

While subsistence information was not recovered from any of the sites, the twin themes of hunting and mobility, derived from the Plains interpretations, ran through the reports. Witthoft argued that the Shoop inhabitants represented the vanguard of "highly mobile nomadic hunters of large game" (Witthoft 1952:64; it should be noted that his observation as to the Shoop inhabitant's mobility was based partly on his examination of the sources of the raw materials found at the site). Many were quite explicit in drawing the analogy with the western Plains sites:

> some of the fluted points from Bull Brook are said to be practically indistinguishable from the points found inside the carcass of the Naco mammoth in faraway Arizona (Willey and Phillips 1958:89).

By the 1960s, the metaphor (historical connection too) was still being drawn with the Plains material, however the lack of faunal sites in the east had become an awkward aspect of the theory:

> although still lacking associated faunal remains, if the Michigan series equates with Clovis, we are obliged to view them as a Great Lakes manifestation of the widespread Llano complex...and to infer that the people who used such weapons were likewise hunters of such Pleistocene mammals as the American proboscideans (Mason 1958:44).

Ritchie thought it difficult to understand why "considering the truly large number of proboscidean remains discovered in the eastern United States...not one single reliable instance is recorded of associated evidence of man" (Ritchie 1965:9; see also Mason 1962). It is perhaps worth noting here that throughout this time period and even up to the present, Griffin (1952, 1964, 1977, 1978) has argued that "the restriction of the diet of these early hunters to "big-game" animals has been by certain archaeologists, not by the people of 10,000 to 8,000 B.C." (Griffin 1964:224).

Expectations borne out on the Plains have thus had a strong influence in the manner in which archaeologists have viewed eastern fluted point materials. Even today, arguments are still being made in the absence of evidence for specialized hunting. Lacking direct evidence, the arguments adopt one of a number of strategies. One strategy is to point to the similarities between eastern and Plains Clovis material, and draw the inference that the analogues in the fluted points and chipped stone tools indicate that the eastern groups also had a "primary dependence on now extinct megafauna for sustenance" (Funk 1978:16, see also Funk 1972, 1976; Stoltman 1978). A second line of argument points to the overlapping distribution of fluted points and extinct megafauna as evincing their interaction (Quimby 1958, 1959; Mason 1962; Martin 1967; Williams and Stoltman 1965). While this is admittedly circumstantial evidence, Dragoo (1976) feels it is "too strong to be ignored." As he observes:

> some of the largest known concentrations of Clovis points are in areas where numerous remains of mammoth and mastodon have been found and it is difficult to believe that <u>unlike their relatives in the West</u> the Clovis hunters of the East ignored these great beasts (Dragoo 1976:9, emphasis mine).

In a show of surprising bravado, Stoltman triumphantly concludes that the evidence converges on the view that "a big-game hunting lifestyle analogous to that of Plains fluted-point makers was characteristic of the east at the same time" (Stoltman 1978:712). And, in part, Stoltman is correct, but not for the reasons he gives nor on the scale he specifies.

In the next chapter the environmental structure of the eastern forests during the Late Pleistocene is discussed, and this will show why big-game hunting was unlikely over the broad expanse of the east; it will also show where a form a specialized hunting was possible and likely carried out. In the subsequenty chapters this is discussed in more detail. From this chapter it should be evident that the view of eastern fluted point groups as specialized big-game hunters is not rooted in any empirical evidence, but rather in a complex of historical and archaeological factors dating back 100 years to the early stirrings of the discipline.

CHAPTER 4

LATE AND POSTGLACIAL ENVIRONMENTS IN EASTERN NORTH AMERICA

The nature of the Pleistocene floral and faunal communities has been debated since the first recognition that the extensive areas of "diluvial gravel" were not the result of Noah's flood. However, while most 19th century naturalists recognized that Agassiz's glaciers, continental in scale, had to have an impact on plant and animal distribution, the magnitude of that impact was problematic (Gray 1889). Many simply suspected, as Charles Darwin and Joseph Hooker had, that the plant and animal communities migrated southward in a linear or zonal front in the face of the oncoming glaciers. Darwin noted:

> As the cold came on, and as each more southern zone became fitted for the inhabitants of the north, these would take the place of the former inhabitants of the temperate regions. The latter, at the same time, would travel further and further southward, unless they were stopped by barriers, in which case they would perish (Darwin 1859:366).

As vertebrate paleontologists and, later, palynologists began to deal with the empirical record of these changes, it became apparent that Pleistocene and post-Pleistocene biotic movements were more complex than the presumed accordian-like shifts from North to South and back again. Moreover, it is now apparent that Pleistocene environmental gradients and communities were more complex and only crudely analogous to the Holocene environments of North America (Wright 1976b). This complexity and its implications for human adaptation are discussed in this chapter.

Glacial ice and glacial climates

The Wisconsin-age Laurentide ice sheet had a significant impact on the climate, and thus the biotic communities, of eastern North America. That ice mass was derived from 3 major centers (the Keewatin, Baffin and Labrador centers), and when intact (between 22,000 and 8000 B.P.), covered nearly all of northern North America. To the east, it extended into the Atlantic Ocean; to the west, it abutted the Rocky Mountains in western Alberta and eastern British Columbia (where it may have coalesced for brief periods of time with the Cordilleran ice sheet, which was not a true ice sheet like the Laurentide, but instead a series of mountain glaciers formed together, see Flint 1971). To the north, the glacier extended above the 80th parallel, and at its maximum southern extent, drove down to the 39th parallel. This ice mass, some 4000 km wide and upwards to 3 km high (Flint 1971), had an impact that went beyond displacing arctic and subarctic life zones. There are, according to climatologists, a number of elements we need to consider (Moran 1976).

There is the overall global cooling that took place, which effectively froze large portions of the northern hemisphere and likely depressed continental temperatures on the order of 7 to 12 degrees centigrade (Flint 1971; Schwarzbach 1961).

Second, the continental glacier was probably a barrier holding the very cold, low level Arctic air mass in the Arctic basin (Bryson 1966; Bryson and Wendland 1967). All cold air masses shallower than the crest of the Laurentide (which ranged in height from 500 to 3500 meters, see Flint 1971), would have been prevented from entering southern North America (Terasmae 1973). Exclusion of this air mass, which influences the continentality or severity of our winters, would have had a damping effect on the seasonal swings in temperature (Moran 1976).

Third, as was suggested by studies of extant ice sheets on Greenland and Antarctica, the Laurentide ice sheet was probably characterized by outward flowing katabatic air. This layer of air, arising on the ice, is generally very cool, shallow (200 to 500 meters thick), and drains off the surface of the glacier much like a sheet of water (Flint 1971). As these winds flow beyond the ice margin they undergo compressional heating: as a consequence, this very cold air only has an impact on climates of the immediate ice margin, say within 50 to 100 km of the boundary (Flint 1971). These are areas where one generally finds tundra vegetation, permafrost, and ice wedge development (Moran 1976; West 1961). Katabatic winds were undoubtedly inconsequential for the broader North American climates. It is worth noting here that if an icefree corridor was present between the Laurentide and Cordilleran ice masses as recent studies suggest (Reeves 1973), then it was likely an extremely inhospitable environment. Katabatic winds, when channelled into deep valleys or fjords, greatly increase in intensity. The pollen record that has recently come out of the region (Ritchie 1980) seems to corroborate this: nothing grew there except rocks, and these are notorious underproducers of pollen.

Finally, there is no reason to suggest that the full glacial Pacific and Gulf of Mexico air masses differed in thermal characteristics from their modern counterparts. The interaction of these air masses with the continental ice must have had a climatic impact, notably in increased moisture to the west and southwest (Bryson and Wendland 1967), but the physical properties of their sources likely remained the same (Moran 1976).

This information, coupled with the fact that the Laurentide ice sheet was a low latitude phenomenon (leaving the adjacent land masses subject to the same relatively high solar radiation as at present), can be used as a basis for a number of inferences about full glacial climates. At one extreme the argument can be advanced that not only were temperatures not significantly different during the full glacial than they are today, but that winters were possibly less severe than at present. Glacial climates may have been more equable broadly speaking, with cooler summers and warmer winters (Graham 1976; Slaughter 1967). Here the argument is that glacial climates were different in kind as well as in degree from non-glacial climates. At the other extreme is the notion that climates of the Pleistocene were identical to those of today only displaced southward, and that consequently the environmental structure was similarly displaced southward during the glacial period. This latter, strictly uniformitarian view is likely incorrect (Wright 1976b), but whether glacial climates are characterized accurately when described as more equable is as yet unknown (and will likely remain so for reasons discussed below). All the same, glacial biotic communities are markedly different than their Holocene counterparts and it is to that discussion that I now turn.

First, however, it is useful to observe that Holocene biotic communities exhibit a marked zonal structure across space, with the latitudinal layering of tundra, boreal, northern hardwood and deciduous forests of the east. This structure is tightly tied to two critical climatic controls: average annual minimum air temperature and available moisture. In western North America the latter is the dominant factor, in the east, it is temperature that has the most pronounced influence. For example, the summer and winter boundaries of the Arctic air mass set the northern and southern boundaries of the Picea dominated Boreal forest, and the southern limit of the Arctic tundra (Bryson 1966). In the abstract, the Holocene biotic communities are best visualized as a series of tightly overlapping distributional curves of individual taxa. The boundaries between groups of cooccuring taxa are "selected" principally by temperature and moisture, but controlled locally by inital population frequency (Botkin et. al. 1972), mode and rate of dispersal, successional history, soils and topography, and inter and intraspecific competition (among other factors).

If it is the case that Pleistocene arctic air masses climates were indeed restricted, then the critical selective factors operative today would have been significantly relaxed. Diffusing these particular temperature isolines should likewise have diffused the biotic boundaries and allowed the intermingling of taxa with a wider degree of ecological tolerance. With the importance of this air mass lessened, the tight zonal patterns would be absent, replaced in influence by more local factors. In other words, during the full and late glacial biotic distributions may have been more influenced by a complex of factors such as aspect, soils, topography and competition, and not subject to the overriding affects of one or two climatic variables as they are today. The impact of Pleistocene climates may have been relatively weaker than it is now, although environmental gradients likely continued to sort vegetation and animal communities north to south (as evidenced by the fact that both spruce trees and woodland caribou invaded temperate regions, but in each instance were limited in their southern displacement [Guilday, Hamilton and Parmalee 1975; Watts and Stuiver 1980]). The near-tropical faunal species of Florida had similar northern boundaries (Guilday et al. 1964).

Pleistocene vegetation

Overall the vegetation complexity recorded by pollen cores from the east in both glacial and periglacial areas shows a lack of evidence for any time-transgressive pollen zones as would be expected were the notion of zonal biotic shifts valid (Wright 1976b). Second, there is now abundant evidence to show that plant taxa moved individually at different rates and at different times (Watts 1973; Davis 1976). Finally, there is a lack of synchroneity in the pollen cores, which suggests that it is unlikely there were any major broad scale climatic shifts over the region save until well into the Holocene (R. Davis et al. 1975).

It had been suggested some time ago that the eastern states all exhibited a full glacial to Holocene pollen sequence which showed, in succession, tundra (T zone), spruce woodland (A zone), pine (B zone), and oak (C zone) (Deevey 1939, 1943). While the timing of these shifts were known to vary by locale, the overall scheme was thought to incorporate much of the southern continent and tie in to the European sequence as well (Deevey and Flint 1957). It has had some applicability in the New England area where it was originally developed (e.g. Davis 1958, 1969b; Leopold 1956, Flint 1971), however beyond that region its utility drops significantly (Watts 1979, but see Spear and Miller 1976 who use the scheme to "facilitate comparison"). The inapplicability of continental scale pollen sequences belies the utility of another often used device in the palynological literature and that is the composite map of vegetation change (e.g. Bernabo and Webb 1977; Delcourt and Delcourt 1979; Webb 1981; Whitehead 1973). Useful as these may be for didactic purposes, with the low number of pollen sites we have and the marked variability present in those sites, for now such maps may be unrealistic (Watts 1979; Wright 1981).

Thus, a review of the pollen sequence for the eastern states is at best an effort to bring together a set of data from different regions and different time periods to illustrate patterns that may be visible only on the most general scale. For this reason, the discussion will focus largely on the time period when fluted point groups were thought to inhabit the east, the period around 12,000 B.P.; for reasons of congruity with the paleoecological literature, the examination will extend from full glacial time (18,000 B.P.) to the establishment of the Holocene vegetation structure (ca. 8000-7000 B.P.). The full glacial period, at least in terms of maximum ice advance, did not occur simultaneously at 18,000 B.P. throughout the continent (cf. CLIMAP 1976). In some areas it was earlier (between 21-18,000 B.P. south of the Great Lakes), and in some areas later (14,000 B.P. west of the Great Lakes and 15,000 B.P. east of the Great Lakes) (Ashworth et al. 1981; Wright 1976b). However, as Watts (1979:429) suggests, it is the massive ice sheet and not the local oscillations at the ice margin that have the most impact on climate and biotic parameters. Hence, records between 18,000 B.P. and 14,000 B.P. should be sufficient to establish the nature of stable full glacial vegetation. By extension, climatic and vegetation changes characteristic of the postglacial appear sooner in some areas, particularly more southerly areas (Delcourt and Delcourt 1979, for example, see postglacial changes beginning around 16,000 B.P. in the lower Mississippi Valley; areas of Minnesota that remained glaciated until 12,000 B.P. will show these changes much later).

Tundra vegetation is evident in full and late glacial age pollen cores. It occurs in cores from areas immediately adjacent to the ice sheet (periglacial areas), as well as in cores from deglaciated areas. The characteristic pollen signature for tundra vegetation is a high amount of herb pollen (over 25%); the dominant herbs may be either grasses or sedges (Delcourt and Delcourt 1981:126; Watts 1979:459).

The presence and distribution of tundra is physically controlled (Odum 1971). Low temperatures, permafrost and a short growing season limit vegetation to hardy nonarboreal species. Vegetation types characteristically consist of "r" selected species (Pianka 1978), and thus the tundra is both a climatic phenomenon as well as a successional phenomenon. Tundra herbs are the initial colonizers in deglaciated regions (Davis 1978:45).

While the distribution of tundra and permafrost are not always coincident (Wright 1981:118), the distribution of permafrost features indicate past conditions sufficient for tundra development (Watts 1979). Permafrost requires a mean annual air isotherm that ranges from 0° to -8° C (Pewe 1973). The former presence of permafrost (and, likely, tundra), is indicated by the presence of ice wedge casts, hundreds of which are now known in temperate North America (Pewe 1973: Table 2). These indicate:

> Permafrost existed in late Wisconsin time, 20,000 to 10,000 years ago, along the glacial border in temperate United States. Later permafrost formed north of the glacial border as the continental ice sheet withdrew exposing drift to the rigorous periglacial climate (Pewe 1973:24).

Tundra assemblages appear in pollen cores from New England dating between 14,000 and 12,000 B.P. (Davis et al. 1980; Davis et al. 1975; Ogden 1959), including western Massachusetts between 13,000 and 12,000 B.P. (Whitehead 1979) and southern Connecticut at 15,000 B.P. (Davis

1969b). Tundra is also recorded between 12,000-13,000 B.P. near the ice front at Longswamp, Pennsylvania (Watts 1979), and at sites in the higher altitudes in the central Appalachians at Cranberry Glades and Buckles Bog (Darlington 1943; Maxwell and Davis 1972). It is recorded earlier still along the coastal Delmarva peninsula (Sirkin 1977; Sirkin et al. 1977). Further to the west, tundra appears in some cores from the midwest (Ogden 1977; Watts 1979; Williams 1974) but infrequently in sections from the immediate Great Lakes region, and then only later in the sequence (Birks 1976; Craig 1972; Wright 1981:118). Tundra vegetation is absent in many of the cores from New York state, but does appear at the Allenberg Bog and Belmont Bog (between 16,000 and 12,500 B.P.) in the western and central regions of the state (Miller 1973; Schwert and Morgan 1980; Spear and Miller 1976).

This patchy distribution of tundra is undoubtedly a function of katabatic winds and the resultant temperature gradient immediately south of the ice margin (Moran 1976), although it would be difficult to show independently of the vegetation evidence the nature and structure of those gradients. It is nonetheless clear that tundra vegetation was restricted either to areas of high altitude or close proximity to the ice margin. In no instance is the assemblage in a low-lying southern area. As Wright summarizes the evidence, tundra or tundra-like vegetation was confined:

> to a deep reentrant in the ice front in the Minnesota areas, a narrow fringe in front of the ice east of the Appalachian Highlands, and a discontinuous distribution down the crest of the mountains (Wright 1981:122).

Equally widespread (and patchy) as the intermittent ribbon of tundra along the ice was the full and late glacial boreal forest that existed south of the ice sheet. This pollen assemblage is characterized by high amounts (in terms of both percentage and absolute values) of Picea (spruce) pollen, and was apparently the most extensive of the "communities" of the full and late glacial period. This forest was not strictly analogous to the present day boreal zones of the Canadian woodland, lacking as it was in pine (Davis 1976; Webb 1981; Wright 1968), and having admixtures of black ash, oak, elm and Artemesia (Amundson and Wright 1979). The characteristic pollen assemblages appear in the oldest sections of pollen cores from Minnesota (Amundson and Wright 1979; Ashworth et al. 1980; Wright 1968; Wright et al. 1963), south to Iowa (Van Zandt 1979) and Illinois (Gruger 1972). Spruce communities are intermingled with the tundra areas further to the east (Miller 1973; Ogden 1966; Shane 1975; Watts 1979), and southeast (Watts 1970, 1979, 1980; Watts and Stuiver 1980; Whitehead 1973). Areas further south in the Mississippi drainage also show an early spruce dominance although occasionally mixed with jack pine and fir (e.g. Anderson Pond, Mingo Pond, Nonconnah Creek, Tennessee: see Delcourt 1979; Delcourt et al. 1980); that vegetation community appears to have disappeared by 15,000 B.P.

West of the Mississippi River the southern limit of the boreal forest is unknown (Wright 1981), however east of the Mississippi Watts and Stuiver (1980) have shown that the limit was north of Gainesville, Florida (Lake Annie site) but south of Pennington, Georgia. Summarizing the distribution of the full and late glacial boreal forest, Wright observes that it:

> formed a belt perhaps 1000 km broad, starting at or near the ice front in the north and ending south near a line extending from central Georgia around the southern end of the Appalachian Highlands to Tennessee, thence westward to the Mississippi alluvial valley, with a possible extension down the valley to southern Louisiana (Wright 1981:122).

In areas south of the Picea dominated pollen assemblages the cores exhibit, during full and late glacial times, evidence of relatively mesic deciduous forests (Delcourt 1980; Watts and Stuiver 1980). At Sheelar Lake, Florida, oak and hickory are common, with the pollen values for the latter (and mesic trees generally), as high as they are today (Watts and Stuiver 1980:325). Watts and Stuiver (1980) infer the vegetation represented by the pollen assemblage was an open pine forest with interspersed broad-leaved trees (ibid.). Delcourt (1980), reporting on a core from southeastern Alabama found a similar situation:

> A forest mosaic of oaks, sweetgum, hickories and southern pines characterized the interfluves of the Gulf Coastal Plain of south central Alabama. The pollen record from Goshen Springs documents the full glacial location for a large number of deciduous and broadleaf evergreen forest taxa (Delcourt 1980:384).

For this reason, the postglacial climatic and vegetation changes so important in northern states are non-existant here. The patterns of the Holocene, as will be discussed later, began 6000 years earlier in the southeast than adjacent to the ice.

At first glance the full glacial pollen cores from the eastern United States reveal an unremarkable cold-adapted floral pattern not only near the ice, but far south of it as well, in areas where boreal taxa could not survive today. Upon closer examination, however, these early pollen "horizons" reveal a curious element of species sympatry. In most of the pollen cores, for instance, the high spruce values are mirrored by relatively high values (on the order of 5-25%) of more thermophilous taxa. This is not unexpected in the more southerly pollen cores, such as South Carolina and Georgia, where Watts (1970, 1980) reports Quercus (oak) and Carya (hickory) as early as 15,000 B.P. Nor is it unexpected in Tennessee where Delcourt (1979) reports deciduous taxa represented some 6% of all taxa at 18,000 B.P., with oak alone representing 30% of all taxa by 16,300 B.P. (Delcourt 1979:266).

It is apparent, however, that these admixtures of boreal and deciduous elements are not unique to sites in the southern states. Gruger (1972), for example, reports on a core from full glacial times in southern Illinois (ca. 18,000 B.P.) characterized not only by spruce but also oak, hickory, elm and high amounts of Artemesia. This is a rather remarkable assemblage of vegetation when one considers that the lowest absolute (not average) temperature limits of deciduous taxa like oak (and beech, elm, hickory, ash, ironwood, birch and maple), is from -41 to -47 degrees centigrade (Delcourt et al. 1980); Wisconsin ice was within 60 kilometers of the site (Gruger 1972). Nor is this site an anomaly. The lowest zone (Zone A) at Kirchner Marsh, Minnesota, contained high amounts (35%) of spruce (Amundson and Wright 1979) in addition to upwards of 5% of Quercus, Ulmus, Larix and Fraxinus. These last two taxa appear in present day boreal zones, but the first two do not. A similar situation is found at Moulton Pond (Maine) and Allenberg Bog (western New York), where relatively high amounts of deciduous taxa appear even in the tundra "zone" (Davis et al. 1975; Miller 1973). Other sites with the same pattern include virtually all for which we have full and late glacial-aged sediments in the pollen cores (e.g. Craig 1972; Davis 1969b; Maxwell and Davis 1972; Mehringer et al. 1970; Schwert and Morgan 1980; Shane 1975; West 1961; Wright 1970; Van Zandt 1979).

These anomalously high values for deciduous taxa, which during the full glacial probably did not surpass 25% of all taxa (save in the more southerly sites), have been noticed for some time (Cushing 1965). The anomaly has been variously interpreted as deciduous pollen being redeposited from older sediments (Anderson 1954), transported long distances by wind (Amundson and Wright 1979; McAndrews 1966; Maxwell and Davis 1972; West 1961), a statistical artifact of overrepresentation of arboreal pollen at the expense of nonarboreal pollen (Davis 1969a), misidentification of the relevant taxa (Whitehead 1973), or, finally, valid evidence of the actual presence of deciduous taxa in the region (Amundson and Wright 1979; Gruger 1972; Miller 1973).

The suggestion that the anomalous taxa were introduced by redeposition is unlikely, given that the taxa are consistently represented over a large area in essentially uniform amounts (Cushing 1964; Wright 1964). For the same reason, the argument that long distance transport brought in the pollen is untenable. In terms of one specific example, Amundson and Wright (1979:7) have further noted that the source of thermophilous pollen in sites in Minnesota had to have been to the south, yet on the evidence from dune patterning, predominant dune forming winds were from N/NW, presumably a function of the glacier. (Note, of course, that dune patterning is primarily a function of the source of sand and not prevailing winds. And there is a difference between dune-forming winds and prevailing winds. However their point is well taken).

In some instances of deciduous taxa mixed in tundra-like assemblages (such as oak in Zone 1 at Moulton Pond, Maine), the overall influx values are low for the arboreal pollen (AP) and lower still for the non-arboreal pollen (NAP), and this makes it doubtful that deciduous trees were actually present on the site (Davis 1969a; Davis et al. 1975). However, other cores exhibit high influx values of the thermophilous pollen (e.g.

Spear and Miller 1976), and thus demonstrate that percentage overrepresentation of deciduous taxa is not always a biasing factor. Whitehead's (1973) observation that the deciduous elements were misidentified, which was directed specifically at Gruger (1972), is a matter resolved by the consistent appearance of deciduous taxa in cores from other scientists. Were Gruger's the only site with high deciduous values, then there might be some validity to the suggestion. We are left then with the conclusion that the patterns are valid, and that they indicate, in the regions in question, an intermingling of boreal and deciduous taxa in areas near and sometimes adjacent to the glacial ice front.

The pollen evidence from later in the glacial period reinforces this view since, as Wright (1964) observes, the presence of deciduous taxa in Minnesota immediately after deglaciation indicates their presence nearby throughout the glacial period. Oak, for example, is a poor colonizer: it moves slowly. Spruce, on the other hand, is an aggressive pioneer and its presence in areas immediately after deglaciation is not unexpected (West 1961; Wright 1964). What is likely then is that the full and late glacial forests were not spruce dominated, or for that matter dominated by other species strictly boreal in character. It is probably the case that these complex forests were mosaics of boreal and deciduous taxa (Brown and Cleland 1968), with the proportions of each varying grossly by latitude and locally by soils and topography, and their proximity to the glacial front. At the same time, the mosaic apparent in the pollen cores may be simply a function of a catchment basin collecting pollen from different (perhaps topographic) microhabitats, or "mini-zones" as it were. Yet the point remains that the presence of these diverse microhabitats indicates an overall azonal vegetation structure unlike that characteristic of the Holocene.

This view of the full and late glacial forests as a mosaic of boreal and deciduous elements has some important implications for the search for Pleistocene refugia. Paleoecologists have long concerned themselves with ascertaining where the temperate forests and species of the Holocene survived during the Pleistocene. Among the proposed regions of refugia were the Gulf Coast/peninsular Florida (Deevey 1949; Watts 1970; Terasmae 1973; Whitehead 1973); within or west of the Appalachians (Braun 1951); the continental shelf off New England (Ogden 1967; Terasmae 1973); the river basins of the southeast (Delcourt and Delcourt 1977); southern Wisconsin and adjacent Minnesota, Iowa and Illinois (Sears 1942); and, finally, Mexico (Deevey 1949).

While many of these areas have been demonstrated to have been inhospitable to temperate plants, the fact remains that a particular specified area of refugia probably did not exist, or at least <u>need not have existed</u> in order for temperate species to have survived the Pleistocene. With the marked overlap of boreal and deciduous species exhibited by the palynological record, it is apparent that deciduous taxa survived in many areas of the unglaciated east, and were not localized by an inhospitable climate in small restricted zones. The diversity of the full and late glacial spruce pollen assemblage obviates the necessity of searching for spatially constricted and localized refugia.

As Amundson and Wright (1979) observe, the top of the spruce zone is "consistently the most abrupt late-Quaternary pollen stratigraphic boundary throughout the Middle West and eastward to New England" (Amundson and Wright 1979:13, see also Bernabo and Webb 1977; Wright 1968). The reasons for the decline are as yet unresolved, but Amundson and Wright (1979) have found no support for the hypothesis that the change from spruce to the successive pine dominated horizon can be explained by a greater incidence of fire. Nor is the rapid decrease in spruce attributable to the immigration of pine (Amundson and Wright 1979:14). Instead, the argument has been advanced that the spruce decline is due to rapid climatic change brought about by the retreat of glacial ice from the area and the subsequent changes in the regional temperature and air circulation gradients. As Amundson and Wright state:

> As the mean frontal positions of arctic air moved north with climatic change and retreat of the ice sheet, the climate was no longer suitable for the regeneration of spruce trees at the southern limit of its range, and more temperate trees expanded at the expense of spruce. The trees that expanded depended in part on what seed sources were close by (Amundson and Wright 1979:14).

Those tree species included pine, which had been effectively prevented from entering the western Great Lakes region by the lakes (Wright 1968), and birch, alder, aspen, ash, fir, elm and oak (Amundson and Wright 1979:14). This pine dominated pollen assemblage had a great deal of internal diversity, and took on varying composition dependent on the age and location of the site.

In the more northerly sites, due largely to ice retreat, the Pinus dominated horizon did not appear until between 11,000 and 9000 B.P. (Amundson and Wright 1979; Bernabo and Webb 1977; Craig 1972; Shane 1975; Wright 1968). And, in at least two instances, this assemblage was not a direct successor to the Picea zone but instead followed an intermediate assemblage that accumulated during the spruce decline but before the pine increase (Ogden 1966; Wright et al. 1963). At Kirchner Marsh, Minnesota

(Wright et al. 1963), this zone is composed of a series of temperate hardwoods with no pine. At Silver Lake, Ohio, the zone has high NAP percentages along with increases in oak and pine. Ogden, however, feels the increases in the oak and pine may be more apparent than real (Ogden 1966). At Lake of the Clouds, north of Kirchner Marsh, Craig reports that the assemblages changed directly from a Picea dominance to a Pinus dominance (Craig 1972). Similar changes were found at Wolf Creek, Minnesota (Birks 1976), Pretty Lake, Indiana (Williams 1974), and Battaglia Bog, Ohio (Shane 1975). Presumably the hiatus at both Silver Lake and Kirchner Marsh represent regions where migrating pine (Wright 1968), was not in the region at the time of spruce decline.

Further to the east in sites in New York and Pennsylvania, pine dominance appears at roughly the same time period as in the Great Lakes region. Pinus values again range upwards of 60% of the pollen in the assemblage (Spear and Miller 1976; see also Miller 1973; Watts 1979). In New England, the pine dominance is slightly later in time (at approximately 9000 years B.P.), but like the Great Lakes situation, this too is a function of arrival of migrating taxa and not climatic change (Davis 1976; see also Davis et al. 1980; Davis et al. 1975; Whitehead 1979). The dominant pine species in the New England region was white pine (P. strobus), which has led to the inference that "the vegetation was predominantly temperate in character" (Davis et al. 1975). This is supported by the synchronous increases in poplar, birch, alder, hornbeam, hemlock and especially oak, although in many instances these increases are masked by the rapid rise and overabundance of pine pollen (Davis 1969a).

In all of these northern cores, Pinus dominated horizons are apparently relatively short-lived, lasting for perhaps 1000 years at the most (e.g. Shane 1975). That, and the masking effect of the pine pollen, tends to make it difficult to interpret the vegetation represented by the assemblages. Craig (1972), for one, sees the pollen of thermophilous trees as being much lower in the pine zone than the preceding zone, while to the east both Spear and Miller (1976) and Davis (1969b) found relatively constant amounts or even increases in both percentage and absolute influx values of thermophilous deciduous taxa. This implies, first, that like the previous pollen horizon, this assemblage is not uniform across space in terms of either diversity or composition, save for a shared dominant species. Second, the time-transgressive distribution of pine (Amundson and Wright 1979) suggests that the structure of the zone is largely a function of migration ability, with pine moving rapidly into areas abandoned by spruce (Bernabo and Webb 1977), and ahead of oak, Alnus and other taxa that in these areas were either slower or not yet in the region in great numbers (Craig 1972). As Watts observes, in the initial millenia after deglaciation, "the fossil floras that are known from glaciated regions record successful migrants already expanding their geographic area" (Watts 1979:428). In a sense, the pine dominated assemblage is due in large part to historical factors. Third, with the arrival of other species into these regions and the commensurate sorting of taxa by climate (Davis 1976), an equilibrium situation is established, and with it competition increases and "k" strategists (like oak) come to dominate assemblages (Pianka 1970). From this, the modern vegetation structure takes shape.

In the southern regions of the continent, floristic changes towards the Holocene pattern took place long before the commensurate changes in the north. The mixed mesophytic forest which assumed its present size and distribution in the mid-Holocene (Delcourt 1979), appeared before 12,000 B.P. in sections of Tennessee, with an earlier expansion of many deciduous elements some 4000 years before that (Delcourt and Delcourt 1977; Delcourt et al. 1980). For archaeological purposes the history of the southeastern forests need not be a great concern, since they took on their modern form well in advance of the presumed arrival of man.

The postglacial pine dominated assemblage in the northern region is thus, in a general sense, like the full and late glacial spruce dominated assemblage in being characterized by marked internal variation and incorporating the coexistence of species with markedly different ecological tolerances. By 8000 B.P. when movement and changes characteristic of the early Holocene come to a halt (Bernabo and Webb 1977), oak, one of the more effective competitors of the eastern forests, begins to dominate assemblages and it, along with Castanea, Juglans, hickory and other MAST producing species, forms the pan-eastern temperate forests.

This encapsulated view of environmental change, the tripartite sequence of spruce-pine-oak dominance is characteristic, at least on a gross scale, of eastern North American vegetation history. It is important to recognize, however, a number of confounding issues. First, inferring from a single taxon (e.g. spruce) an entire vegetation community (e.g. boreal forest) tends to mask variability within that assemblage. Spruce may well have been the dominant pollen type and even the most frequent tree species on the Pleistocene landscape (although the latter is an entirely separate issue from the former, since abundance of pollen does not necessarily equal abundance on the landscape). But since the concern is with man's adaptive options, the crucial information is knowledge of the ecological diversity present on the landscape. The spruce forests of the Pleistocene, containing as they did relatively high amounts of thermophilous trees, were neither like those of the modern boreal nor did they likely require the same kinds of adaptations as in the modern boreal. The adaptive options were greater.

Second, the zones in pollen diagrams are defined, especially in glaciated areas, by the arrival of migrating species (Davis 1976). This implies that the boundaries in the pollen cores are site specific and time-transgressive; that owing to the differing tolerances of tree species, the same zonal criteria cannot always be utilized; and, that arrival of a species which is limited by migration speed cannot be attributed to climatic change (nor can its absence indicate unfavorable climates) (Davis 1976:23). Watts (1973) argues that one result of this is the tendency to ignore the transitional phases between pollen "zones". At Kirchner Marsh and Silver Lake the hiatus was obvious and the transition phase recognizable, but in other sites with less obvious transition zones (or, rather, more rapid changeover between zones) one can easily be led to the possibly erroneous conclusion that the vegetation community itself witnessed a rapid change. From his analysis of plant migration and invasion Watts (1973:203-4) concluded that the forest assemblages visible today "owe their composition far more to purely historical factors...than to any necessity for particular groups of species to be associated together".

For these reasons, it is important to evaluate critically suggested reconstructions of late and postglacial vegetation community changes (e.g. Bernabo and Webb 1977). By tracking such indicator taxa as spruce, pine, oak and "herbs", for example, Bernabo and Webb (1977) argue they can define the extent and movement of boreal forest, conifer-hardwood forest, deciduous forest and prairie formation. This might be the case, but only if one assumes as they do that the numerical dominance of a particular pollen type indicates a numerical dominance of the particular tree on the landscape; that a single taxa (e.g. spruce) can represent an entire vegetation community (e.g. boreal forest), and the internal association of those vegetation communities have not changed since the full glacial period 18,000 years ago. As in the case of many of these reconstructions (e.g. Webb and Brysons's [1972] application of pollen transfer functions), the analysis is based on strictly uniformitarian principles. These three assumptions, are not a priori invalid, but unlikely to be true in most instances (Davis 1976; Wright 1976b). One need only consider the variability introduced by factors like plant succession, soils, climate and competition, or the ambiguity caused by sampling vagaries (as, for example, differential pollen dispersal, transport, representation and destruction of pollen), to see the difficulty of operating under these assumptions.

Palynological data do have the analytical advantage of being reliable (in the statistical sense), since unlike many sources of paleoecological data pollen sites are relatively numerous. Vagaries in the record can be replicated or shown to be unique, and thus it can be determined whether any anomalies are actually present (as in the instance above where the presence of deciduous pollen in full and late glacial pollen zones was shown to be present in sites from Maine to Minnesota). Interpretations are at the same time limited. Most identifications of pollen taxa are only to the level of genera and only rarely to the level of species. Finer scale resolution of the precise thermophilous nature of these complex glacial forests depends on more accurate identification and, consequently, greater knowledge of the ecologies of these co-existing species. Finally, finer scale resolution of the spatial structure of these forests is important: half a dozen sites per state is simply not enough to infer tree distributions. Demonstration that glacial climates were more equable requires information on the movement of thermophilous deciduous taxa during the glacial (i.e. did they move north, or were they simply holding their ground in the face of boreal species moving south?), in addition to getting a better understanding of the relationship between climate and vegetation. For now, it can only be stated that in a nominal sense and when examined individually, each of the major vegetation stages reveals a great deal of internal ecological diversity (diversity in the sense of allowing a wide range of ecological tolerance, not diversity in a numerical sense of having more different kinds of trees).

Pleistocene fauna

In the absence of detailed palynological information, evidence confirming the complex nature of glacial environments depends on independent sources of data as, for example, the paleontological record of Pleistocene and post-Pleistocene faunas.

While there are literally hundreds of sites yielding pollen cores (Davis and Webb 1975), those with faunal assemblages are much less abundant. Vertebrates are preserved in only rare circumstances in the acidic soils of the eastern United States. Moreover, unlike pollen data vertebrate remains are subject to a wholly different set of biases. Since the deposits are most often in cave or rockshelter environments, the remains are subject to mixing, burial and scavenging. Because most cave faunas are composed predominantly of small mammals (Guilday et al. 1969), one has to consider whether the species were actually inhabiting the cave or the immediate region around the cave, whether they were brought into the cave by predator activity (owls being a common example of a cave-dwelling predator), or whether some combination of these two factors applies. If a site accumulated through predator activity rather than entrapment, then it must be determined whether the predator was wide ranging (e.g. a raptor) or had a limited search range (Guilday et al. 1978:57). Finally, it must be determined whether the predator was an opportunistic feeder or concentrating on particular species. Sorting out the ecological meaning of specific changes within a fauna becomes a problem of differentiating environmental change across space and through time, from changes in the predator species inhabiting the site, from changes in the (prey) species themselves competing and perhaps excluding sibling species from the region.

Faunal remains from archaeological sites, as distinct from purely paleontological sites, are subject to the further bias of cultural selection. This may be direct, in the instance of animal remains carried into the site, or indirect, as in the case of camp followers (e.g. rats) who co-exist with the human groups.

When one couples these factors with the complexities introduced by difficulties in quantifying faunal abundances (Grayson 1979), it appears as though the faunal data may well be unuseable. However this problem is more apparent than real. Given that sufficient attention was paid to the mode of depositon of the faunal remains at each site, that the hypothesized changes are apparent across a wide range of taxa (range in the sense of the ecologies of the animals and their sizes), and that data are restricted to a nominal scale, one can have a certain confidence in the faunal record. The scale of concern for this analysis, change on a pan-continental basis, should further enable us to avoid much of the sampling and interpretational ambiguities.

It is important to distinguish between large and small mammals. The Pleistocene representatives of the former (generally taken to mean all animals over 50 kilograms body weight) are largely extinct, and because the cause of their extinction is unknown, their extinction tells us little directly of their ecological tolerances (Guilday 1982). Moreover, large animals are quintessential "k" strategists; their range, mobility, and migratory behavior give them greater freedom in their adaptations. The American mastodon (Mammut americanum), for example, was a browser that preferred open spruce woodland and spruce forests. However, the species was not confined to these habitats; analysis of undigested plant remains found in the ribcages of these animals reveals twigs and cones of conifers, leaves, coarse grasses, swamp plants and mosses (Kurten and Anderson 1980:344-345). The mammalian fauna associated with the Kimmswick mastodon includes a variety of species adapted to deciduous woodland with open grassy areas (e.g. Geomys and Synaptomys cooperi;Graham et al. 1981:1116). As Guilday has summarized the matter:

> The extinct large mammals, though spectacular, tell us little of the precise climatic conditions under which they lived. What their presence clearly implies is a greater degree of ecological diversity. It implies an environment capable of supporting not only a forest fauna, as in the Holocene but, in addition, a greater variety of browsing and grazing herbivores (Guilday 1982:23).

Information from large mammals complements reconstructions based on small mammals, but is by itself inappropriate for fine scale environmental analysis. The large mammal data are also not subject to the biases influencing the accumulation of the small mammal record (it is exceedingly difficult for a raptor to carry a mastodon into a cave).

Because of their more restricted ecological ranges (Guilday and Parmalee 1972) small mammals are more valuable in reconstructing paleoenvironments. Yet their presence in a fauna, even when predator bias has been taken into account, is not always a valid indicator of a particular environment. As Grayson (1981) points out, studies of this sort always rely on the assumption that the ecologies of specific mammals is the same today as it was in the past. This assumption is difficult to prove in the best of circumstances; as a consequence, it is best to use suites of taxa whose ecologies are known. While the habitat preference of a single taxon might change through time, "it is less likely that all members of a suite of taxa would change, and that all would change in the same direction" (Grayson 1981:35).

As was the case with pollen data, the examination of the faunal record considers the period from the full glacial (ca. 18,000 B.P.) to the appearance of Holocene environments (8,000-7,000 years B.P.). However the data that we have from faunal sites in the eastern United States date mostly to the late glacial period. Faunal accumulations that are full glacial in age appear to be restricted to large mammals, although this curious fact may be determined more by collector bias than any inherent lack of 18,000 year old small mammal faunas (Meltzer and Mead 1983).

There are less than two dozen faunal sites in the eastern United States for which we have evidence from both small and large mammals, although sites with only large mammals or isolated occurences of large mammals are quite numerous (e.g. the totals in Dreimanis 1967 and 1968 on mastodon occurrences; Meltzer and Mead [1984], Appendix I, give a complete listing of radiocarbon dated Eastern sites with large mammal faunas). This discussion focuses on data from ten sites (Figure 1).

The Pennsylvania sites, New Paris No.4 and Bootlegger Sink, are both sinkholes in limestone parent material. New Paris No. 4 is late glacial in age, dating to 11,300±1000 B.P. (the later date of 9,540±500 B.P. was rejected; Binford in Guilday, Martin and McCrady 1964:132). Bootlegger Sink is undated; in the absence of both radiocarbon and stratigraphic evidence the authors used the faunal material (partially boreal in character) to argue that the site was late glacial in age (Guilday, Hamilton and McCrady 1966:160). New Paris had a pollen profile indicative of an open spruce-pine woodland (Guilday et al. 1978:57). Approximately forty species of mammals were recovered from each site.

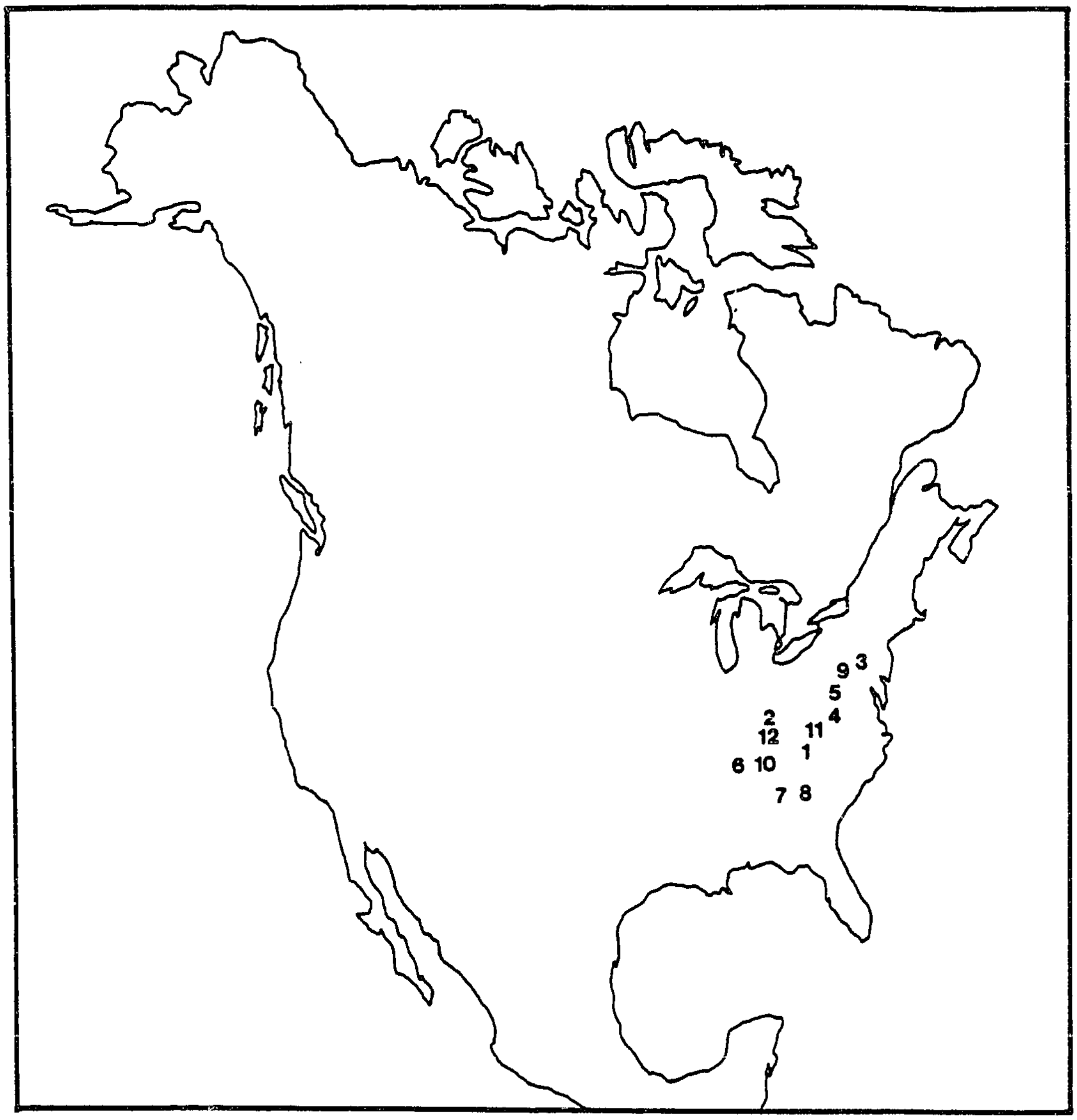

FIGURE 1. Location of paleontological sites discussed in text.

1. Baker Bluff, TN	7. Ladds, GA
2. Big Bone Lick, KY	8. Little Kettle Creek, GA
3. Bootlegger Sink, PA	9. New Paris No. 4, PA
4. Clark's Cave, VA	10. Robinson Cave, TN
5. Eagle Cave, WV	11. Saltville, VA
6. First American Bank, TN	12. Welsh Cave, KY

Eagle Cave overlooks the south branch of the Potomac River in Pendleton County, West Virginia. As is the case with New Paris and Bootlegger Sink, the fauna has elements of boreal and temperate small mammals; the fauna likely was accumulated primarily by raptorial birds (Guilday and Hamilton 1973:47). There were 29 species of mammals, the largest of which were a porcupine and an immature beaver. There are no absolute dates from the site, although judging from the fauna the deposit is late Pleistocene in age (Guilday and Hamilton 1973:57).

Clark's Cave, Virginia, is also a raptor deposit with a high ratio of small to large mammals. Some 54 species of mammals were found, many of which were boreal in character. In fact, the fauna was observed to be "almost identical with that of New Paris, No. 4" (Guilday, Parmalee and Hamilton 1977:75), and in the absence of independent dating, that simlarity was used as a basis for arguing the sites were roughly contemporaneous (Guilday, Parmalee and Hamilton 1977:78).

The faunal deposit at Welsh Cave, Kentucky, has elements of both large and small mammals. Unlike many cave sites, the stratigraphy at Welsh Cave was fairly unmixed, and all 25 species recovered appear to be contemporaneous (Guilday, Hamilton and McCrady 1971:256). Large and small mammal remains represent a variety of habitats north and west of the site. The remains of approximately 31 individuals of _Platygonus compressus_ (flat-headed peccary) were found; bone collagen from ribs and limb bones of these animals was radiocarbon dated at 12,950±550 (I-2982). The site deposits appear to have built up by entrapment rather than raptor deposition.

The First American Bank site in downtown Nashville, Tennessee, is a fissure that, as late as historic times, connected with the surface. There were three periods of deposition at the site, the earliest of which was late Pleistocene in age, and included the entrapment of *Smilodon floridanus* (Sabertooth cat), mastodon, horse and the long nosed peccary (*Mylohyus nasutus*). A plains form of gopher (*Geomys* cf. *bursarius*) was also found, although its age and context in the fauna are unclear (Guilday 1977:88). Altogether 21 species are included in the fauna.

The Baker Bluff Cave in northeastern Tennessee contained some 60 species of mammals, 29 of which no longer inhabit the site or differ in some fashion from the modern taxa (e.g. a Bergmann's response; Guilday et al. 1978:51). There are three radiocarbon dates from the site: 19,100±850, 11,640±250, 10,560±220 (a fourth was rejected as being clearly erroneous). The dates are all on bone fractions (apatite in 2 cases, collagen in the third) and are thus not altogether reliable (Haas and Banewicz 1980; Hassan et al. 1977; Meltzer and Mead 1983). As was the case with the Clark's Cave and New Paris faunas, Baker Bluff had a strong boreal component occupying the site during the glacial times.

The last two sites are located in northern Georgia: the Ladds site is in Bartow County in the northwest corner of the state, Little Kettle Creek is in Wilkes County in the northeast corner of the state. Neither of the sites has absolute ages, however the fauna of each has boreal affinities indicating at the very least a late Pleistocene age (Ray 1967; Voorhies 1974).

It is important to realize that the fauna at these sites may represent *second* order responses to climatic change, perhaps primarily influenced by floral distribution (Graham 1976). Thus, if the proposed vegetation reconstruction is correct, it should be reflected in the faunal record.

However it is important to note too the data from these late Pleistocene sites are not nearly as detailed as the data from the pollen record. These very few sites represent for the most part paleontological "instants", synchronous slices of vertebrate history. Rarely do these sites show sequences of deposition and species change through time, as does the pollen record (Bootlegger Sink is argued to represent just such a sequence, although there is no stratigraphy and the "temporal" sequence is based on the changeover from boreal to deciduous elements; see Guilday, Hamilton and McCrady 1966). Even though the faunal record is synchronic and also restricted in time (to the late Pleistocene), it repeats the patterning apparent in the much greater detail from the pollen record. It is evident from the review of the changes in the vegetation during the glacial period that there was a great deal of movement of individual species. There was also a great deal of species diversity which took the form of the sympatry of boreal and deciduous species that are now allopatic.

The faunal record, while it cannot be used to track the movement and change of biotic zones, can be used as an indicator of environments and as a measure of species diversity in the Late Pleistocene. It is useful in this regard to distinguish between faunal species in a deposit that are extinct versus those that are extralimital versus those that are local. Extinct refers to species (or genera) loss without replacement or evolution. Extralimital refers to species in a deposit whose modern day distributions are outside the present habitat and environs surrounding the site. Local includes those species found in a site that still inhabit the site area and environs.

Classification of an animal species in a deposit as being either an extralimital record or a locally occuring form depends on determining the modern day distribution of the species and habitat preference. These can generally be grouped into three broad catagories: "boreal," "steppe" and "deciduous." They are divided as follows:

> "Boreal" species have a northern and montane distribution, and the southern limit of their distribution can be correlated with summer high temperature extremes. "Deciduous" species have a southern distribution, and the northern limit of their distribution can be correlated with winter low temperature extremes. "Steppe" species have a western distribution, and the eastern limit of their distribution can be correlated with moisture gradients (Graham 1976:344).

Figure 2 illustrates the differences in the distribution of a boreal species (Microtus xanthognathus, the yellow cheeked vole), a steppe species (Spermophilus tridecemlineatus, the 13-lined ground squirrel) and a deciduous species (Microtus pinetorum, the pine vole). Despite the differences in their modern distributions, all three of these species co-occur at Clark's Cave (Guilday, Parmalee and Hamilton 1977).

Table 3 summarizes the extinct and extralimital (boreal and steppe) forms from the 10 cave sites. There are a number of points to be made from this data. First, as was the case with the pollen data, there is evidence from several sites and faunal species of tundra in northern latitudes and higher altitudes. The Labrador collared lemming (Dicrostonyx hudsonius) occurs at New Paris No. 4 (Guilday, Martin and McCrady 1964:160). While this lemming may occasionally range into the fringes of the northern Hudsonian life zone in modern times (Figure 3), it is a true barren ground form (Guilday, Martin and McCrady 1964:120).

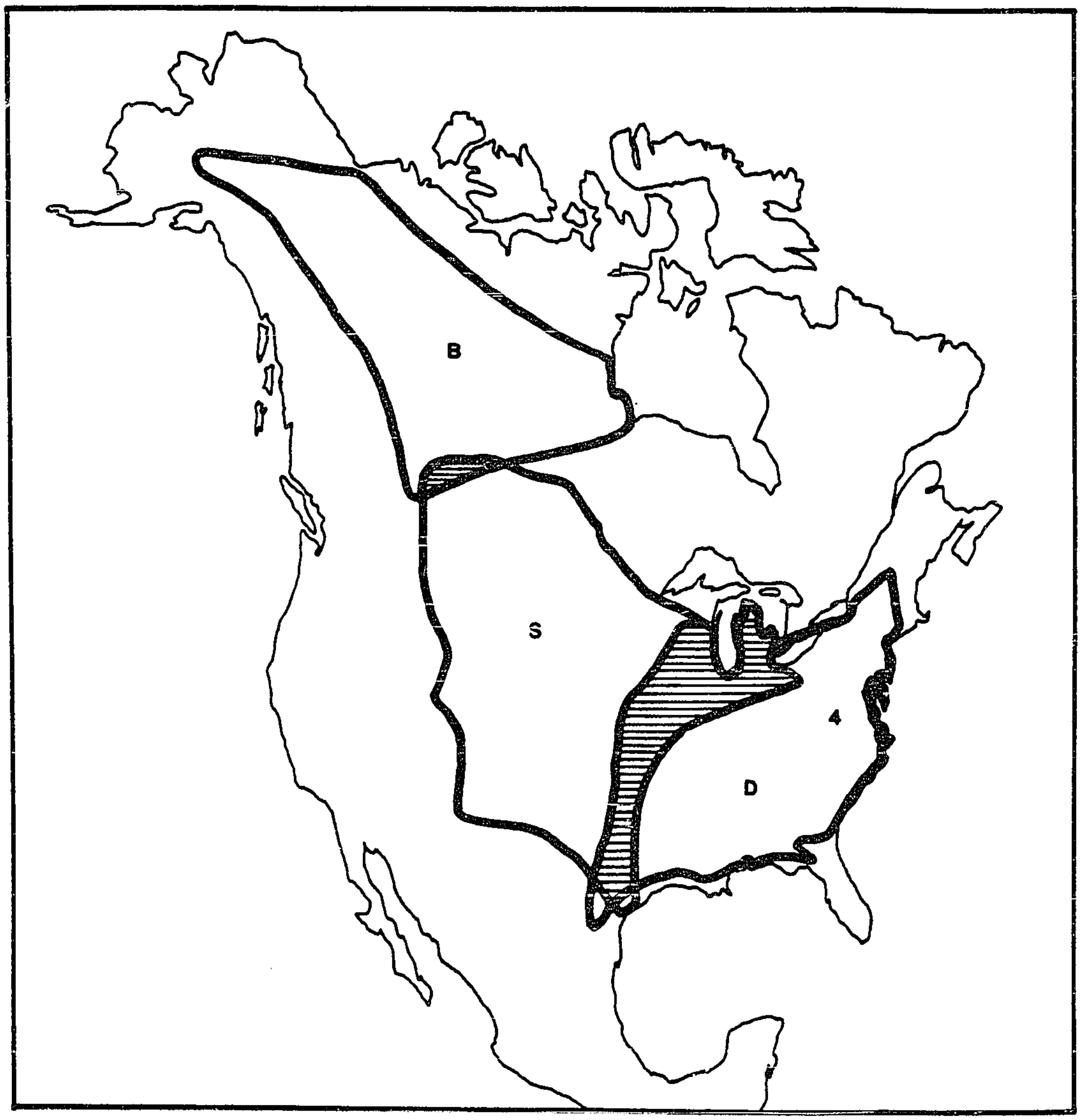

FIGURE 2. Modern (outline) distribution of boreal (B), deciduous (D) and steppe (S) species which co-occurred in Late Pleistocene of Clark's Cave, VA (Site 4, see Figure 1).

TABLE 3. Late Pleistocene age paleontological sites

Site (State)	Extinct species	Extralimital species
Baker Bluff (TN)	Castoroides ohioensis Dasypus bellus Platygonus compressus cf. Sangamona fugitiva Tapirus cf. veroensis Felis onca augusta	Sorex arcticus Phenacomys intermedius Microtus xanthognathus Synaptomys borealis Martes americana Rangifer tarandus Taxidea taxus* Spermophilus tridecemlineatus*
Bootlegger Sink (PA)		Sorex arcticus Glaucomys sabrinus Microtus chrotorrhinus Microtus xanthognathus Synaptomys borealis Rangifer tarandus Spermophilus tridecemlineatus*
Clark's Cave (VA)	Canis dirus	Sorex arcticus Synaptomys borealis Phenacomys intermedius Microtus xanthognathus Mustela erminea Martes americana Spermophilus tridecemlineatus* Eutamius minimus*
Eagle Cave (WV)		Sorex arcticus Synaptomys borealis Phenacomys cf. intermedius Microtus xanthognathus Martes americana Spermophilus tridecemlineatus*
First American Bank (TN)	Smilodon floridanus Mammut americanum Mylohyus nasutus Equus sp. Musk ox?	Geomys cf. bursarius*
Ladds (GA)	Tapirus veroensis Tremarctos floridanus	Sorex cinereus Sorex fumeus Synaptomys cooperi

Little Kettle Creek (GA)	*Mammut americanum* *Mammuthus jeffersoni*	*Clethrionomys gapperi* *Synaptomys cooperi* *Bison sp.**
New Paris No. 4 (PA)	*Mylohyus nasutus*	*Dicrostonyx hudsonius* *Phenacomys cf. intermedius* *Synaptomys borealis* *Microtus chrotorrhinus* *Microtus xanthognathus* *Sorex arcticus* *Microsorex hoyi* *Spermophilus tridecemlineatus**
Robinson Cave (TN)	*Canis dirus* *Sangamona cf. fugitiva* *Megalonyx jeffersonii* *Mammut americanum* *Dasypus bellus*	*Sorex arcticus* *Microsorex hoyi* *Microtus pennsylvanicus* *Synaptomys borealis* *Martes americana* *Spermophilus tridecemlineatus**
Welsh Cave (KY)	*Canis dirus* *Platygonus compressus* *Equus sp.* *Mammuthus jeffersoni*	*Sorex palustris* *Microsorex hoyi* *Phenacomys intermedius* *Microtus xanthognathus* *Clethrionomys gapperi* *Lepus americanus* *Mustela nivalis* *Ursus horribilis* *Spermophilus tridecemlineatus** *Geomys cf. bursarius** *Taxidea taxus**

* Denotes extralimital steppe species; all others in this column are extralimital boreal species. See text for distinction.

A species of Ptarmigan (Lagopus sp.), has been reported from Clark's Cave and Back Creek Cave No. 2, both in Bath County, Virginia. Ptarmigan are birds of the open tundra whose present distribution ranges north of northern Quebec and Newfoundland. The Ptarmigan elements were tentatively identified as Rock ptarmigan (Lagopus cf. mutus) as opposed to Willow ptarmigan (Lagopus lagopus); both occupy a similar range, but the willow form prefers areas of stunted and scattered trees (Guilday, Parmalee and Hamilton 1977:30-31).

Caribou (Rangifer sp.) is reported from a number of Pleistocene age sites (Graham 1979). The southernmost occurrence is in Sullivan County, Tennessee (Guy Wilson Cave; Guilday, Hamilton and Parmalee 1975). Archaeologically caribou occurs at the Holcombe Beach site in Michigan (Cleland 1965; Cleland also reports other occurences in southern Michigan), and at Dutchess Quarry Cave, Orange County, New York (Funk et al. 1969:17). Cleland identified the Holcombe caribou as Rangifer arcticus (Barren ground caribou, currently designated as Rangifer tarandus groenlandicus, Kurten and Anderson 1980:315). However the barren ground form and the woodland form do not appear to be allopatric, nor, for that matter, are the behavioral or morphological differences between the two subspecies unambiguous (Spiess 1979:31-36).

Nonetheless, while the caribou alone may not be a sound indicator of tundra, these three species confirm the pollen evidence from as far south as Buckle's Bog (Maxwell and Davis 1972) of an open, treeless grass and sedge expanse existing along the ice sheet and in higher elevations in the Appalachians.

FIGURE 3. Modern (outline) and fossil (numbered sites) distribution of *Dicrostonyx hudsonius* (9 = New Paris No. 4).

Along with tundra forms, there are distributed throughout these late Pleistocene deposits a suite of boreal forms; like the pollen evidence for Picea, the boreal faunas are distributed in a north-south gradient of increasingly fewer occurrences of boreal species (Guilday et al. 1978:57). There are four species of boreal microtines that are particularly useful indicators of cold climates (Guilday and Parmalee 1972). A comparison of their modern distribution with their Late Pleistocene occurrences indicates the degree of habitat change.

The modern distribution of Phenacomys intermedius (the heather vole) is north of the continental United States in the present day Canadian and Hudsonian life zones (Figure 4). During the Pleistocene this species occupied sites in Pennsylvania, Virginia and Kentucky (Table 3) and ranged as far south as Baker Bluff, Tennessee (approximately 36° North latitude; Guilday and Parmalee 1972; Guilday et al. 1978).

Microtus xanthognathus, the yellow-cheeked vole, occurs in late Pleistocene sites in Pennsylvania (New Paris No. 4 and Bootlegger Sink) and at virtually all other sites except the Georgia sites. The modern distribution of the species is in northern Manitoba, Saskatchewan and Alberta, northwest up through the Yukon territory and east central Alaska (Figure 5; Graham 1979:Fig. 6). It inhabits boreal swamps, spruce forests and bordering tundra (Burt and Grossenheider 1952).

The northern bog lemming (Synaptomys borealis) inhabits wet alphine and subalpine meadows throughout the Canadian provinces and up into Alaska (Figure 6). During the late Pleistocene the species occurred up and down the eastern forests, as far south as Robinson Cave. The southern bog lemming (Synaptomys cooperi) overlaps with the distribution of Synaptomys

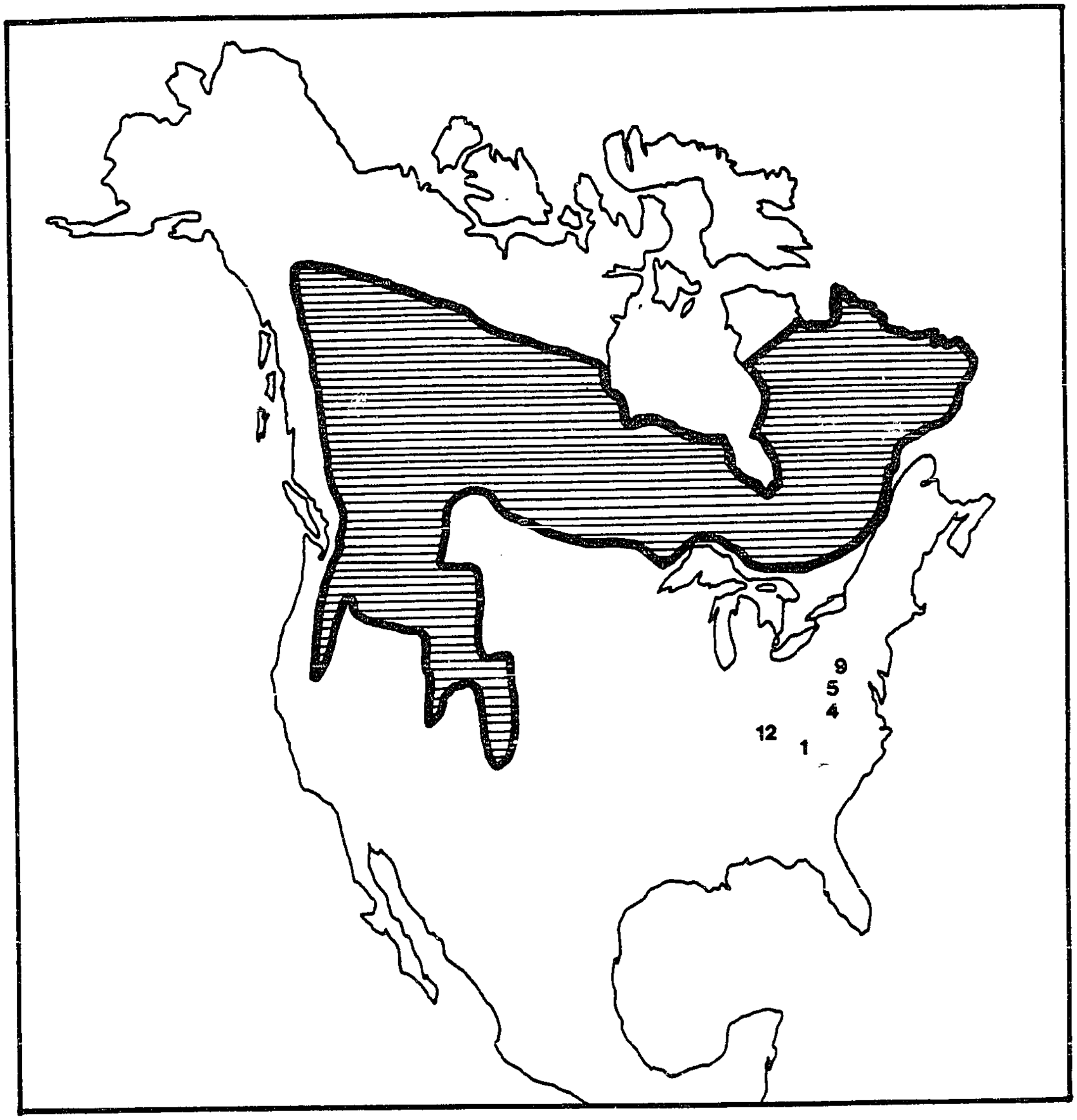

FIGURE 4. Modern (outline) and fossil (numbered sites) distribution of <u>Phenacomys intermedius</u> (1 = Baker Bluff; 4 = Clark's Cave; 5 = Eagle Cave; 9 = New Paris No. 4; 12 = Welsh Cave).

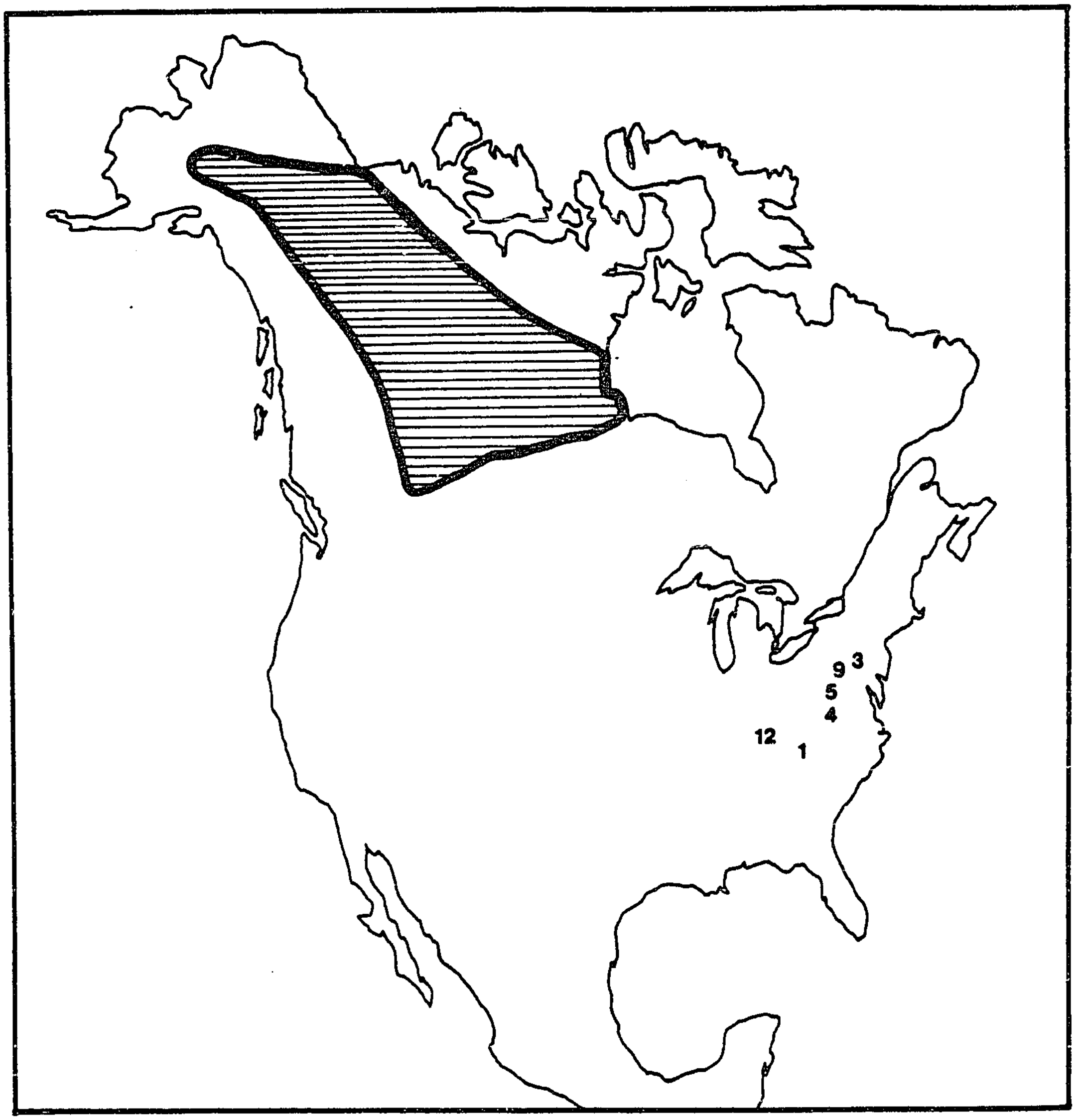

FIGURE 5. Modern (outline) and fossil (numbered sites) distribution of *Microtus xanthognathus* (1 = Baker Bluff; 3 = Bootlegger Sink; 4 = Clark's Cave; 5 = Eagle Cave; 9 = New Paris No. 4; 12 = Welsh Cave)

borealis (they co-occur in Baker Bluff and Robinson Caves); however in their modern distributions they are only sympatric in a narrow belt of southeastern Canada at the juncture of the Hudsonian and Canadian life zones (Guilday et al. 1964:162). The southern bog lemming, whose modern distribution is primarily in the northern states and Canada, occurs at the sites of Ladds and Little Kettle Creek, Georgia (Voorhies 1974; Kurten and Anderson 1980:60 incorrectly list this species as S. borealis at these sites).

The boreal red-backed vole, Clethrionomys gapperi, inhabits coniferous, deciduous or mixed forests in higher altitude and latitude environments (Figure 7). Unlike the heather vole (Phenacomys) which has a similar distribution, the red-backed vole ranges further south in the eastern United States along the chain of the Appalachians (Hall 1981). Its Pleistocene occurrences are also further south than the heather vole; Clethrionomys has been found at Robinson Cave and Little Kettle Creek, GA (Voorhies 1974:88; the Little Kettle Creek occurrence is the southern-most record for the species).

While the voles furnish striking evidence of boreal affinities for these late Pleistocene sites, other species of mammals furnish equally unequivocal evidence. The Arctic shrew (Sorex arcticus) whose present day habitat includes Tamarack and spruce swamps throughout Canada, the Northwest Territories and Alaska (Figure 8), occupied sites as far south as Tennessee during the Pleistocene.

The presence of these various boreal forms in late Pleistocene sites in the northeast (sites such as New Paris No. 4), is not unexpected, given that the modern fauna in these regions is equally boreal and deciduous (Graham 1976:344). In the sites of the southeast, however, the boreal

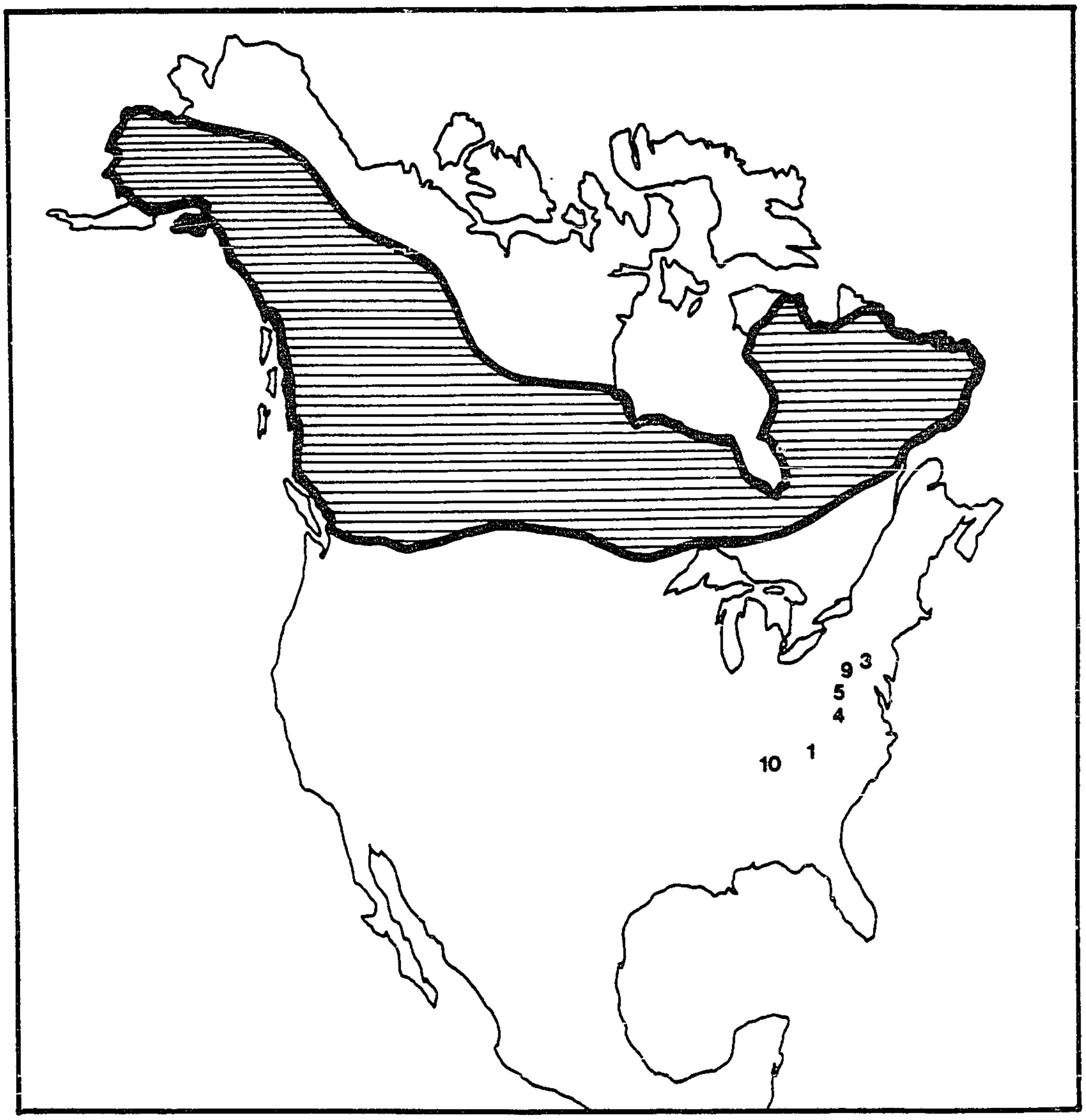

FIGURE 6. Modern (outline) and fossil (numbered sites) distribution of *Synaptomys borealis* (1 = Baker Bluff; 3 = Bootlegger Sink; 4 = Clark's Cave; 5 = Eagle Cave; 9 = New Paris No. 4; 10 = Robinson Cave).

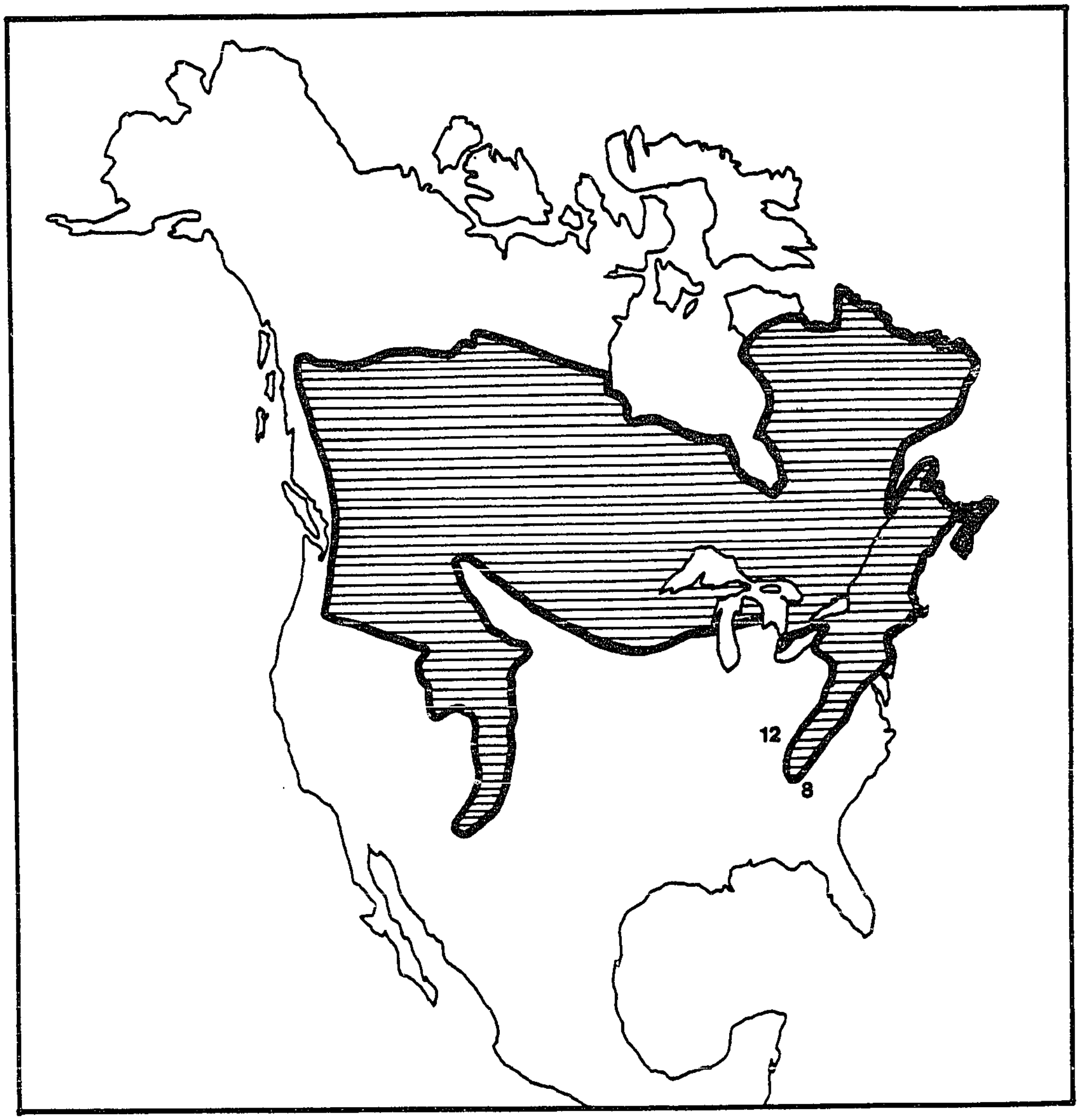

FIGURE 7. Modern (outline) and fossil (numbered sites) distribution of *Clethrionomys gapperi* (8 = Little Kettle Creek; 12 = Welsh Cave)

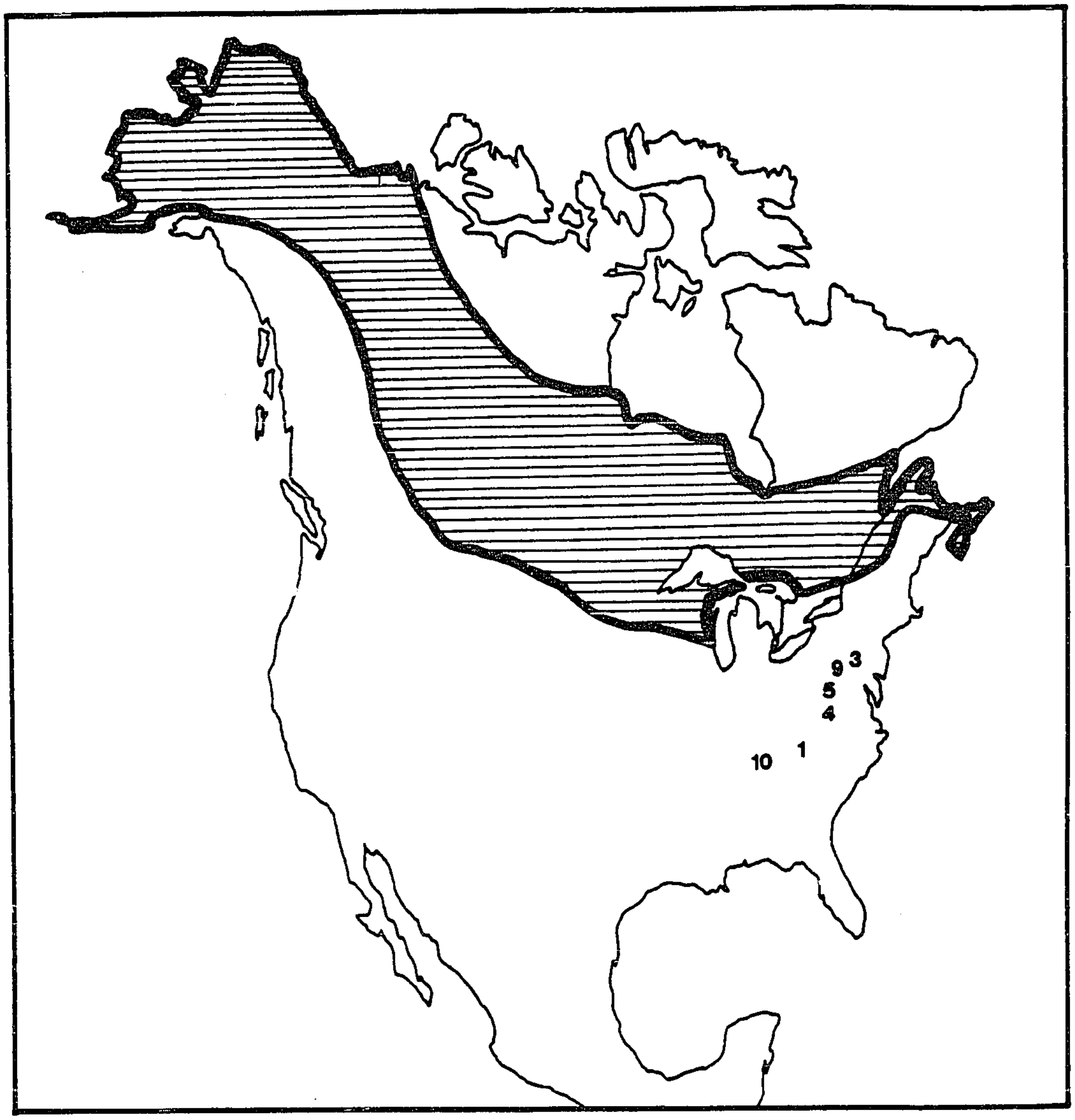

FIGURE 8. Modern (outline) and fossil (numbered sites) distribution of *Sorex arcticus* (1 = Baker Bluff; 3 = Bootlegger Sink; 4 = Clark's Cave; 5 = Eagle Cave; 9 = New Paris No. 4; 10 = Robinson Cave).

forms are not expected, and their presence indicates not only massive range changes but perhaps lowering of the mean annual temperature as well, the latter is an interpretation not supported by the evidence from Pleistocene herptofaunas, as is discussed below.

The boreal forms, however numerous they were, generally were not the exclusive animals of the fauna. Rather, they co-occured with a surprising range of both deciduous and steppe mammals. As Guilday (1982:24) has observed for the mid-Appalachian region, "boreal animals clearly predominated but shared the area with temperate and midwestern species of small mammals".

At Clark's Cave there were 53 species of mammals recovered; 9 of the species found in the deposit no longer inhabit the mid-Appalachians (1 species is extinct, the other 8 either have boreal or midwestern affinities; see Figure 2). Of the remaining 44 species, 11 moved to higher elevations in the region, while 5 are today smaller than their late Pleistocene counterparts. This size reduction in these taxa during the Holocene is a result of Bergmann's rule, which states that in species of warm blooded vertebrates, races from cooler climates tend to be larger than races of the same species living in warmer climates. In the fossil samples, Pleistocene mammals are larger in body size than races of the same species now occurring in those same regions (Mayr 1970:197-198). A Bergmann's response is seen in mammalian taxa at Baker Bluff Cave and new Paris No. 4, and is particularly well documented for a species of shrew, <u>Blarina</u> <u>brevicauda</u> (Graham and Semken 1976).

The intermingling, during the late Pleistocene, of species that are now allopatric takes place at Baker Bluff as well. Of the 60 species of mammals, six are extinct, ten are no longer in the area, nine have moved to higher elevations, and four are larger than modern forms. Yet while 48% of the taxa in the Pleistocene levels of Baker Bluff are in some form different than the modern fauna at the site, at least half of the species are not. It should be noted too that one of the extinct species is Dasypus bellus (the beautiful armadillo); while the habitat of this species is unknown, its modern counterpart, Dasypus novemcinctus, is chiefly tropical (McBee and Baker 1982).

The data from the faunal sites in the southern regions clearly indicates that the southward movement of the boreal species was not en masse (or in zones), but rather the migrating boreal species were integrated with the local species (Graham 1976). It appears too based on the mammal data that the sympatry of boreal and deciduous taxa was due to the movement of northern species south, and not southern species north. With the possible exception of two extinct species whose habitats are not precisely known (e.g. Dasypus bellus and Tapirus cf. veroensis, the Vero tapir):

> there were no species in the Baker Bluff faunal sequence of southern affinities, which are at or near the northern edge of their modern distribution in the central Appalachians (Guilday et al. 1978:61).

None of the species of birds or mammals found at Clark's Cave are found solely to the south of Virginia today (Guilday, Parmalee and Hamilton 1977:75). In fact, even at Welsh Cave and Robinson Caves to the west and south, no mammals of modern southern distribution have been recovered (Guilday, Hamilton and McCrady 1971:316). It appears that all late Pleistocene range changes were either northern or western adjustments (Guilday, Hamilton and McCrady 1971:316). The contemporaneity of the boreal and deciduous taxa and the lack of any southern forms has been taken as evidence of a general cooling of the climates and, as is discussed below, changes in the seasonal structure of the climates.

However, that interpretation of the climates and the evidence for the lack of any southern forms moving north is not supported by the data from Pleistocene herptofaunas. Holman (1980) argues, after a review of the herptofauna data from many of the sites discussed here (New Paris, No. 4, Clark's Cave, Baker Bluff, Robinson Cave and Ladds), that the faunas mainly have:

> (A) extralimital southern species existing with species that occur in the area today, or (B) mixtures of northern and southern extralimital species existing with species that occur in the area today (Holman 1980:134, emphasis added).

Holman interprets this as indicating generally warmer climates during the late Pleistocene. This contradiction between the herptofauna and mammalian data cannot be resolved in these pages, although for a variety of reasons the interpretation from the mammalian data is more compelling. The pollen data and the many diverse boreal species of mammals that moved into the southern latitudes provide more reliable evidence than the data from the amphibians and reptiles (samples of which are generally smaller than mammalian samples).

The data from the eastern sites, aside from providing evidence of tundra conditions as well as the co-occurrence of boreal and deciduous taxa also indicates that the late glacial environments were more open than the environments of the present (Graham 1979). The large Pleistocene grazers (Mammuthus, Bison, Equus and Platygonus) are found in many sites throughout the east, including some of those discussed here (Welsh Cave, Little Kettle Creek). Saltville, Virginia and Big Bone Lick, Kentucky, faunal sites known since the late 18th century each have a complement of both browsers and grazers. Mammoth and bison, although not as numerous in the complex forests of the east as they were in the Plains states, were able to survive in the open woodlands.

Data from the occurrence of small mammals confirms the interpretation of the forests as open. The 13-lined ground squirrel (Spermophilus tridecemlineatus) occurs in most of the sites discussed (Table 3). The modern habitat for this species includes shortgrass prairies and golf courses; its modern distribution centers on the midwestern and western Plains (Figure 9). It does not now live in the forested east (Guilday et al. 1978:35). The Plains pocket gopher (Geomys bursarius), which has a similar modern distribution, co-occurs with Spermophilus tridecemlineatus at Welsh Cave and by itself at the First American Bank site. At both of these sites, these small mammal prairie forms co-occur with large mammal grazers.

The modern environmental gradients from north to south in the eastern United States are steep and step-like between narrow ecotones. During the Pleistocene, longitudinal and latitudinal gradients are apparent from the pollen profiles (above), however the marked temperature and habitat changes of the Holocene are not evident. This is confirmed in the faunal record as well. The frequency of boreal taxa diminishes as one moves from north to south and there is a commensurate increase in the number of deciduous species (Guilday et al. 1978:57).

But, as Guilday et al. (1978:63) observe, 15 species of small rodents were identified from the northern end of the gradient (New Paris No. 4); of those 15 species, all but one (Dicrostonyx hudsonius) occur at Baker Bluff. This contrasts strongly with the modern distribution of small

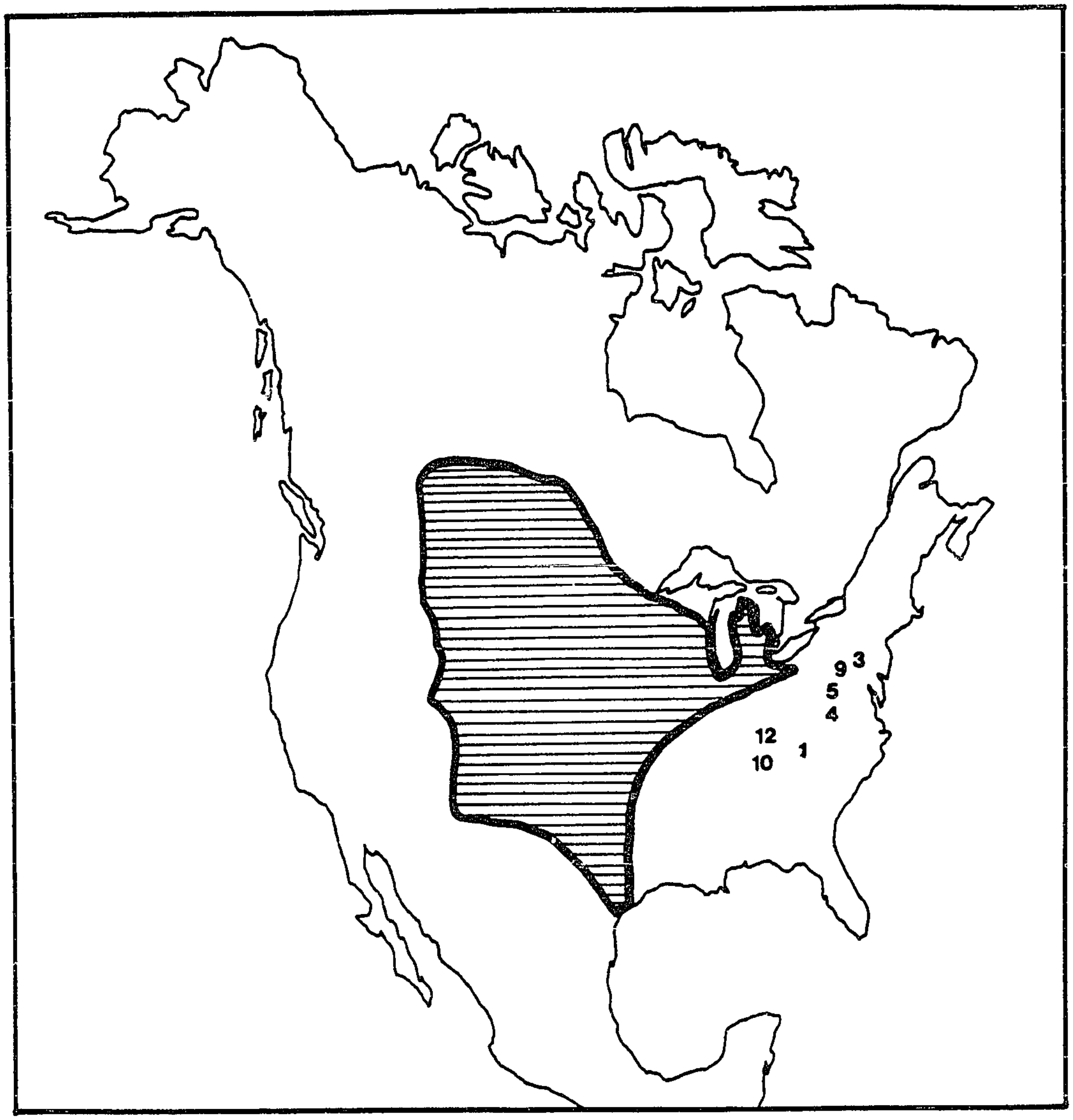

FIGURE 9. Modern (outline) and fossil (numbered sites) distribution of *Spermophilus tridecemlineatus* (1 = Baker Bluff; 3 = Bootlegger Sink; 4 = Clark's Cave; 5 = Eagle Cave; 9 = New Paris No. 4; 10 = Robinson Cave; 12 = Welsh Cave).

rodents. Today there are 10 species of small rodents at New Paris No. 4; eight of them occur around Baker Bluff today. Of the 12 species of small rodents reported from the Baker Bluff area today, four do not range as far north as south-central Pennsylvania (Guilday et al. 1978:63). Thus, while these sites had 14 species (93%) of small rodents in common during the Pleistocene, today they share only 8 species (57% in common). The gradient shift that took place in post-Pleistocene times therefore appears to be more than a simple shift from boreal-temperate to a temperate-austral environmental gradient, which returns us to the subject of climatic equability.

Species abundance in the paleoenvironmental record is not easily measured; hence, discussion of ecological diversity is limited to species richness (number of species present) rather than species evenness (proportional representation of different species). Nonetheless, even by this partial measure it is evident that the low-latitude complex boreal-deciduous forests were extremely species rich (Watts 1979:464). Guilday (1982) has estimated that the Pleistocene fauna in the mid Appalachians included some 24 more species of mammals than found there today. In the higher latitudes, the predominant vegetation and faunal community was tundra, with low species diversity.

The paleoenvironmental setting of eastern fluted point sites

Having analyzed the general paleoenvironmental patterns in eastern North America, it is useful to turn next to the environmental setting of individual fluted point sites. The environmental setting of a site can either be inferred directly from organic remains at the site, or indirectly from regional-scale floral and faunal records. In the former instance, the resolution is better and, as some have argued (e.g. Moeller 1980:85-86; Simons et al. 1983:2), one gets a sense of the site as opposed to the system environment.

Direct evidence of the paleoenvironmental setting of a site requires the recovery of floral and faunal remains from the site or the immediate site area. This, of course, makes environmental reconstruction subject to certain biases: preservation is poor and recovery methods are variable - if not frequently inadequate. But there is an additional bias involved. Floral and faunal remains at a site and associated with human activity may or may not accurately reflect the local environment, since they result from human selection or disturbance within that environment. The remains are, in effect a sample of unknown size and representativeness.

Demonstrating that a sample of remains recovered directly from a site context is representative of the local environment is a complex problem. As just discussed, demonstrating redundancy, either among different classes of remains or among many examples of the same class of remains can check potential biases, or at least reveal anomalous variation.

But in only a couple of instances in eastern fluted point studies were efforts made to secure environmental remains from more than one source. This is not surprising, since in most cases the recovery of environmental remains was simply a by-product of the search for other kinds of data (subsistence, radiocarbon), and not a separate or systematic pursuit. The bulk of the data on site environments were not collected specifically for that purpose. As a consequence, the reconstruction of the environmental setting of a site relies on whatever available data exist. These reconstructions are generally interesting, sometimes provocative, but because they are biased in an unmeasurable way, rarely definitive. With these caveats in mind, I examine the evidence for the paleoenvironmental settings of the eastern fluted point sites.

The only detailed study of the paleoenvironmental setting of an eastern fluted point site in the unglaciated region is Carbone's (1974, 1976) work at the Thunderbird site. His analysis is based on a variety of sources, including the analysis of faunal remains, pollen, plant opal phytoliths, charcoal, wood and seeds, mostly from within the site itself. These evidences indicated that within the immediate area of the site there were "at least six microhabitats" which could be exploited by fluted point groups (Carbone 1976:185). These included

> alpine tundra at the higher elevations, coniferous forests on the slopes of the higher ridges, grasslands and mixed conifer-deciduous forests on the valley floor and foothills, boggy areas around sinkholes as well as lower floodplain situations, and mixed deciduous gallery forests along the rivers, possibly composed of oak/hornbeam (Carbone 1976:185).

This admixture of boreal and deciduous species evident at the Thunderbird site matches the larger scale variation in the environment (as discussed earlier).

At the Thunderbird nearly all sediments were floated and in a systematic effort to collect micro-floral and faunal remains.

In the glaciated region a similar but not nearly so extensive an effort was made at the Shawnee-Minisink site. Paleoenvironmental reconstruction there relied on wood/charcoal, seeds and terrestrial gastropods. The evidence indicated an ecology "best characterized by a shift from a pre-boreal spruce-fir and pine forest habitat to a true boreal pine forest" (Dent 1981:81). The site, located on a terrace of the Delaware River, was probably in a damp, wooded area (Dent and Kauffman, In press; Moeller 1980).

All sediments at 6LF21 were also floated (Moeller 1980), but the only material useful to an environmental reconstruction came from a stained area indicating a possible postmold (Moeller 1980). Two samples of the charcoal were identified as "red oak and either juniper or white cedar" (Moeller 1980:35).

This evidence, and Moeller's discussion of it, highlight some of the points made earlier. Moeller noted that according to the regional pollen record the site should have been in a "forest-tundra that was gradually changing to an open-spruce woodland" (Moeller 1980:37). He rightly notes that this generalization does not take into account the range of local variation, and further argues that it is not "until the excavation of 6LF21" that the environment of the northeast was thought to have been anything but a strictly boreal pine-spruce forest (Moeller 1980:5). As I just argued, the boreal pine-spruce forest is something of a straw-man. Paleoecologists have known for some time that these environments were, as Carbone (1976) calls them, a "hodge-podge" of boreal and deciduous species, and that there was a great deal of microhabitat variation (see also Brown and Cleland 1968; Graham 1976). This, in fact, is the root of my reluctance to use the regional environmental reconstruction to infer the environmental setting of a site.

Moeller's evidence must be tempered by the fact that the remains in the hearth could have been carried into the site. The oak and juniper/white cedar are not, perforce indicators of the local environment, but only indicators of the environments through which the groups at 6LF21 had passed.

Simons et al. (1983) interpretation of the environmental setting of the Gainey site is tempered by a more sophisticated understanding of the relationship between the regional and local environment. Without having firm dates for the site's occupation (but recall geochronological estimates put the occupation sometime after 10,400 BP.), they infer that the region was characterized by spruce-parkland. However they note that protected lower areas likely had stands of hardy oaks and other woody plants. This is possibly supported by oak, maple, elm and perhaps beech charcoal that _may_ be associated with the fluted point occupation (Simons et al. 1983:4). These wood samples all come from hearths with debitage of the fluted point occupation, so again there is the unresolved issue of whether curation has biased the sample.

At the Parkhill site, also in the Great Lakes, a pollen sample was recovered from a hearth containing two fluted point bases and a channel flake. The pollen sample was identified as containing "mostly pine and spruce pollen" (Roosa 1977a:349). Similar pollen spectra have been dated elsewhere at between 9750 and 10,750 B.P. (Roosa 1977a:349). Since the pollen diagram is not published, it is impossible to determine what other species occurred.

The Dutchess Quarry Cave data are also problematic. Obviously the caribou is a boreal species, but on that inhabits both wooded and non-wooded settings (Spiess 1979). What its presence at Dutchess Quarry indicates about the local environment is unclear, particularly given the possibility that the remains were curated food stuffs carried into the site.

Charcoal samples from the hearth at the Debert site were tentatively identified as _Picea_ sp. and members of the _Gymnospermae_ family (softwoods). The presence of wood suggested to MacDonald that a stand of trees was nearby, although he left open the possibility of whether this represented a closed forest or a forest-tundra setting (MacDonald 1968:118). There is no pollen evidence from the site proper (MacDonald 1968), but two nearby cores are informative.

The core from Folly Bog, taken in conjunction with the investigations at Debert (Livingstone 1968:103), has a basal pollen zone dated to 10,764±101 - well within the range of the age of the Debert occupation. This basal pollen zone is the typical "A" zone, a boreal foest characterized by a high incidence of spruce pollen, along with fir, pine and some willow (Livingstone 1968). There is no evidence for a tundra pollen assemblage, a fact which puzzled Livingstone (1968:105). He attributed the lack of an "L" zone (now commonly referred to as a "T" zone) to possible sample inadequacies or, perhaps, to a local vegetation anomaly. Folly Bog is 16 km from Debert; 4 km closer to Debert is a core from Frog Lake (Gramly 1982). The core from Frog Lake, according to Gramly (1982), indicates a tundra environment, rich in sedges and willows.

It is quite possible that the Debert site was situated on a forest-tundra edge. But one fact is clear: it was a cold, periglacial environment. The glacial history of the area indicates ice-wedge casts nearby and possibly on the site, with active ice caps within 60 miles if the site (MacDonald 1968).

The occupation of the Vail site corresponds to a time when spruce parkland was replacing tundra in northern New England (Gramly 1982). But as Gramly notes the altitude of the Vail site may have delayed this process, with a tundra still existing at the time of its occupation (Gramly 1982:9).

While the data on site paleoenvironments are not altogether satisfactory, they are sufficient to indicate occupation by fluted point groups of both complex boreal/deciduous forests and tundra or near tundra settings. The analysis in this section suggests that paleoenvironmental setting can be used to define a set of groups that will aid in partitioning the variability in eastern fluted point sites.

Implications for adaptive strategies

The late Pleistocene environments of eastern North America were extremely diverse, as both the pollen and faunal record attest. The shift into Holocene climates and environments was complex: things did not simply become warmer. Rather, the increasingly continental climates accentuated climatic gradients, narrowed ecotones, and established the diversity and distributional patterns of the modern communities (Bryson et al. 1970; Graham 1976). Modern vegetation associations were present in sections of the southeast by 12,000 B.P.; modern faunal associations appear shortly thereafter. Hosterman's Pit, an early Holocene faunal deposit in Pennsylvania 136 km northeast of New Paris No. 4, has a completely temperate fauna by 9240 B.P. (Guilday 1967). Within a timespan of perhaps 2000 years the fauna "changed from an assemblage of cold weather species characteristic of central Canada today to the temperate fauna that still lives in the area" (Guilday 1967:232). It was to that diversity, and that period of change, that the fluted point groups were adapted.

Harris (1969) has made the argument that specialized subsistence strategies characteristically occupied only specialized or low diversity ecosystems. By contrast, generalized hunter-gatherers occupied higher diversity or more generalized ecosystems (Harris 1969:8). One can make the argument from a slightly different angle with the same results. Resources that employ "r" type reproductive strategies (MacArthur and Wilson 1967; Pianka 1978) relative to *Homo sapiens* are probably the only resources that can be the focus of specialized subsistence systems (Dunnell 1981:533). Because "r" strategists are most common in low diversity environments, this will restrict specialization to those environments.

It can be argued, further, that specialization can take place in diverse environments, as long as there are sufficient resources within those environments. Certainly models of foraging theory (Smith 1983) predict that productive environments should be used in a more specialized manner than less productive ones, and that when resources in the environment are abundant, foragers will have a tendency to be more selective and restrict their diets to better food types (Pianka 1978:265). But the crucial limiting factor is the absolute abundance of food (Estabrook and Dunham 1976:413). The energy needs of human populations are high, requiring highly abundant resources.

As Pielou (1975) and others (e.g. Harris 1969) observe, high abundance of individuals per species is inversely related to ecosystem diversity. Thus, specialization is common in low diversity environments (indeed, low diversity environments cannot support generalized strategies), but will occur in highly diverse environments only so long as the resources being exploited are available or sufficiently reliable to provide the requisite biomass and energy to make dietary specialization an efficient option. Quite obviously, this is dependent on population density and the technological system in concordance with the density of the various food items. By and large, as relative and absolute density of preferred food items decreases, as they do in more diverse environments, the resources utilized expand (Hespenheide 1980). The fact that specialized subsistence strategies are rare in the prehistoric eastern forests prior to the appearance of agriculturalists (who, of course, modify and simplify their environment), is strong supportive evidence that adaptive specialization is generally uncommon among human groups in diverse environments.

It can be inferred from these arguments that since fluted point groups occupied both the tundra and forest environments, then different subsistence strategies were likely practiced. In the low diversity tundra a specialized subsistence activity would have offered the only viable strategy for survival. These eastern fluted point groups likely exploited caribou, the only species in this environment that could provide sufficient economic return to satisfy basic food requirements (MacDonald 1971:36), at least before the advent of intensive fishing technologies several thousand years later (Cleland 1982). Eastern fluted point groups in the species-rich forests were likely generalists, exploiting a variety of plant and animal resources, as seen at Shawnee-Minisink (McNett et al. 1977).

Dincauze and Curran (1983) have argued that all eastern fluted point groups were generalized foragers, even those in the northern tundra latitudes. But if these groups were actually out on the tundra, as seems clear, then at least one activity of the posited generalized subsistence system was highly specialized. It would be useful to determine whether the tundra sites represent specialized subsistence systems, operating on an annual basis, or specialized subsistence activities, taking place on a seasonal timetable.

It has been suggested that one "would expect major industrial (but not necessarily stylistic) differences between the periglacial and the Southeastern groups" (Fitting 1975:31). In fact, there should not only be differences in the tool kits and possibly stylistic variation of artifacts like projectile points, but there may also be differences in the structure of the site record.

Much of the archaeological record for sites in the complex eastern forests should be in the form of small scale foraging stations. The resources exploited by generalized foragers are extensive and dispersed:

> Nut-collecting camps leave little readily observable in the way of food remains to mark their former location and the tools employed ... [they] are certainly not as conducive to discovery as projectiles [and bone] which accompany hunting stations (Dunnell 1972:81).

In fact, the only archaeologically visible aspect of this subsistence strategy that might be anticipated a priori are quarry related sites and isolated fluted point stations.

By comparison, in tundra settings where intensive hunting and butchering took place, one expects a great deal of lithic tool consumption. Moreover, hunters focusing on the intensive exploitation of point resources such as the caribou, produce a site record more conducive to site discovery. The semi-annual migration of this species is sometimes patterned, with the result that certain localities are used and reused on a seasonal basis (Campbell 1968; Heffly 1981). In these settings the archaeological record will be more dense, with abundant lithic debris and well worn tools. Further, one should see kill sites, functionally analogous to Clovis and Folsom kill sites: a cluster of projectile points and little else. Habitation sites associated with kill sites should have high frequencies of cutting and scraping tools. The relevant archaeological data are analyzed in the two chapters that follow.

CHAPTER 5

THE EASTERN FLUTED POINT OCCUPATIONS: ANALYSIS OF THE SITE DATA

Recently, Gardner (1977) wrote that it is "suspected but not widely touted ... that not all eastern fluted point sites are alike" (Gardner 1977:262, emphasis mine). Gardner (1977), like others, views the corpus of eastern fluted point sites from the vantage of a particular site - in his case the Thunderbird site. From the vantage point of the single site it is impossible to see just how each site is similar or different from the others. This, as I argued in the second chapter, requires a detailed analytical overview of all sites. The absence of such overviews explains the reluctance to tout the suspicion.

In this chapter I analyze data from the 22 sites introduced in the second chapter. The aim of the analysis is to document patterning and variability in these eastern fluted point sites, and determine whether that variability conforms with expected variation in subsistence and settlement strategy derived from the analysis of paleoenvironments in the previous chapters. In this chapter, a number of lines of evidence from eastern fluted point sites are examined and analyzed, including radiocarbon dates, geochronological dates, subsistence remains, site location and situation, lithic raw material use and technological and functional variability in the tool kits. My initial concern is with the temporal and spatial placement of the eastern fluted point sites.

The age of eastern fluted point sites

Radiocarbon dates

Only ten of the 22 sites have radiocarbon dates (Table 4). These dates range in age from 12500 B.P. to 1650 A.D. Unfortunately, they also range quite a bit in their reliability. Mead and I devised a scheme for gauging the reliability of a radiocarbon date (Meltzer and Mead 1983:Table 1). A slightly revised version of this scheme has been applied to the data in Table 4 (the revisions of the scheme reflect our lessened confidence in bone collagen as a reliable dating material; see our forthcoming paper [Meltzer and Mead 1984]). A score of 8 or 9 is considered a highly reliable date; a score of 7 or less is considered an unreliable date.

Excluding the clearly anomalous dates at West Athens Hill and Williamson, application of the rating system gives the following scores: Bull Brook (7); Debert (9); Dutchess Quarry Cave (7); Shawnee-Minisink (W-2994 - 9; W-3134 - 7; W-3338, W-3391 - 6); 6LF21 (9); Thunderbird (7); Vail (9); and Whipple (9). These ratings identify Debert, Shawnee-Minisink, 6LF21, Vail and Whipple as reliably dated sites. The dates at four of these sites warrant further discussion.

There are 13 dates from eight hearths at the Debert site (MacDonald 1968: Table 4). All dates are derived from charcoal samples (possibly carbonized *Picea*), and the association between the material dated and the fluted point occupation is "firm" (MacDonald 1968:53) The average of the 13 dates is 10600±47; the dates range from 11026 to 10466 B.P. (MacDonald 1968:56). The low frequency of stylistic change among the artifacts leads MacDonald to suggest that the span of occupation at the site is very brief (MacDonald 1968:53).

TABLE 4. Chronology of the eastern fluted point occupation

Site	Age	Comments
Barnes	12500-10000	Outcrops of Bayport chert, dominant raw material at site, not exposed until 12500 B.P.
Bull Brook	9300±400 8720±400 6940±800 8940±400	All dates run on charcoal from various hearths at site; no guarantee charcoal related to fluted point occupation
Davis	<12800	Site lies below highest shoreline of Champlain Sea
Debert	10466±128 10656±134 10545±126 10641±244 10572±121 10518±120 10467±118 10773±226 10511±120 10652±114 10837±119 11026±225 10128±275	All dates run on charcoal; average all dates 10600±47
Dutchess Quarry Cave	12530±370	Bone collagen date, DQC 1, associated with "Cumberland" point
Fisher	12500-10400	Site at base of former lagoon of Lake Algonquin
Gainey	10400?	Rarity of Bayport chert suggests its sources covered by Lake Algonquin
Kings Road	<12400	Site within confines of Lake Albany
Parkhill	10750-9750	Site on Lake Algonquin beach; post dates Lake Saginaw/Whittlesey
Port Mobil	<18000	No precise chronological data; site area deglaciated 18000 B.P.
Potts	<11200	Site within confines of Lake Iroquois

Reagen	12800-10000	Site at or slightly above high shoreline of Champlain Sea
Shawnee-Minisink	10590±300	Charcoal from hearth with fish bone and hawthorne
	10750±600	
	9310±1000	Stained earth associated with fluted point; both dates from same sample
	11050±1000	
Shoop	ND	
6LF21	10190±300	Charcoal from hearth
Thunderbird	9900±340	Charcoal from early Archaic horizon
Twin Fields	<14000	
Vail	10300±90	Charcoal from Feature 1
	11120±180	
	10460±330	TAMS date on charcoal (AA-117)*
	10600±330	TAMS date on charcoal (AA-114)
		(Dates average 10540±230)
	10040±390	TAMS date on humates (AA-116)
Welling	ND	
Wells Creek	ND	
West Athens Hill	<12400	Site within confines of Lake Albany
Whipple	9820±450	TAMS date on charcoal (AA-149a)
	11430±390	TAMS date on charcoal (AA-149b)
		(Dates average 10700±300)
	10150±820	TAMS date on charcoal (AA-150)
	10670±570	TAMS date on charcoal (AA-150)
	10890±650	TAMS date on charcoal (AA-150)
		(Dates average 10630±380)
Williamson	ND	

*TAMS is an acronym for "Tandem accelerator mass spectometer"; these dates were provided by C.V. Haynes.

There are five dates from the Vail site, all but one on charcoal and all from the same Feature 1 (Gramly 1982:60). Two of the dates were run using traditional counting devices; three of the dates (AA-114,AA-116 and AA-117) were recently run on the Tandem accelerator mass spectrometer (Haynes et al. 1983). The laboratory treatment for the two dates run in traditional counters differed for each sample - they were sent to different labs - and on that basis Gramly (1982:60-61) rejects the date of 10300 B.P. Averaging these two Vail dates would be inappropriate, owing to differences in the dates and error estimates (Long and Rippeteau 1974:206-208; the "ground rules" of the different laboratories are not the critical factor in deciding whether to average - cf. Gramly 1982:61).

In an effort to refine the age of the Vail site, Haynes et al. (1983) ran three additional samples from the site on the accelerator. The dates run on charcoal (AA-117 and AA-114) more closely approximate the date Gramly (1982) rejected; these two dates average 10540±230. I would suggest that a date of 10500 B.P. is an accurate reflection of the age of the Vail site.

There are five dates available for the Whipple site (Table 4), all of which were run on the accelerator (Haynes et al. 1983). Three of the dates from the same sample (AA-150) of charcoal average 10630 B.P.; the remaining dates average 10700 B.P. (Haynes et al. 1983: Table 2).

The remarkable congruity of the radiocarbon dates for these three sites, all falling around 10600 B.P., is matched by similarity in the styles of certain of the artifacts. Fluted points found at Vail are stylistically almost identical to those found at Debert: both sites, along with Whipple and Bull Brook (Haynes et al. 1983; MacDonald 1983:100), produce points with deeply concave bases, an attribute virtually unique among eastern fluted points (Meltzer 1983b).

The reliable dates from Shawnee-Minisink, W-2994 and W-3134, are statistically coeval as measured by the t statistic (t= -.23; unable to reject Ho at 0.05 level). Although the samples were drawn 60 feet from one another, they potentially date contemporary events: the fluted point occupations at the site. The average of these two dates is 10622±268 B.P.

The very early and very late dates from the Shawnee-Minisink sites are given lower ratings on the basis of the dated material (stained earth). Their wide error estimates, plus or minus 1000 years, indicate a very imprecise date and supports the low ratings.

Of the remaining three dated sites, the Thunderbird date - 9900 B.P - is not associated with the fluted point component at the site. Nonetheless it provides a minimum age for the fluted point levels which are stratigraphically below the Early Archaic material.

The radiocarbon dates from Dutchess Quarry Cave and Bull Brook have long been controversial. The Dutchess Quarry Cave date is surprisingly early - 12530 years B.P. - and is associated with what is said to be a Cumberland fluted point. Oddly enough, before the results of the radiocarbon analysis were available, the point was described as a "perfect Cumberland" in the text of the original site report (Funk et al. 1969:16). However, in an addendum to that article, added in the proof stage, the date was announced and the "perfect Cumberland" of five pages previous had become "not a classic example of the type" (Funk et al. 1969:21). It was later treated as "Cumberland?" (Funk 1976:206).

There is no reason to doubt the association of the dated material and the point fragment. The apparent problem surrounding the radiocarbon date is the fact that Cumberland points have long been thought to represent a later fluted point occupation (e.g. Mason 1962), and would thus be incongruous with a 12500 B.P. age (Snow 1980:135). As it happens, both the assignment of the point type and the reliability of the date are open to question.

Owing to recent excavations in other caves around the original Dutchess Quarry Cave (now called Cave No. 1), there is now a larger sample of fluted points. Like the first point found, these are all fragments (Kopper et al. 1978:132 describe one as "whole" but from its description it is a reworked fragment); and like the first point they are described as Cumberland points. But from a close examination of the photographs accompanying the reports (Funk et al. 1969:15; Kopper et al. 1978:131) the assignment of the point type is debatable. The points do not appear to have the marked neck constriction or pronounced blade like flutes characteristic of Cumberland points (see Chapter 6).

The Dutchess Quarry Cave points more closely resemble those points from the Great Lakes region called Barnes points (Wright and Roosa 1966). Descriptions of these points (Roosa 1965:96-97; Roosa and Deller 1982:6) note their rough similarity to Cumberland, but also specify differences in size and basal finishing techniques (Roosa and Deller 1982:8). These are differences to which the points from Dutchess Quarry Cave appear to conform. This is discussed in more detail in Chapter 6; it is important to note here only that the issue of the point type is sufficiently unclear so as not to be a factor in assessing the radiocarbon date.

The material used for the radiocarbon determination, however, is a factor of some concern. Bone collagen was used for the Dutchess Quarry date. Collagen has been shown to yield widely varying dates on the same sample (Mead and Meltzer 1984), which confirms analytical and theoretical questions of its utility (e.g. Taylor 1980). For these reasons, it is perhaps best to hold the Dutchess Quarry date from consideration until further dates are run and the age determination is checked.

The dates from Bull Brook scored a 7 on the rating system. The dates are run on reliable material - charcoal - but have been questioned on the association of the charcoal with the fluted point occupation (Grimes 1979). The charcoal for the age determination came from various hearths or a reddened zone at the site (Byers 1959), and as Griffin notes, when the sample was submitted to him there was no guarantee it would "specifically date the Bull Brook occupation" (Griffin 1977:8). Most believe Bull Brook is significantly <u>older</u> than the dates indicate (Griffin 1977; Grimes 1979; Mason 1962), as would be the case given the observation that the projectile points at this site are similar to the points at Debert, Vail and Whipple.

In 1962 Mason argued that the Bull Brook projectile points were similar to geochronologically dated fluted points from the Great Lakes area, and on that basis assigned an earlier age to the site. In a response to Mason, Byers argued there was no justification in "assigning the Bull Brook site an age greater than that permitted by the radiocarbon dates without a considerable body of substantial evidence" (Byers 1962:247).

Geochronological dates

Geochronological dates are based on glacial lake chronologies and the timing of ice retreat. For a variety of reasons caution must be exercised in the use of these data. First, the chronology of ice retreat is still a matter of controversy (e.g. Genes et al. 1981 versus Gadd 1982; Bryson

1969 versus Prest 1969). The problem, as summarized by Dreimanis, is that the information is too fragmentary, "particularly on the retreats in between readvances" and on the chronology of ice margin/proglacial lake shorelines in the Great Lakes region (Dreimanis 1977:72; see also Evenson et al. 1976).

Second, the chronology and duration of the late Pleistocene lakes and seas is poorly resolved (Mason 1981:70; for specific estimates of the ages of various lake stages see Quimby 1958; Hough 1963; Saarnisto 1974; Karrow et al. 1975; Snow 1980; Mason 1981; Jackson 1983). Table 5 is a rough consensus of the basic stages and ages of the major proglacial lakes.

Third, and perhaps most important, an artifact or a site on a raised fossil beach may or may not guarantee that the artifact or the site was deposited when the beach was active and the lake existed (Mason 1981:92). Fluted points could have been deposited on beaches long after the extinction of the lakes that formed them. Deller (1976) for example, found that three separate point types (fluted, Hi-Lo and Plano points) all occur on three separate beaches remaining from Lake Maumee, Lake Whittlesey and Lake Algonquin (Deller 1976:4). Either fluted point groups were using former lake shorelines and lake beds, or three point styles thought to be successive in time were all contemporaneous, lasted a very long time in this separate but coeval state, and lasted earlier or later (as the case may be) than previously thought. The first suggestion seems most likely (Deller 1976; Mason 1981).

TABLE 5. Ages and Stages of Glacial Lakes

Lake	Basin	Age (Years B.P.)
Chicago (various substages)	Michigan	14000 - 12500
Early Algonquin	Michigan/Huron/ Erie	12500 - 11500
Main Algonquin	Michigan/Huron	11000 - 10400
Maumee	Huron/Erie	14000 - 13600
Arkona	Huron/Erie	13600 - 13500
Saginaw/Whittlesey	Huron/Erie	13000 - 12700
Warren	Huron/Erie	12700 - 12600
Grassmere-Lundy	Huron/Erie	12600 - 12500
Early Erie	Erie	12000 -
Stanley	Huron	10000 -
Iroquois	Ontario	12400 - 11200
Early Ontario	Ontario	11200 -
Albany	Lower Hudson Valley	13500 - 12900
Champlain Sea	St. Lawrence Lowland	12800 - 10000

Geochronological data, as Mason (1981:92) concludes, have certain limitations:

> The location of an archaeological site on a fossil beach or a terrace on or near a glacial moraine can only provide of itself a maximum possible age for the site.

In order to establish a minimum age of an occupation, additional data are needed. Most often this involves information on the age of subsequent cultural components. For example, in the Great Lakes region Early Archaic occupations are dated at 9950 B.P. (Mason 1981:115), and this sets an upper boundary for the fluted point occupations. Unfortunately, the components that immediately follow the fluted point occupation in New York and New England are poorly known. Point types reminiscent of certain southeastern varieties (e.g. Hardaway and Kirk) are found in these areas but none are dated (Snow 1980:161-163). In the southeastern states Dalton and other Early Archaic components are dated as early as 10500 B.P. (in Missouri) and as late as 9900 B.P.

The maximum ages of the Fisher and Gainey sites are probably both around 10400 B.P., since each is associated with features that were under the waters of glacial Lake Algonquin - which was drained by 10400 B.P. In addition, the Gainey site has, according to one of its investigators, "Bull Brook" points (H. Wright, personal communication, 1984). These points are highly similar to the Vail and Whipple points, dated at 10600 B.P.

The two other Great Lakes fluted point sites - Barnes and Parkhill - have maximum ages of 12500 B.P. It was not until that time that the chert used at Barnes was uncovered by the waters of glacial Lakes Grassmere or Lundy (Voss 1977:255). Parkhill is situated on a Lake Algonquin beach, and thus must postdate glacial Lakes Saginaw/Whittlesey. All four of these sites predate 9950 B.P.

Further to the east there are two sites associated with the Champlain Sea. The maximum age of the Davis and Reagen sites postdates 12800 B.P., since the sites lie below the high water mark of this late Pleistocene sea (Ritchie 1965; Funk 1976). It is not possible in either case to estimate minimum ages.

The Kings Road and West Athens Hill sites are both located under the waters of glacial Lake Albany (Funk 1976:211). The lake had probably drained by 12900 B.P. (Table 5), and certainly by 12400 B.P. (Funk 1976:211). These are the maximum ages for these sites. The Potts site is located within the confines of glacial Lake Iroquois. The chronology of Lake Iroquois is unclear. Ritchie (1965:14) sees the lake draining around 10450 B.P.; Funk (1976), on the basis of more up-to-date evidence, argues this is too recent, and that the lake was drained earlier. The dates in Table 5 suggest around 11200 B.P. Again, minimum ages are unavailable.

There are a number of sites whose location is unrelated to a proglacial lake of known age and duration. Certain of those sites are north of the line of Wisconsin maximum ice advance, and maximum ages can be set on that basis. From south to north, these sites include Port Mobil, Dutchess Quarry Cave, Twin Fields and Bull Brook. The maximum ages for these sites are 18,000 B.P., 15,000 B.P. 14,000 B.P. and 14,000 B.P. respectively.

For those sites south of the line of the Wisconsin ice advance, precise maximum age determinations are impossible. In fact, for those sites - Shoop, Thunderbird, Welling, Wells Creek and Williamson - it is equally difficult to ascertain the minimum ages of the occupation - except in the most general of terms. Only at the Thunderbird site, where an Early Archaic component is stratigraphically above a fluted point component and is dated by radiocarbon at 9900 B.P. is there a reliable minimum age.

From the evidence just examined one can argue that there is considerable potential variation in the age of the fluted point occupation. The sites range in age from an upper limit of 9900 B.P. to a lower limit potentially in excess of 18,000 B.P. One can further argue, however, that at some sites the potential for variation is less than at others. In fact, it is possible to define a series of groups for which either well defined or maximum ages are known (Table 6).

First, there is a group of sites whose age is less than 10,400 B.P., but greater than 9950 B.P. Included in this narrow and relatively late period are Fisher, Gainey and 5LF21. A second group of sites cluster in age around 10600 B.P. The sites in this category, Debert, Shawnee-

Minisink, Vail and Whipple, are all reliably dated by the radiocarbon technique. The ages bracketing the occupations at these two groups of sites are narrowed and fairly well known. That and the close proximity of the dates within the groups confirms the fact that not all of the sites of the eastern fluted occupation are the same age.

Beyond these first two groups the ages of the fluted point occupation become less clear-cut. The potential age of the sites is greater, and the range within which the actual date exists is greater. The Potts site is less than 11,200 B.P., but there are no dates that might aid in setting a minimum age.

Barnes, Parkhill, Davis, Reagen, Kings Road and West Athens Hill are all less than 12,500 years old. The Barnes and Parkhill occupations fall somewhere between a minimum age of 9950 B.P. and the 12,500 B.P. date. Presumably the occupations at the other sites in this group fall within a range of comparable duration.

The potential ages of the Bull Brook and Twin Fields occupations are even greater. These sites are in areas deglaciated around 14,000 B.P., and certainly by 13,500 B.P. (Curran and Dincauze 1977; Snow 1980), hence, their potential age ranges from a maximum of 14,000 B.P. to a minimum of, say, 9900 B.P. (this latter figure, based on the Great Lakes sequence, may not be relevant here, but is inserted to illustrate the range within which this occupation may date). But, again, based on apparent similarities in projectile point style, Bull Brook may in fact fall in the second grouping of sites dated to approximately 10600 B.P.

TABLE 6. EASTERN FLUTED POINT SITES GROUPED BY AGE

Group	Approximate age of occupation	Sites
1	9900 B.P. - 10400 B.P.	Fisher Gainey 6LF21*
2	10600 B.P. - 11200 B.P.	Debert* Shawnee-Minisink* Vail* Whipple*
3	11200 B.P.>	Potts
4	12500 B.P.>	Barnes! Parkhill! Davis Reagen Kings Road West Athens Hill
5	14000 B.P.>	Bull Brook Twin Fields
6	15000 B.P.>	Dutchess Quarry Cave
7	18000 B.P.>	Port Mobil
8	Unknown or minimum estimate only	Shoop Thunderbird! Welling Wells Creek Williamson

* Reliably dated by radiocarbon technique
! Minimum age available - see text

If the radiocarbon date for the Dutchess Quarry Caves is rejected as unreliable deglaciation evidence indicates that the maximum age of the site must postdate 15,000 B.P. _If_ the points at Dutchess Quarry Cave are indeed Barnes points, and _if_ those points are of similar antiquity in the Hudson Valley as they are in the Great Lakes region, then the maximum age of the Dutchess Quarry site may more closely approximate 12,500 B.P.

Finally, the Port Mobil site, undated by any other means, has a maximum age as determined by the timing of deglaciation of 18,000 B.P.

Omitted from these groups of sites by age are a number of sites for which no information is obtainable. Not surprisingly, this includes all sites south of the limits of glacial ice: Shoop, Thunderbird, Welling, Wells Creek and Williamson. As noted above, a minimum age of 9900 B.P. is available for the fluted point component of the Thunderbird Site.

In summary, it is clear that there are age differences in the fluted point occupations. In part, those differences are due to poor resolution. Groups 3 through 7 (Table 6) are defined on the basis on maximum ages alone. It may be that with additional data those sites will prove to be of similar age, and comparable in age to the sites of either Groups 1 or 2. As it stands, there are a couple of groups of known age, narrowly defined (Groups 1 and 2), with the remainder of unknown and increasingly broader potential age.

The distribution of eastern fluted point sites

When eastern fluted point sites are plotted on a map (Figure 10), a number of patterns emerge. The most obvious feature, and the one of greatest potential significance, is the concentration of sites in the northern latitudes, and specifically north of the line of maximum glacial advance. Of the 22 sites, 17 are located north of the line of maximum advance; with the addition of the three sites that can be located but have otherwise insufficient data for analysis (Harney Flats, Munsungun Lake and Whipple), the totals are increased to 19 of 25 sites located north of the line of maximum advance. As MacDonald observes (1983), it is notable that "no fluted point sites of significance have been reported from the southeast" (MacDonald 1983:106). Although he has does not consider the

Thunderbird, Wells Creek or Williamson sites to be significant, his point nonetheless is well taken. Most of the sites are not in what were the complex boreal/deciduous forests of the late Pleistocene.

In exploring this pattern further, the obvious question that must be answered is whether the site data are congruent with the area of occupation. Are all fluted point materials similarly concentrated north of the line of maximum ice advance? More specifically, are the thousands of isolated fluted points reported from eastern North America clustered in the northern, glaciated regions? This can be tested readily.

Isolated fluted points (isolates) are defined as fluted points that occur by themselves and not in the context of a Paleo-indian site. All counts of isolates used here are thus exclusive of the points recovered from sites. The reason for distinguishing the two is to insure independent samples are being utilized. Isolates are found throughout the eastern United States; by recent count there are well over 6000 (the data discussed here are presented in Tables 7 and 8, compiled from Brennan 1982; Mason 1958; Seeman and Prufer 1982; Stoltman and Workman 1969; and my own counts of unpublished isolates from various institutions).

Plotting the distribution of isolates yields a pattern quite unlike the distribution of sites. The frequency of isolates is higher in unglaciated as opposed to glaciated regions. Excluding for the moment all the border states (states bisected by the line of maximum ice advance: New Jersey, Pennsylvania, Ohio, Indiana and Illinois), fully 90% (4422/4925) of all isolates are located in the unglaciated area of the eastern United States (Table 7a). Including those border states for which reliable point

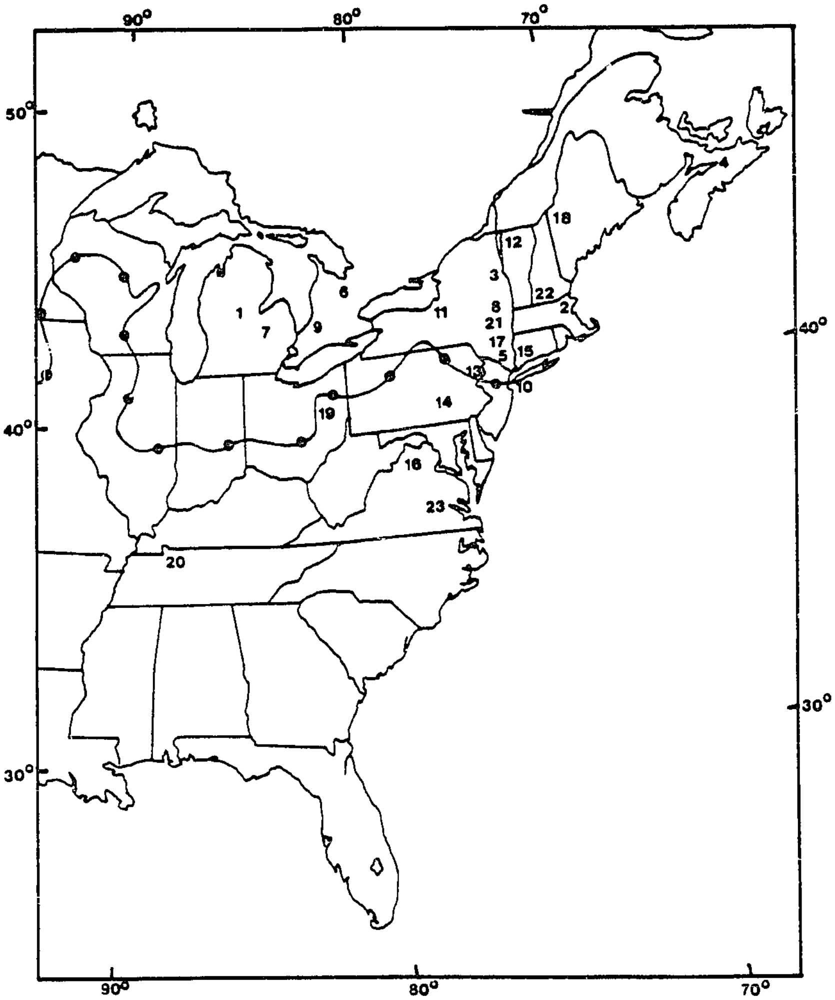

FIGURE 10. Location of eastern fluted point sites.

1. Barnes, MI
2. Bull Brook, MA
3. Davis, NY
4. Debert, NS
5. Dutchess Quarry Cave, NY
6. Fisher, ON
7. Gainey, MI
8. King's Road
9. Parkhill, ON
10. Port Mobil, NY
11. Potts, NY
12. Reagen, VT
13. Shawnee-Minisink, PA
14. Shoop, PA
15. 6LF21, CT
16. Thunderbird, VA
17. Twin Fields, NY
18. Vail, ME
19. Welling, OH
20. Wells Creek, TN
21. West Athens Hill, NY
22. Whipple, NH
23. Williamson, VA

frequencies by county are available (New Jersey, Pennsylvania and Ohio), the figure drops somewhat: 81% of the isolates are located in the unglaciated region (5028/6207).

This drop in percentage points from 90% to 81% is due almost entirely to the inclusion of 623 isolates from the glaciated region of Ohio. In Ohio, unlike other border states, only 33% (307/930) of the isolates are located in unglaciated areas of the state. Lepper (1983a) attributes this disproportion to differences in modern land use. The unglaciated area, low in isolates, is less intensely cultivated than the glaciated portion of the state, suggesting a biased set of counts from the state (Lepper 1983a:32). For this reason the Ohio counts are omitted from subsequent analysis.

It is clear, simply from the frequency data, that isolates and sites are not distributed in a similar fashion. A chi-square test can be used to determine the significance of the difference between the frequency of sites and isolates in glaciated and unglaciated regions. The resulting significant chi-square value, 104.57 ($p<.001$) indicates that the frequency and location of sites/isolates are independent.

Breaking that value down using adjusted residuals (Everitt 1977) shows how each of the cells contributed to the high chi square. Adjusted residual values are approximately normally distributed with mean 0 and standard deviation 1. Thus, a value of 1.96 (distance from the mean) is significant at the 0.01 level, and so on. Because this is a two tailed test, it indicates the direction away from the mean - and thus whether a cell is significantly over or under represented. The adjusted residual values in Table 7a indicate that glaciated regions are significantly underrepresented (at the 0.001 level) by isolates (-10.20) but significantly overrepresented by sites (+10.20) (Table 7a). Including the border states (Table 7b) affects the magnitude but not the significance or direction of these figures.

TABLE 7. Frequency of isolates and sites in glaciated and unglaciated regions

A. All states exclusive of border states (New Jersey, Pennsylvania, Ohio, Indiana, Illinois)

	Glaciated Region	Unglaciated Region	Total
Isolates	503	4811	5314
Sites	15	4	19
Total	518	4815	5333

Chi-square value = 104.57, significant at 0.001

Adjusted residuals by cell:	-10.20	+10.20
	+10.20	-10.20

B. All states in (A), and New Jersey and Pennsylvania

	Glaciated Region	Unglaciated Region	Total
Isolates	556	5110	5666
Sites	16	6	22
Total	572	5116	5688

Chi-square value = 95.98, significant at 0.001

Adjusted residuals by cell:	-9.79	+9.79
	+9.79	-9.79

So far the discussion has focused on frequency data, but the observations made of these data and the conclusions drawn from it carry over to data on <u>density</u>. Omitting the border states, the glaciated area includes a total of only 230,554 square miles (Table 8). The unglaciated area includes nearly twice that much, at 418,429 square miles (Table 8; data on area size compiled from data on individual states derived from National Geographic 1975). Despite the marked differences in size, the density of isolates/area in unglaciated versus glaciated regions differs by an order of magnitude. The density of isolates in unglaciated regions is (.0105 isolates/square mile), five times higher than it is in glaciated regions (.0021 isolates/square mile). In contrast with the isolate density data, the density of sites is greater in glaciated regions (.000065 sites/square mile) by an order of magnitude over the density of sites in unglaciated regions (.0000086 sites/square mile).

TABLE 8. Density of isolates and sites in glaciated and unglaciated regions*

Region	Area (Sq.Miles)	Isolates/Area	Sites/Area
Glaciated	230,554	.0021	.000065
Unglaciated	460,673	.0104	.0000086

* Frequency data from Table 7a

The density data conform closely to the frequency data; they also indicate there are important differences in isolates and sites in glaciated versus unglaciated regions. Glaciated regions have a higher frequency and density of sites than unglaciated regions, but have a lower frequency and density of isolates than unglaciated regions.

Having argued there are significant quantitative differences in the record of sites and isolates in glaciated versus unglaciated regions, it is also relevant to add that there appear to be qualitative differences as well. Of the five sites located in the unglaciated region, four of them are quarry or quarry related sites (Thunderbird, Welling, Wells Creek, and Williamson). As such, they are all relatively large and highly visible sites. In the glaciated regions, there is no dominant site type. There are also large, highly visible quarry and quarry related sites (Fisher, Kings Road, West Athens Hill); in addition, there are large, non-quarry sites (e.g. Debert, Bull Brook, Vail), and small, non-quarry sites (e.g. Barnes, Davis, 6LF21, Twin Fields). The differences in site types are explored in more detail later in this chapter; the point I wish to make here is that dividing the sites even using these general categories yields apparent qualitative differences in the archaeological record of the glaciated and unglaciated areas.

In the foregoing discussion I have distinguished between glaciated and unglaciated regions for two reasons: first, because these two areas differ in the potential for site creation, preservation and discovery; second, because these areas manifest markedly different environments during the time of fluted point occupations. In effect, I anticipated that there would be differences in site frequency and density owing to both differences in aboriginal land use and differences in the potential of each region to yield an archaeological record.

It is a simple matter to show that differences exist in the numbers of isolates and sites in the two areas. In addition, there appear to be differences in the kinds of sites in these two areas. But attributing the cause of that disparity to differences in aboriginal land use and/or differences in site formation processes is a more complex problem (Grimes 1983:22). It is impossible to state that the disparity between glaciated and unglaciated regions is, for example 60% a result of differences in aboriginal land use and 40% a result of differences in site formation processes. Nonetheless, it is possible to specify some of the relevant variables that have contributed to the pattern of sites and isolates in glaciated and unglaciated areas.

One important variable is the ages of the sediments and surfaces in unglaciated versus glaciated North America. Surface deposits in the glaciated region are, of course, less than 18,000 years old - in much of the region they are less than 12,000 years old. Nearly all of these deposits have their source in transported material (either by ice, wind or water); there has been very little in situ soil development taking place in the last 12,000 years (Hunt 1972:198). On average, these deposits are three feet in thickness (Hunt 1972:185), although obviously in certain areas tills are much deeper.

Sediment of the unglaciated regions is much more complex. With the exception of the Coastal Plain and the major river valleys, the sediments of the unglaciated east are dominantly residual in origin, and as such are extremely old. These sediments are "pre-Wisconsinan; many are pre-Quaternary, and some pre-Cenozoic" (Hunt 1972:128). In some places these ancient deposits are more than 100 feet thick; where they are overlain by younger (post-Wisconsin) sediments, the overlying deposits are "shallow," and generally "3 to 4 feet deep" (Hunt 1972:198). By contrast, the river valleys of the unglaciated area often have deep deposits of post-Wisconsin age sediments (Hunt 1972; Olafson 1971). Because of this alluvial action, valley surfaces of late Pleistocene age become deeply buried. At the St. Albans site in West Virginia, for example, early Archaic (ca.8000 B.P.) components are buried 18 feet below the surface; core samples indicate a possible cultural occupation as deep as 36.5 feet (Broyles 1971:47-48). A similar situation occurs in areas effected by late Pleistocene and early Holocene wind action. There are extensive loess deposits 100 to 200 feet thick blanketing the eastern edge of the Mississippi River (Hunt 1974:124). Again in this instance surfaces of late Pleistocene age are deeply buried.

The consequences of this are straightforward: those settings most conducive to site preservation (buried deposits) are least conducive to site discovery. It is no surprise that only three fluted point sites (Dutchess Quarry Cave, Shawnee-Minisink and 6LF21) were deeply buried (at depths greater than five feet), while the rest were surface and near surface phenomena. Surface and near-surface sites in both glaciated and unglaciated areas are highly visible; surfaces of late Pleistocene age, particularly in the unglaciated region, are deeply buried and thus of low visibility. Sites are discovered, in these settings, only by fortuitous circumstances (e.g. Moeller 1980:3).

There are also important differences in modern-day population and land use in glaciated versus unglaciated areas that are responsible for the disparity in the number of sites and isolates. The types of farming in glaciated versus unglaciated areas are on the whole quite distinct. With the exception of certain areas of the corn belt in Ohio, Indiana and Illinois, the predominant type of farming in the glaciated region is dairying (USDA 1958). South of the dairying areas, in the unglaciated east, corn, truck and fruit crops, cotton and tobacco are farmed extensively (USDA 1958:112).

Agronomic practices associated with dairying on the one hand, and general farming on the other, differ along at least one significant dimension: the degree of plowing and cultivation (see also Lepper 1983b). The result is that more extensive areas of the unglaciated region are turned over yearly by the plow than in glaciated areas, and this likely contributes to the higher number and density of isolates found in unglaciated areas. Since most of the material of late Pleistocene age is close to the surface, the plow is likely to turn it up (save in situations like deep alluvial and loess covered valleys, and mountainous areas).

To one degree or another these two features contribute to the pattern of sites and isolates seen in glaciated and unglaciated eastern North America. But there is, in addition, another reason why one might expect frequency differences in sites and isolates. Recall that four of the five sites in the unglaciated region were quarry or quarry related, while only 3 of the 17 sites in the glaciated region were of similar type. Large and small <u>non</u>-quarry sites, while abundant in glaciated regions, are absent in the unglaciated area. Now these sites may exist in the unglaciated area, but perhaps are so deeply buried or badly mixed that they have not been recognized or discovered. But it is worth speculating, as I suggested in Chapter 4, that larger, non-quarry sites are not a significant part of the archaeological record in the unglaciated east.

Stone outcrops are spatially clustered or <u>point</u> resources. As a point resource, an outcrop will be visited and revisited to maintain the stone needs of a group (Gardner 1974). The result of these activities is the accumulation of debris which is often quite large and thus highly visible in the archaeological record. Certainly this is evident in the four quarry sites located in the unglaciated east. Reversing the argument (a dangerous but not unreasonable procedure in the context of speculation), the <u>absence</u> of non-quarry sites <u>might</u> indicate the absence of significant, non-quarry point resources.

As argued in Chapter 4, the inhabitants of the complex boreal/deciduous forests of the unglaciated east were generalized foragers. Reuse of particular localities may well have been less frequent, and hence the possibility of multiple occupations leading to the creation of a recognizable site was lessened. In effect, the dominance of quarry-related sites may indicate that stone was the only significant point resource being exploited. Now, of course, the absence of non-quarry sites cannot be taken as evidence of the validity of this hypothesis, particularly in light of the discussion just concluded of the various factors effecting the record, but the suggestion is plausible.

One might speculate too on the creation of sites in the glaciated area. On the reasonable assumption that creation of a site is more likely to occur at a point resource (Dunnell 1972:81), one can argue that large, non-quarry sites indicate the exploitation of significant, non-quarry point resources. As argued in Chapter 4, there was at least one species - the caribou - that was sufficiently clustered spatially and temporally that it could be considered a point resource. If the non-quarry sites of the glaciated region are, in fact, related to exploitation of migrating caribou, they should fulfill two necessary conditions: they should show evidence of seasonal use, and they should be located in tundra or near tundra environment.

Certain sites - Bull Brook, Debert, and Vail - evince multiple, seasonal occupations (Gramly 1982; Grimes 1979; MacDonald 1968) consistent with this view. It is intriguing to note too that the Shoop site, physically located in the unglaciated region but in a similar environment in late glacial time, shares these characteristics of site structure (Cox 1972). What makes this intriguing is that the Shoop site is the farthest north of any of the sites of the unglaciated region. The site is undated, but if it proves to have archaeological assemblages similar to the known periglacial sites, then it is exciting to speculate that Shoop might have been situated in a tundra or periglacial environment. This, in turn, would have significant implications for the age of the site: Shoop would date to at least 12,000 B.P., the time when the area would have been a tundra environment (Watts 1979; see also Chapter 4). It is for this reason that I have treated Shoop separately from the quarry-related sites of the unglaciated east.

In summary, it can be observed that sites are not scattered evenly across the area of occupation. There are an inordinate number in the glaciated region (Table 7). Second, there are formation processes that bias these data. The site record for the glaciated area cannot be used to draw inferences regarding site types in the unglaciated area. Nor is there a warrant to regard them as "typical" of eastern fluted point sites. The samples from the two areas are simply not comparable. Finally, there are potential differences in aboriginal land use in glaciated versus unglaciated areas.

It is useful to link this variation to differences in the age and paleoenvironmental setting of these sites, as previously determined. Table 9 shows eastern fluted point sites partitioned along two dimensions: paleoenvironmental setting and site location.

Two sites - Debert and Vail - appear to have been situated in tundra or near tundra settings (Gramly 1982; MacDonald 1968; see also Livingstone 1968). It is interesting to note that these two sites are also grouped together on the basis of age (Table 6), and both show evidence of multiple, seasonal occupations.

TABLE 9. Eastern fluted point sites grouped by location and environmental setting

	Glaciated region	Unglaciated region
Tundra	Debert Vail	
Mixed boreal/ deciduous forest	Gainey Parkhill Shawnee-Minisink 6LF21	Thunderbird
Unknown	Barnes* Bull Brook* Davis Dutchess Quarry Fisher Kings Road Port Mobil Potts Reagen Twin Fields West Athens Hill Whipple*	Shoop* Welling* Wells Creek! Williamson!

* Possible tundra setting
! Probable mixed forest setting

The environmental setting of the Shoop site is unknown, but its proximity to the line of maximum ice advance, and its similarity along certain lines to Debert and Vail suggest that the site might have been occupied while the region was in tundra. Supporting evidence for this speculation will have to come from further research.

Site 6LF21 and the Gainey site are not only of similar age (Table 6), but they also share a similar environmental setting: they, along with Parkhill and Shawnee-Minisink, were located within complex forests that - given their location with respect to the retreating ice - were probably dominated by boreal elements. Given the ages and location of these sites it would seem unlikely that they were situated in close proximity to a tundra environment.

In the unglaciated region the biotic community was probably very similar to that of the previous group, although likely included more deciduous elements. This is indicated by the records for the Thunderbird site (Carbone 1976). The Wells Creek and Williamson sites are included in the category with the Thunderbird site based on their presumed age and their location with regard to Thunderbird and nearby palynological sites (Delcourt 1979; Delcourt et al. 1980).

The remainder of the sites are known only by location, not by their paleoenvironmental setting. Certain of these sites (e.g. Barnes, Bull Brook, Dutchess Quarry Cave) could have been associated with a tundra setting. However the data are unclear, and any assignment would be conjectural, and must be supplemented by additional chronological or paleoenvironmental data.

The Welling site is listed as "unknown" owing to its proximity to the ice front. Since the site is undated, and since tundra or periglacial environments did exist in Ohio (Shane 1975), it is possible that the site was not located within the complex boreal/deciduous forests.

Site situation

Site situation is a more specific aspect of site location; it refers to the positioning of the site vis-a-vis the local resources, topography and landforms. There are a number of factors that appear to influence site situation.

Gardner (1974, 1977) has argued that the most important among them is the location of lithic raw material outcrops or sources. He bases this conclusion on the remarkable uniformity in the selection of cryptocrystalline siliceous rocks as the raw material base for tool manufacture among eastern fluted point groups (Goodyear 1979:1; see also Kraft 1973; Ritchie 1965). Many of the eastern fluted point sites - Fisher, Kings Road, Thunderbird, Welling, Wells Creek, West Athens Hill and Williamson - are situated adjacent to or very near lithic outcrops.

Obviously sites rich in raw material produce a great deal of lithic debris, and this makes makes them more visible in the archaeological record. Thus, it would be premature to conclude from their visibility that sites related to lithic outcrops were necessarily the focal point of the settlement system. Such a conclusion requires determining whether these sites were simply quarry-related, low activity sites, or whether they were indeed large-scale habitation sites.

River systems and proglacial lakes were also a focal point for fluted point sites. A number of sites - Barnes, Davis, Fisher, Parkhill and Reagen - are situated directly on the former strandlines of lakes and, in the case of Davis and Reagen, the Champlain Sea. There is no compelling evidence to demonstrate that fluted point groups were exploiting the resources of the lake or lake margin environment (Cleland 1982:768; Curran and Dincauze 1977:334).

This lack of evidence lends credence to the suggestion that lakes which fronted the ice sheets were too cold, too brief in existence, and too loaded with glacial sediments to have supported much animal life (Snow 1980:109). The Champlain Sea, a large marine transgression that took place when the Atlantic Ocean flooded the St. Lawrence lowland 12000 years ago, contained a number of species of marine mammals (Harington 1977). But there is no evidence eastern fluted point groups were exploiting Cetaceans.

There are other reasons why the beaches of glacial lakes attracted fluted point settlements. The lakes may have served as barriers to channel animal movements. It has been suggested, for example, that fluted points on the landward side of the Champlain Sea represent exploitation of the Caribou, whose movements would have been directed through the narrow strip of land between the sea and the Adirondack and Green mountains (Loring 1980:33).

Alternatively, fluted point groups could have camped on the beaches long after the extinction of the lakes which formed them (Mason 1981). Later, non-fluted point groups had adaptations tied into former strandlines (Storck 1979), and there is some evidence that fluted point groups were exploitating former strandlines as well (Deller 1976; see discussion above). Raised beaches could have been better drained and therefore drier than the surrounding countryside of swamply lake bottoms; they may have provided a strategic vantage for sighting migrating animals; they may have been used as corridors for animal movement; or they may have simply provided good exposures of useable till or cobbles (Deller 1976; Eisenberg 1978; Gramly 1982; Jackson 1983; Mason 1981; Simons et al.

1983). Regardless of the activities that took place, the evidence that fluted point groups were using abandoned strandlines has important implications for geochronology, as already discussed, and for settlement models.

Local elevation, which may have been a primary consideration in the occupation of beach ridges, was important in fluted poist site situation outside the lake region. Fluted point sites are routinely placed on high river terraces, moraines, knolls, or local well-elevated spots (Cunningham 1973; Ritchie 1965). Use of high river terraces may be related to higher water levels in rivers draining the ice fields (Ritchie and Funk 1973:6). Shawnee-Minisink and Thunderbird (but not Port Mobil) were at water's edge when occupied (Eisenberg 1978; Gardner 1974).

On the assumption that many of these areas were not heavily forested, these higher elevation sites may have been selected to provide a view of the surrounding landscape (Dragoo 1976; Funk 1976; Seeman and Prufer 1982). This would have enabled fluted point groups to watch for animals (Dragoo 1976:9), or the migration of game (Funk 1976:222). The location of the Shoop site struck Witthoft (1952) as peculiar and unexpected, but others suggested the setting is understandable in terms of the "commanding view" it would have provided over much of the valley when the region was unforested (Cox 1972:8; Funk 1976:221). Recall the possibility that the site was in a tundra or periglacial environment.

Where a site is in the proximity of a rock outcrop or quarry its precise situation often appears determined more by topography than immediacy to the stone source. For example, the actual source of the stone used at Wells Creek is four miles from the site; the site is situated on the central hill of the Wells Creek crater, which in the absence of trees would have afforded an "an ideal vantage point" for viewing the floor of the surrounding basin (Dragoo 1973:5). A similar situation occurs at West Athens Hill, which is the highest peak on a long ridge (Funk 1976:222) and at the Williamson site (Dragoo 1976:9).

The higher elevations of sites with respect to their surroundings is often taken as prima facie evidence for hunting (Seeman and Prufer 1982). In fact, it is also used to explain the lack of kill sites. As the argument goes, game was sighted from elevated observations points,

> subsequent ambushes and butchering then took place on the valley floor, carcasses left on floodplain bars or levees would more often then not be scavenged and subsequently dispersed with the following flood season (Seeman and Prufer 1982:160).

Seeman and Prufer (1982:160) suggest that this model of upland observation and habitation site and lowland kill site fits well with the available data on western Paleo-indian settlement systems documented by Judge (1973).

Unfortunately, where there is reasonable indirect evidence for specialized hunting - as at Vail and Debert - the site situations do not fit the western model, but then neither do the presence of floodplain sites like Shawnee-Minisink and Thunderbird. It is more plausible to view the use of elevated areas as a more efficient way of moving across the landscape. In deglaciated regions, where swamp and bogs likely appeared following the retreat of the ice, topographic high spots would have been better drained, drier, and more easily traversed.

Two other aspects of fluted point site situation are worthy of note. First, with the obvious exception of Dutchess Quarry Cave (and the possible exception of Meadowcroft), there is little evidence that caves or rockshelters were utilized by fluted point groups (Funk 1976:221). Certainly this pattern does not exist for lack of caves. Dutchess Quarry Cave, as mentioned, is in an area of classic temperate karst (Kopper et al. 1978:125). Limestone caverns occur in every state from Pennsylvania to Tennessee, particularly in the lower Paleozoic limestone formations of the Valley and Ridge province (Hunt 1974:261). Moreover, this pattern is exclusive to fluted point groups. Occupation of caves and rockshelters begins with later Dalton groups (Goodyear 1982:391) and continues through the historic period.

Second, the settings of the Debert, Vail and Whipple sites warrant comment. Vail and Whipple share a similar aspect: each is located in a river valley with natural barriers serving to direct any animal movement through the valley toward the sites (Gramly 1982:57). Gramly (1982:72-73; Gramly and Rutledge 1981:359) interprets this as evidence that these localities served as points for the interception and exploitation of caribou herds migrating through the region. MacDonald (1968:120) has interpreted the location of the Debert site in a similar manner. The Kings Road site, on a setting that "only vaguely suggests a rise" (Funk 1976:222), has similarly been interpreted as "favorably located for interception of moving herds" (Snow 1980:141).

In seven of the 22 sites the feature or resource dominating the site situation was the proximity of the site to a stone outcrop. In all but two of the sites (Kings Road and Wells Creek), the sites were situated almost directly on the outcrop. At Wells Creek the site was four miles from the outcrop (Dragoo 1976); the distance between Kings Road and the local outcrops of Normanskill chert have never been specified, although the impression is given that the distances are not great (Funk 1976; Weinman and Weinman 1978).

In nine of the 22 sites (Dutchess Quarry, Gainey, Port Mobil, Potts, Shoop, Twin Fields, Wells Creek, West Athens Hill and Williamson) the site is situated on a topographic high. These sites are not necessarily at high elevations in absolute terms, rather they are all at high elevations relative to the surrounding countryside. The lowest of these, the Potts site, is on a glacial drumlin only 20 feet above the surrounding country (Ritchie 1965).

Five sites are situated on glacial lake beaches. These may or may not be related to the glacial lakes themselves, which were likely too cold, too loaded with sediment, and too brief in existence to have supported animal resources. At least 10 other sites were situated in close proximity to a river or a stream (Bull Brook, Port Mobil, Shawnee-Minisink, Shoop, 6LF21, Thunderbird, Twin Fields, Vail, Welling and Williamson).

Finally, four sites (Kings Road, Debert, Vail and Whipple) are apparently situated so as to have been strategically located in the path of migrating animals. Other sites, particularly those near proglacial lakes, may also have been similarly situated - with the lake water serving to channel animal migration. However, in the absence of knowing where the lake levels were at the time of site occupation this must remain a speculation.

The sites have already been partitioned on the basis of age (Table 6) and location (Table 9). It is useful to examine whether site situation cross-cuts those groups (and is thus unrelated to age/location variation) or corresponds to those groups. From the data at hand, it is evident that in at least one instance there is a marked correspondence between groupings derived by age/location and site situation.

The Debert and Vail sites, already shown to roughly correspond in age and having been located in a like environment, also share important characteristics of site situation. As just discussed, each appears to have been situated for the interception of migrating herd animals. The Whipple site is situated in the same manner, which is intriguing since the Whipple fluted points are stylistically similar to the Debert and Vail points (and thus possibly of the same age).

Stone outcrop-related sites appear to cross-cut age/location groups. These sites are not restricted to glaciated/unglaciated areas or environments, and their ages are not restricted to any of the known groupings. In fact, the ages of most of these quarry-related sites is unknown.

Sites situated on glacial lake beaches are, of course, restricted to the glaciated region, but there is no evident variation by age-group. Sites situated with respect to rivers and streams cross-cut both age and location groupings.

Subsistence remains

There are only four eastern fluted point sites that have preserved organic remains representing subsistence activites. The scarcity of these data are indicative of strong biases that have effected the archaeological record. There are at least two elements responsible for this significant amount of negative data: a natural bias that effects the preservation of organic materials, and a set of biases toward the discovery and recovery of organic materials.

Poor preservation of organic materials characterizes much of the eastern United States. This poor preservation is due to the fact that the eastern states receive high amounts of rainfall, and as a result produce lush vegetation growth and plentiful organic matter. When the organic materials decompose a variety of organic and inorganic acids are produced: these include carbonic, sulfuric and nitric acid. As these acids are leached into the soil they are absorbed in the mineral portion and replace soil bases. Over the long term, this leads to increased soil acidity (Brady 1974:379-380; Hunt 1974). Since the eastern fluted point occupation is late Pleistocene in age, the potential for the preservation of organic remains is greatly reduced.

But, as Dent and Kaufman (In press) note, soil acidity is only partly to blame for the scarcity of organic remains at these sites. Also responsible are the techniques used to recover those materials. Recall from Table 2 that screening of soil material took place at less than half the excavated sites! At only three of those sites (Gardner 1974; McNett et al. 1977; Moeller 1980) were flotation techniques (Streuver 1968; Watson 1976) for the recovery of micro faunal and floral remains used.

As faunal analysts have pointed out many times, the potential for the recovery of organic materials - and this can be generalized to the recovery of any material - is dependent on the size of the material (Casteel 1972; Payne 1975; Thomas 1969). The larger the material, the greater its visibility and the greater the likelihood of its being recovered. The smaller the material, the less likely it will be recovered without the aid of special detection and collection techniques.

The simplest way to demonstrate, for example, that plants were an unimportant subsistence resource, would be to use no screens or screens with a large gauge size. This would insure that the generally small remains of seeds, dried fruits, nut shells and pits would never be recovered. In effect, this is what has happened in eastern fluted point studies. Since neither screens nor flotation techniques are routinely used, when organic remains are recovered they are uniformly the remains of large animals, and not the remains of small mammals and plants. Conversely, where flotation is used, it provides a great deal of evidence for the use of plants and fish. All this compounds existing biases (Dunnell 1972) against the discovery and recovery of non-hunting stations.

The general lack of remains of small mammals and plants is thus not compelling evidence that these resources were not exploited by fluted point groups. Rather, this indicates simply that the techniques for their recovery are wanting, for when the proper techniques are used, as at Shawnee-Minisink, the remains are found. Thus, the evidence for subsistence remains is necessarily biased toward the recovery of large mammal remains, and against the recovery of smaller plant and animal remains. Only when all soil material from all sites is screened and floated on a comparable basis (Munson 1981) will it be possible to draw firm conclusions about this positive and negative data.

Having noted these biases, it is useful to review the specific evidence for subsistence activities at these sites. Organic remains of putative subsistence activities have been recovered from four sites: Bull Brook, Dutchess Quarry Cave, Shawnee-Minisink, and Whipple.

The remains from Bull Brook are controversial. Fragments of bone were found in artifact bearing lenses; the size of the fragments suggested that they came from the long bones of a deer (Byers 1955, 1962:248). As Grimes observes, a number of authors have taken this to mean caribou (Fitting et al. 1966:137; Grimes 1979:117). But the assignment of the bones to a particular species of cervid, or some species other than deer or caribou, is problematic:

> from our experience at Bull Brook, the bone refuse is extremely fragmented, calcined, and badly weathered, and difficult to identify .... and here again the association is not certain (Grimes 1979:118).

The evidence from the caves at Dutchess Quarry is more compelling. The caves are situated -- and have their genesis - in a region of karst topography, and these limestone rich sediments provide excellent bone preservation (Kopper et al. 1978). At the original Dutchess Quarry Cave (now called Cave 1), caribou bones were identified in Stratum 2, the level which contained the purported Cumberland point (Barnes? point) along with a thick side-notched point (Guilday, in Funk et al. 1969:17-18). The remains included teeth, antler, radius and ulna fragments (Funk et al. 1970:183). There were no other species of boreal affinity in this stratum. Importantly, the caribou limb bones appear to have been "broken for marrow" (Guilday, in Funk et al. 1969:18).

Subsequent excavations in recent years have produced additional remains from Dutchess Quarry Cave No. 8 (Kopper et al. 1978).Faunal remains from this cave include large birds, fish, and "the cracked left radius of a caribou" (Kopper et al. 1978:133). Most of the materials in this cave are thought to have been transported into the chamber from occupation floors in the talus sill outside the cave mouth, the cave evidently being too small to comfortably admit human occupation (Kopper et al. 1978:135). The bone refuse comes from a stratum containing fluted points, similar to the Barnes/Cumberland points froun in Cave 1 (Kopper et al. 1978:135). While the caribou and fish bones may relate to the occupation, the large birds may not. Their remains may simply be the remnants of raptors who once inhabited the site; a finer taxonomic identification of these remains will help resolve this matter.

A number of secondary sources (e.g. Grimes 1979:119; Kopper et al. 1978:135) have indicated that caribou remains have been recovered from the Whipple site in New Hampshire. Little has been published on the association of these remains with the fluted point materials.

Systematic screening and flotation of soil materials were part of the recovery strategy at the Shawnee-Minisink site (Dent and Kaufman, In press). Over a period of four years, more than 1200 samples were taken, processed and analyzed from the site. The results are striking, and emphasize the importance of good recovery technique to offset poor preservation. As Dent (1981:81) notes, the remains from the fluted point component at the site included

> carbonized seeds from acalypha, blackberry, chenopod, hawthorn plum, hackberry, and grape ... as well as ... charred fish bone.

The fish bones were recovered from a hearth in direct association with fluted point materials.

The recovered organic remains suggest that caribou exploitation took place in at least one and possibly three eastern fluted point sites. But this evidence is potentially misleading, insofar as the recovery techniques are biased toward these larger remains. Any statements on the importance of caribou exploitation in the larger subsistence system will require additional and independent evidence.

In the one case where systematic recovery techniques aimed at detecting small organic remains have been used, the number of resources recovered significantly increases. Since these techniques have not been used at other eastern fluted point sites, it remains unclear whether the absence of additional subsistence remains indicates specialized caribou exploitation or simply poor recovery technique (Moeller 1980:39).

Lithic raw material use

Ritchie (1957:11) observed that eastern fluted point materials are characteristically manufactured of "high grade flint". Twenty-five years later there is no reason to challenge this observation. At all of the sites the lithic assemblages are routinely - if not exclusively - composed of cryptocrystalline quartz raw material, including chalcedony, jasper, chert and flint (Goodyear 1979; Ritchie 1965:6). Following common usage in the geological literature (Blatt et al. 1972; Pettijohn 1975), chert is used as a general term to refer to all these varieties. At only two sites - Debert and Reagen - are there non-chert artifacts. In both cases the tools of these materials represent only a small portion (both by weight and by frequency) of the total assemblage (MacDonald 1968:62; Ritchie 1953:250).

As discussed in Chapter 2, the patterns of raw material use are potentially valuable for deriving the settlement system of eastern fluted point groups (Ritchie 1957; Ritchie and Funk 1973; Witthoft 1952). Both the type and source of these stones is potentially identifiable. The presence of locally available and exotic stones in an assemblage "leads to some very definite conclusions regarding the movements into and within the area by the first inhabitants" (Ritchie 1965:6).

But as argued earlier, determining the source of a stone utilized at a site is not a straightforward procedure (Gardner 1974; Witthoft 1952). Other processes, aside from human transport have moved stone material. Importantly, the stone material is not moved in bulk, but rather dispersed in cobble or pebble form. Witthoft (1952), for example, notes that Onondaga chert - the prime constituent of the Shoop assemblage and a material that outcrops in New York - is common in pebble form in "till of northern Pennsylvania, and is found in the river gravels of the Susquehanna all the way to the Chesapeake Bay" (Witthoft 1952:471).

Equally problematic is the fact that outcrop sources are poorly mapped and the types of stone they yield have not been adequately studied (Miller 1982). There is a tendency to identify stone to an outcrop source based only "on the few well known outcrops" (Gardner 1974:42).

Resolving the matter of raw material use and settlement mobility then is a two-step process. The first, and easier step, is to determine whether the stone at a site came from an outcrop or cobble source. The second step is the determination of where the stone source or sources are in relation to the site. I discuss each of these in turn.

Witthoft (1952) approached the problem of distinguishing whether the Shoop inhabitants actually visited the outcrops or simply derived their stone from locally available pebbles by analyzing carefully the character of the lithic assemblage, particularly the debitage. He found that

> no artifact or chip from the site shows any trace of a pebble surface. This contrasts strongly with other Onondaga chert-producing sites in the Susquehanna Valley, where such pebbles are abundant. At least twenty spalls and tools do show nodule surfaces, however, such as occur at the Onondaga chert outcrops but which are invariably obliterated on stream pebbles (Witthoft 1952:471).

This led him to the conclusion that the Onondaga chert was carried to Shoop by groups who had visited the outcrop in western New York, rather than having been derived from pebbles of the Susquehanna outwash (Witthoft 1952:471).

Following Witthoft's lead, a hierarchical, 2-dimensional classification can be constructed to (1) sort stone material from an outcrop versus a cobble source; and (2) determine how many of each kind of source were used. The first dimension is the kind of cortex: there are three modes, primary, secondary, and unknown. Primary cortex includes all cortex flakes indicative of an outcrop source. These are identifiable as cortex flakes that are angular, tabular, bedded or nodular (Fitzhugh 1972:39; Witthoft 1952:470-471). Secondary cortex includes all cortex flakes indicative of stone sources transported from an outcrop. Since the transport mechanism is water or glacial ice, these cortex flakes are identifiable as rounded, water-smoothed or pebble-like in their surface morphology (Fitzhugh 1972:39; Witthoft 1952:470-471). Unknown cortex, an assemblage that contains no cortex flakes, is not, prima facie, indicative of either an outcrop or a cobble source. However it does indicate that stone was transported to the site by artificial means.

The second dimension is the complexity or diversity of the lithic raw material in the assemblage. Raw material diversity ranges on a continuum from low, dominated by one or a few kinds of raw material, to high, with many kinds of raw material represented. Dividing these two ends of a continuum is arbitrary. For the purposes of this analysis, a lithic source with a calculated Simpson's concentration index (Pielou 1975; see also MacArthur 1972) of greater than 0.5 is considered a simple source. This means there is a better than 50% chance that any two items picked up independently and at random from a source type will be the same rock type. A source with calculated values less than 0.5 is complex.

The classification that results from the combination of these dimensions (Table 10) is used in the following manner. The cortex mode (Dimension 1) is identified for each type of raw material present in the assemblage. This step is repeated for each raw material type. Then the diversity (Dimension 2) of each cortex mode (primary, secondary, unknown), is calculated, using the frequency of raw material types within each mode. Finally, any raw material class that dominates across the entire assemblage is identified.

TABLE 10. Classification of lithic raw material using cortex type and diversity

Dimension 1 (Cortex type)	Primary		Secondary		Unknown	
Dimension 2 (Diversity)	Simple	Complex	Simple	Complex	Simple	Complex
CLASSES	PS	PC	SS	SC	US	UC

The primary/simple (PS) class indicates use of a single or few outcrop sources. This can be either local or exotic, depending on the location of the outcrop vis a vis the site. The primary/complex (PC) class results from use of multiple rock outcrops. It is unlikely that this class would have any members, save in those areas where a variety of stone types outcrop near one another, or where fluted point groups were sufficiently mobile so as to visit a number of quarries.

The secondary/simple (SS) class should also have few members, since most secondary deposits are complex, having materials carried in from a wide area. The secondary /complex (SC) class is probably common on sites situated on moraines or river terraces, since it indicates use of transported cobble sources.

The unknown/simple (US) class indicates transportation of material by artificial means from limited sources. The fact that the diversity is limited suggests that the source is limited. This implies an outcrop source as opposed to a cobble source. The unknown/complex (UC) class indicates transportation of material by artificial means from multiple sources. The sources in this case could be either multiple outcrops (as in class PC), or cobble beds (as in class SC).

Plotting the location of stone sources so that their relationship to sites can be determined is a complex matter. Efforts have been made in recent years to document the variability in rock types and the location of sources (e.g. Fanale 1974; Lavin and Prothero 1981; Luedtke 1978; Miller 1982). By and large these studies have been limited to identifying primary sources or outcrops. They have shown that there are a great many more outcrops than previously recognized; that simple macroscopic analysis is insufficient to identify with precision a stone type; and, that stone types from primary sources can be differentiated using microscopic and trace element techniques, but that the identification of stone from secondary sources poses some problems (Lavin and Prothero 1981:4; Miller 1982:20).

These conclusions have implications for eastern fluted point studies insofar as the identifications, commonly done on the macroscopic level, and source identifications, done to the major outcrops, are frequently imprecise. Gardner (1974:42) provides a useful illustration of the problem:

> When samples of Flint Run jasper (VA) were first taken to a meeting in 1971, several archaeologists familiar with such material identified it without hesitation as Pennsylvania [jasper], with some even specifying the Vera Cruz quarries.

In those instances where a site is adjacent to an outcrop (e.g. Thunderbird, West Athens Hill), the identification of the stone type and source is probably very secure. However, where material is identified as coming from a quarry hundreds of miles from a site, the inference should be treated cautiously.

It is evident from Table 10 that certain kinds of data are necessary to make the classification work. For the remainder of the discussion in this section the classification in Table 10 is used as far as the data allow, then I offer some hypotheses, guesses really, for some of the sites for which data are lacking. The basic data for this discussion are given in Table 11.

As far as can be determined from the literature, the Barnes lithic assemblage falls into class US (there is no record of cortex flakes, and the assemblage is dominantly Bayport chert). The dominance of a single rock type - despite the absence of cortex flakes - indicates a quarry or an outcrop visit. The stone type is identified as Bayport chert, which is said to outcrop on either side of Saginaw Bay, in Huron and Arenac Counties, Michigan (the site is in Midland County, Michigan). The Saginaw Bay outcrops are identified as the source of the stone, despite the fact that Bayport chert "is at the surface elsewhere in the state" (Voss 1977:255). The rationale for assigning the Barnes site Bayport chert to the Saginaw outcrops is that "most, if not all, of the prehistorically used Bayport chert came from the Saginaw Bay quarries" (Voss 1977:255). Recall that age estimates for the site were based on the fact that these outcrops were underwater until 12,500 B.P. (Voss 1977:255; see also Mason 1981). A non-outcrop stone source would make the age estimates incorrect.

Raw material use at Debert is dominantly PS (Table 11). Cortex flakes of the homogenous chalcedony are found indicating that the stone was brought to the site as vein plates and geodes (MacDonald 1968:65). Homogenous chalcedony makes up roughly 34% of the entire stone assemblage. Cortex flakes of brecciated chalcedony are rare, and not discussed in

TABLE 11. Lithic raw material use at eastern fluted point sites

Site	Lithic raw material	Dim1*	Dim2*	Dominant Class*	Distance source*
Barnes	Bayport chert!	U	S	US	?
	Fine-banded chert	U			?
	Fine-mottled chert	U			?
Bull Brook	Unknown	?	?	?	non-local?
Davis	Beekmantown flint	U	S?	US?	local
	Normanskill chert	U			?
	Unknown (Taconite?)	U			?
Debert	Brecciated chalcedony!	P	S	PS	100 km
	Homogenous chalcedony!	P	S		100 km
	Rhyolite	S	S		local
	Siltstone	U	?		?
	Quartz	U	?		?
Dutchess Quarry	Kalkberg/Normanskill!	U	S	US	local
	Pennsylvania jasper	U			?
Fisher	Fossil Hill chert	U?	S?	US?	local?
Gainey	Upper Mercer chert!	U	S?	US?	380 km
	Flint Ridge chert	U			370 km
	Onondaga chert	U			320 km
	Bayport chert	U			96 km
	Dundee chert	U			130 km
Kings Road	Normanskill flint!	P	S	PS	local
	Vermont jasper	S	S		?
	Pennsylvania jasper	U	C?		?
	Onondaga chert	U			?
	Flint Ridge chert	U			?
Parkhill	Fossil Hill chert	U	S?	US?	160 km
Port Mobil	Pennsylvania jasper	U	C?	UC?	100 km
	Normanskill flint	U			200 km
	Black flint	U			?
	Onondaga chert	U			?
Potts	Onondaga chert	U	S?	US?	local

Reagen	Chert	U	C?	UC?	?
	Basalt	U			?
	Rhyolite	U			?
	Quartzite	U			?
Shawnee-Minisink	Black flint!	U	S?	US?	local?
	Jasper	U			?
	Argillite	U			?
	Onondaga chert	U			?
Shoop	Onondaga chert!	P	S	PS	320 km
	Pennsylvania jasper	U	S		local?
6LF21	Flint!	S	S	SS	local
	Quartz	U	S		local?
Thunderbird	Jasper	P	S	PS	local
Twin Fields	Normanskill chert	P	S	PS	local
	Onondaga chert	U			
Vail	Ledge Ridge chert	U	S	US?	30 km
Welling	Upper Mercer chert!	U	S?	US?	local
	Vanport flint	U			?
Wells Creek	Fort Payne chert	P	S?	PS?	6 km
W.Athens Hill	Normanskill flint!	P	S	PS	local
	Onondaga chert	U	C?		?
	Pennsylvania jasper	U			?
	Upper Mercer chert	U			?
	Fort Ann flint	U			?
	Quartz	U			?
Williamson	Chalcedony	U	S?	US?	local
	Chert	U			local
	Flint	U			local

* A single ? indicates information unknown; a ? following a letter (e.g. U?) indicates an inference based on available data.

! Dominant raw material type.

detail; however, MacDonald (1968:61) implies that the flakes indicate an outcrop source. Brecciated chalcedony makes up roughly 40% of the entire stone assemblage (MacDonald 1968:61-62). The remainder of the stone assemblage is manufactured of siltstone, rhyolite and occasionally quartz (MacDonald 1968:62). There are no data on the frequency or presence/absence of cortex of these stone types; it is worthy of note that rhyolite is locally available in the till but is "reserved for temporary crude tools such as hammerstones, anvils, choppers and crushers" (MacDonald 1968:62). Both the brecciated and the homogenous chalcedony appear to have come from outcrop sources; the source by "present evidence" seems to have been "an offshore quarry near Parrsboro" which is itself within 100 kilometers of the site (MacDonald 1968:61).

There are data on two of the Hudson Valley sites: Dutchess Quarry Cave and Kings Road. There are only four artifacts from the Dutchess Quarry Caves, all of which are projectile points, three of which are of the same material. Dutchess Quarry exhibits class US in raw material. The three points of Normanskill/Kalkberg flint could have been manufactured on locally available material; the fourth point is evidently manufactured of Pennsylvania jasper.

The majority of the material at the Kings Road site exhibits class PS in raw material use. While decortication flakes are "rare," they indicate quarrying from veins or outcrops of Normanskill flint (Funk, Weinman and Weinman 1969:12). Normanskill flint comprises 91% of the entire assemblage (Funk 1976:224); the fact that the outcrops are some distance from the site explains the relative infrequency of cortical flakes. The remaining 9% of the Kings Road assemblage is composed mostly of Pennsylvania jasper, along with Onondaga chert, "Vermont jasper, and Flint Ridge, Ohio, chalcedony" (Funk, Weinman, and Weinman 1969:12; Funk 1976:224). Funk (1976:224) mentions that "flakes" of the Vermont jasper are found, leading him to infer a cobble source for this material. However data are not given on any of the other raw material types. But one gets the impression from reading the reports (Funk, Weinman and Weinman 1969; Weinman and Weinman 1978) that all of the artifacts not manufactured of Normanskill flint are mostly prepared tools and very few flakes. The portion of the assemblage not manufactured of Normanskill flint can tentatively be assigned to the UC class of raw material use.

The data from the Shoop site have already been discussed. The raw material dominating the assemblage is identified as Onondaga chert; the assemblage contains cortical flakes indicating an outcrop source (Witthoft 1952:470-471). The bulk of the assemblage thus indicates class PS raw material use. The very few items not manufactured of Onondaga chert either do not include flakes or, if they do, have not been described as being cortex flakes. Hence, the remainder of the Shoop assemblage can be classified into class US. But this class only amounts to about 21 artifacts and flakes (Cox 1972:19), all of material derived from Pennsylvania sources.

There are two kinds of raw material present in the 6LF21 assemblage, flint and quartz. Each are available locally, and Moeller (1980:30) has found flakes of flint cortex indicating a cobble source. Nonetheless, he feels that there was use of a quarry or outcrop source as well, although has no data by which to demonstrate this (Moeller 1980:31). He has located neither primary cortex flakes nor, for that matter, a source. Hence, the flint at 6LF21 indicates class SS raw material use.

It was earlier suggested that class SS would rarely appear, since most secondary sources are inherently complex. Site 6LF21 does nothing to change this expectation. Moeller (1980) estimates that the 7400 plus tools and flakes represent only about six pounds of rock. It is quite conceivable that this represents the use of a single cobble. There are no data on the quartz artifacts, hence the material is assigned to the US class of raw material use. It should be noted that the bulk of the assemblage at 6LF21 is manufactured of flint, and thus derived from simple secondary sources.

The dominant lithic raw material at Vail is Ledge Ridge chert. There are no cortex flakes in the assemblage (Gramly 1982:43), although certain tools exhibit chert block cortices (Gramly 1982:37). Raw material utilization is assigned to the PS class. This implies use of an outcrop source, a conclusion reached by Gramly (1982:62) as well. The nearest Ledge Ridge outcrop is 30 km from the site (Gramly 1982:18)

There are no data on flake types at Wells Creek (Dragoo 1973); it is noted, however, that the chert was brought into the site as "blocks or plates" (Dragoo 1973:10). This suggests that the source of the material is an outcrop. Hence, the assemblage is tentatively assigned to the PS class. The chert type, identified as Ft. Payne chert, outcrops some 6 kilometers from the site (Dragoo 1976:9-10).

West Athens Hill, by contrast, is located directly on veins of Normanskill flint (Funk 1973:30), and while data are not given on flake types the proximity of the outcrop makes it reasonable to infer that the source of the stone is this outcrop. The Normanskill flint is provisionally assigned to the primary simple (PS) class. Like the nearby Kings Road site, a suite of additional raw material types occur at West

Athens Hill, including stone identified as Pennsylvania jasper, Upper Mercer (Ohio) flint, Onondaga chert, Fort Ann flint (New York), Oriskany flint, quartz and quartzite (Funk 1976:224). Evidently none of this material occurs as cortex flakes, and thus the lot is assigned to the UC class of raw material use. This indicates either great mobility or, perhaps more likely, the use of gravel sources. In either case, lithic reduction took place off the site. Overall, however, the assemblage is dominated by primary/simple (PS) raw material use.

It is an interesting fact that for many of the sites examined thus far the assemblages are dominated by single raw material types that appear to have come from primary outcrop sources. Nonetheless, a wide variety of additional raw material types are present in low frequency. Vail appears to be the only site where lithic raw material is restricted to one stone type. Not even the locally occurring cobbles of grainy rhyolite show use, this despite an overall scarcity of Ledge Ridge chert (Gramly and Rutledge 1981:358).

In four of the sites dominated by a single raw material type (Barnes, Debert, Shoop and Vail), current knowledge of stone types and outcrop locations would indicate that the dominant stone is exotic to the site. The stone is not available in the immediate vicinity of the site, In fact, in some cases the distances involved may be upwards of 160 to 320 kilometers (Table 11).

Raw material use at the remainder of the sites in Table 11 cannot be classified precisely, but in certain instances the published descriptions are sufficient to allow some guesses about raw material use strategies. First, the Gainey site appears to be very similar to Barnes. The dominant material is Upper Mercer chert, but there are a variety of other cherts which appear in low frequency. The dominance of Upper Mercer chert suggests an outcrop source, which is intriguing, since the outcrops of this rock are some 380 kilometers from the site (Simons et al. 1983). It does not appear that any locally available material was used at the site the assemblage thus may be provisionally classified as US.

The Thunderbird and Williamson sites, like West Athens Hill, are situated on or adjacent to raw material outcrops (Gardner 1974; Johnson 1978). Gardner has indicated that all of the stone at Thunderbird is derived from the local Flint Run jasper quarries (Gardner 1974:6; but see Gross 1974:104), implying that exotic raw materials are absent. These sites are tentatively classified as PS.

Although data are lacking, two sites appear to fit into the SC (secondary/complex) class. At both Port Mobil and Plenge the diversity of stone types is quite high, implying either a cobble source or multiple outcrop sources. The fact that both sites are situated near likely cobble sources would suggest the former. Port Mobil is on a river channel off the Hudson River drainage; Eisenberg (1978:135) suggests that "local exposures of exploitable glacial pebbles and cobbles" may have been one of the attractions for locating the site. Snow (1980:134), however, does not consider the possibility that a glacially-transported source was used, instead suggesting that the diversity of stone types at Port Mobil indicates "expensive tastes" (Snow 1980:134). The implication here is that the inhabitants of Port Mobil either travelled or traded great distances to obtain their raw material.

Plenge is situated near a terminal glacial moraine just off the Delaware River valley. The fluted points at Plenge are highly diverse in terms of raw material. Snow (1980:132) again attributes this to long distance movement stone through human mobility or trade. The proximity of a glacially derived cobble source would suggest otherwise, as Kraft (1973:61) notes.

The argument on the use of lithic raw material as an indicator of settlement mobility made in the previous chapter stressed a number of points. Among them, that natural processes, particularly glaciation, are responsible for the movement of stone throughout the eastern states, and this must be considered in any discussion of settlement mobility. Unfortunately, this issue is frequently not addressed, instead the assumption is made that exotic material in a site was carried in by human rather than natural agencies.

No such assumptions have been made in the analysis of raw material conducted in this section. Rather, a classification was devised (Table 10) for sorting lithic raw material derived from outcrop versus cobble sources. Having partitioned the data in this manner opens the possibility of determining the mobility of eastern fluted point groups, since the confounding effects of natural transport have been eliminated.

When the data are arrayed in this manner (Table 11) clear patterns emerge. First, in nearly all instances there was a single dominant raw material type at each site and thus, by extension, a single mode of raw material derivation. In no instance was there evidence that an assemblage had been derived equally from outcrop as well as cobble sources: generally one or the other dominated.

Second, for the most part the stone at each of the sites was in fact derived from an outcrop source. Eight of the sites are assigned to the PS (primary/simple) class. An additional ten sites are assigned class US (unknown/simple). As argued above, the low diversity of raw material types present at these sites bespeaks a single source, which in turn implies an outcrop. Following this line of argument, and evidence from the site records, I would tentatively identify six of the ten sites as having class PS raw material use (the sites identified as US which I feel are actually PS are Barnes, Dutchess Quarry Cave, Gainey, Parkhill, Welling and Williamson). In effect, 14 of 22 sites show use of an outcrop source.

What is particularly interesting about these data is that, when combined with information on outcrop location, they provide suggestive evidence for settlement mobility. Table 11 specifies, where the information is available, the estimated distance between the site and the nearest known outcrop of the relevant raw material. I have arbitrarily divided these distances into two classes: local and non-local. If an outcrop source is within 10 kilometers of a site, then for analytical purposes I consider it local; if the source is greater than 10 kilometers from the site it is non-local. Again, all instances of secondary transport have been eliminated.

Table 12 divides the sites as to whether their raw material is derived from local or non-local sources; the number of sites in each category is roughly the same. This indicates, of course, that not all fluted point sites are dominated by exotic lithic raw material.

The evidence in Table 12 should not be construed as demonstrating differences in settlement mobility among eastern fluted point groups. These are sites, not systems, and as such represent only a part of the overall mobility pattern. To observe that local material was used in one site says little about raw material use in other sites of the same settlement system.

TABLE 12. Sites with lithic raw material derived from an outcrop source (PS and US), partitioned by distance to source

Local source*	Non-local source*
Dutchess Quarry Cave	Barnes
Kings Road	Debert
Thunderbird	Gainey
Twin Fields	Parkhill
Welling	Shoop
Wells Creek	Vail
West Athens Hill	
Williamson	

* See text for distinction between local and non-local sources

However, when the data in Table 12 are partitioned along geographic and paleoenvironmenal lines (Table 13), an intriguing pattern emerges that may be related to settlement mobility. Table 13 indicates that in 5/6 sites where non-local outcrops were used, the sites are located in the glaciated region.

TABLE 13. Sites from Table 12 partitioned by location

	Local source*	Non-local source*
Glaciated Region	Dutchess Quarry Cave Kings Road Twin Fields West Athens Hill	Barnes Debert Gainey Parkhill Vail
Unglaciated Region	Thunderbird Welling Wells Creek Williamson	Shoop

* See text for distinction between local and non-local sources

The pattern in Table 13 could indicate that sites dominated by non-local or exotic lithic raw material have not been discovered in the unglaciated region. Alternatively, it could mean there are no sites in the unglaciated region with non-local or exotic raw material. In the former instance, the pattern as it stands would be a function of biased data and thus of little interest; in the latter instance, a consequence of different settlement systems in the glaciated and unglaciated regions.

If the pattern is valid, that is, if all sites in the unglaciated region are dominated by local raw material, then this implies that fluted point groups in this region were not highly mobile or, if they were, did not curate their lithic raw material, but instead moved from outcrop to outcrop in the course of their settlement rounds. This latter suggestion seems unlikely. My suspicion, and it is only a suspicion, is that the pattern of local raw material dominating sites in the unglaciated region is a function of differences in settlement system mobility between the glaciated and the unglaciated region, and not simply a result of biased data. Further research is needed on this matter.

The exception to the pattern of sites in the unglaciated region being dominated by local material, the Shoop site, warrants comment. Shoop, of course, has been previously shown to bear a striking similarity to certain sites of the glaciated region, particularly the two situated in the tundra environment: Debert and Vail. This reinforces that pattern, and again suggests that despite its location in the unglaciated east, at the time of its occupation the Shoop site was possibly situated on a periglacial landscape. This, of course, has significant implications for the age of the Shoop site, since the area was in tundra vegetation well over 12000 years ago (Watts 1979), thus making the Shoop site one of the oldest of the eastern fluted point sites (ironic, given arguments in Witthoft 1952).

Interassemblage variability: artifacts

There is a long held notion that the artifact assemblages in eastern fluted point sites are essentially uniform across all sites (Byers 1954; Cleland 1976; Funk 1972, 1976; Mason 1981; Ritchie 1957; Snow 1980). This is a claim worth exploring carefully since, if true, it would conflict with the arguments developed thus far that these groups were exploiting at least two markedly different environments and practicing significantly different subsistence strategies in each. One should see, as Fitting (1975) suggests, markedly different assemblages in tundra versus woodland fluted point sites. In this section, I explore the artifact assemblage variability among the eastern fluted point sites. Studies of artifact use among contemporary ethnographic groups have shown that most people "use unretouched flakes for the great majority of tasks requiring chipped stone" (Jelinek 1971:19; see also Gould et al. 1971; Jelinek 1977; Hayden 1979; White and Thomas 1972). This appears to characterize fluted point groups as well. Wilmsen (1970) observed in his studies of Paleoindian technology that "flaking techniques were directed toward the production of flakes that could be converted into tools with a minimum of further modification" (Wilmsen 1970:67).

These findings have implications for the morphological typologies commonly employed in the analysis of artifacts (Jelinek 1971). They indicate that the discrete object may not be the appropriate unit of observation (Dunnell 1977:54). An object may have wear patterns indicative of a number of different functional tasks (Dunnell and Campbell 1977); the object itself may be simply the record of a series of unrelated uses

(White and Thomas 1972:277).

This, in turn, suggests that there is no invariant relationship between a tool's gross morphology and its usewear patterns (Schiffer 1979). The relationship between form and function must be demonstrated, and cannot be assumed, particularly since the shape of the object may play only a "minor role in decisions about tool use" (Schiffer 1979:20).

Given this, the ideal analysis of artifacts in eastern fluted point sites would proceed along lines outlined by White and Thomas (1972) and others (Dunnell 1977; Schiffer 1979). The basic analytic unit would be at the level of the attribute: the working edge or worn areas of the object. Tools would be defined as cooccuring wear sets, independent of the objects themselves. This would insure the separation of tools occurring on objects of identical morphology, yet having different wear patterns, as well as insure the recognition of tools having identical wear patterns yet occurring on objects of markedly different morphology (Meltzer 1981a). Tool classes would be defined on the basis of artifact function, not on the basis of morphological patterns that may occur independent of function.

The ideal analysis is seldom achieved in eastern fluted point studies. Wear or even attribute-based artifact analysis is rare (but see Dragoo 1973; Funk 1976 for useful steps in this direction). Instead, traditional morphological/functional categories are commonly employed. This "morphological bias" (Dunnell 1977:54) has resulted in a great deal of attention being paid to objects showing a regular shape, with little attention to utilized flakes and detritus. Projectile points, for example, are split into a number of distint morphotypes (e.g. Ritchie 1953), while worn, irregularly shaped tools are lumped into the single, uninformative category of "utilized flake".

Unfortunately, the analysis of the tool kits undertaken in this section has to rely on these traditional, morphological categories. The panregional scale of this study effectively prevents undertaking the kind of "ideal" analysis just sketched. The logistics of analyzing toolkits from three dozen sites including over 100,000 physical objects (a conservative estimate) scattered over thousands of miles and in many different collections are quite overwhelming. I am thus, of necessity, restricted to the artifact categories employed in the published record, since that record must be the primary data source in a study of this scale.

There are both advantages and disadvantages to using data in this form. On the one hand, because the traditional artifact categories are widely recognized and commonly employed, one can assume a certain degree of comparability between assemblages. It is not unreasonable to compare, say, frequencies of "endscrapers" in two or more different sites, since the investigators of those sites likely share a notion of what an "endscraper" looks like.

On the other hand, using these traditional artifact categories has its limitations. For one, it limits the kinds of analyses possible; detailed functional analysis of the assemblages is simply beyond the scope of this study. Moreover, because only shaped tools (Dunnell and Campbell 1977) are treated in detail, and non-shaped tools are lumped into the category of "utilized flake", the potential functional variability of these assemblages is obscured. Since some assemblages are dominated by shaped tools, while others are not, this tends to bias comparisons of assemblage diversity.

To overcome these limitations, I have avoided drawing fine-scale functional distinctions among these assemblages, and have paid attention to the degree that each assemblage is dominated by shaped versus non-shaped tools. However desirable, one cannot change the form of the published record, nor read differences in usewear patterns from descriptions of tool morphology. Hence, analysis proceeds cautiously from the available data.

Table 14 lists the artifact classes used in my analysis. These 18 classes encompass all the artifact classes recognized from all the eastern fluted point sites used in the analysis (one unique and probably functionally insignificant class of remains, a group of 13 pendants from the Reagen site, is not included in this list).

These artifact classes are all mutually exclusive. Moreover, as mentioned, they are the "lowest common denominators", a set of types routinely used in classifying artifact assemblages from eastern fluted point sites (e.g. Cox 1972; Dragoo 1973; Funk 1973; Gardner 1974; Gramly 1982; Kraft 1973; MacDonald 1968). Because these artifact classes are commonly defined and recognized, assemblage data from all sites was classified by this scheme with minimal reworking.

The classes of artifacts in Table 14 can usefully be divided into four technological/functional groupings: primary tools, production waste, staging artifacts, and utilized tools (Dunnell 1972:22). Primary tools are those used in the manufacture of other tools, which includes HAMMERSTONES, ANVILS and ABRADERS. Bone or antler fabricators have not been recovered from any of the sites in this analysis.

TABLE 14. Artifact classes used in analysis

Number	Name and description
1	HAMMERSTONE - generally non-cryptocrystalline cobble exhibiting crushing and spalling on surface and ends
2	ANVIL - large cobbles with pitted or pecked depressions
3	CORE - nucleus of stone material exhibiting scars from the removal of flakes or blades
4	DEBITAGE - unworn residual lithic material resulting from manufacture
5	PREFORM - generally bifacial, oval, unfinished and unused artifact
6	UTILIZED FLAKE - irregularly shaped flake exhibiting usewear
7	PIECES ESQUILLEES - bifacial/unifacial artifact with secondary bipolar damage/usewear
8	ABRADER - artifact exhibiting shallow ground grooves on face
9	CHOPPER - heavy cobble from which large spalls removed from one face
10	BIFACIAL KNIFE - bifacial, regularly shaped (generally oval) artifact exhibiting wear from cutting
11	DRILL - bifacial artifact often lenticular in cross-section showing wear from rotary use
12	AWL/PERFORATOR - unifacial, marginally retouched artifact with sharp tip
13	DENTICULATE - artifact exhibiting unifacial notching producing a working edge with regular small projections
14	GRAVER - small, worn spur on the margin of a thin flake or unifacial artifact (such as an endscraper)
15	ENDSCRAPER - unifacial, regularly shaped (generally trapezoidal) artifact worn along front edge
16	SIDESCRAPER - unifacial, regularly shaped (generally oblong) artifact worn along side(s)
17	SPOKESHAVE - generally unifacial, regularly shaped artifact worn along concavity in edge
18	FLUTED POINT - lanceolate shaped bifacially worked artifact exhibiting a longitudinal flake scar extended up from the base

Production wastes are the byproducts of manufacture, and include both CORES and DEBITAGE. Both artifact classes in this category are unworn.

Staging artifacts are those objects prepared for use but not actually utilized. In some cases (e.g. Funk, Weinman and Weinman 1969; Gardner 1974) objects of this sort are divided into a number of different morphological categories (Boyer 1974), presumably representing stages of tool preparation. Since this analytical procedure is used in only a few instances, all of these objects are here lumped in the category of PREFORM.

Utilized tools include the remainder of the artifact classes, and all of these objects are assumed to have been utilized as tools for resource procurement. Presumably all of the tool classes in this category show evidence of wear, despite the fact that these are dominantly morphologically derived classes.

Two of the tool classes warrant further comment. The UTILIZED FLAKE class incorporates all flake tools in an assemblage. It is a catchall category for objects that are irregular in their plan, and do not fit into established morphological type categories. Obviously these items are worn, since they are designated as utilized. But, it is important to stress that this is not an internally homogeneous class: a wide range of tools must be included in this category, for reasons already given.

The PIECES ESQUILLEES category is problematic. As is discussed below, there is some question as to whether these artifacts are production wastes or are actually utilized tools. They are treated as utilized tools, since their role in tool production cannot be unequivocally demonstrated.

The occurrence and frequency of these tool classes at the eastern fluted point sites used in this analysis are shown in Tables 15, 16 and 17. The numbered headings of these Tables correspond to the numbers of the artifact categories as listed in Table 14. These are the raw data for the analyses and discussions that follow. At the outset, it is important to stress that these data are not all comparable. Obviously, occurrence data are available for nearly all of the sites in the analysis, while frequency data are available for only 14 of those sites (Tables 16 and 17). Hence, quantitative analysis is limited to a smaller group of sites.

Three sites for which frequency data are available - Davis, Potts and Reagen - have either no debitage counts or debitage counts that represent only a sample of the flake material recovered from the site. Since debitage is the single most abundant artifact class in all the sites, this will have a tendency to skew analyses and interpretation. In fact, the Potts data are probably altogether unreliable: Gramly (1982) suggests that the site and assemblage is much larger than the published record indicates. Hence, these three sites are excluded from quantitative analyses.

Additional data screening is discussed below, as it is relevant to specific analyses and discussions.

TABLE 15. Presence of artifact classes by sites

	Artifact Class (Numbers from Table 14)																	
Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Barnes				+		+				+					+	+		+
Bull Brook	+	+		+			+			+	+			+	+	+		+
Davis							+								+	+		+
Debert	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+
Dutchess Quarry Cave																		+
Fisher				+	+	+								+	+	+	+	+
Gainey				+	+	+				+				+	+	+		+
Kings Road	+		+	+	+	+		+	+	+			+		+	+	+	+
Parkhill				+	+	+				+				+	+			+
Port Mobil			+	+	+	+				+	+		+	+	+	+	+	+
Potts						+				+				+	+	+	+	+
Reagen				+		+				+				+	+	+	+	+
Shawnee-Minisink	+	+	+	+		+		+		+					+			+
Shoop				+	+	+	+			+		+		+	+	+		+
6LF21	+		+	+		+				+	+			+	+	+	+	+
Thunderbird	+		+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
Twin Fields			+	+		+				+			+	+	+	+	+	+
Vail	+	+	+	+		+	+			+	+	+	+	+	+	+		+
Welling				+	+	+								+	+		+	+
Wells Creek	+		+	+	+	+			+	+	+		+	+	+	+	+	+
West Athens Hill	+	+	+	+	+	+	+	+		+				+	+	+		+
Williamson	+		+	+	+	+		+	+	+	+	+		+	+	+	+	+

TABLE 16. Frequency of technological classes by site

	Artifact Class (Numbers from Table 14)						
Site	1	2	3	4A*	5	UT*	N*
Barnes				2653		44	2697
Davis				11!		10	11
Debert	31	9	35	24843	17	3660	28595
Dutchess Quarry						4	4
Kings Road	4		431	16636	138	253	17462
Potts				7!		61	68
Reagen				101!		152	253
Shawnee-Minisink	5	1	10	6000(E)		63	6079
Shoop				884(E)	18	611	1513
6LF21	1		15	7395		34	7445
Twin Fields			1	1064		92	1157
Vail	322(A)		3	7885		1705	9915
Wells Creek	44		454	11371	209	874	12952
West Athens	167	10	3122(E)	9607	176	399	13481

* Included in Class 4A (Flakes) are counts of both DEBITAGE and UTILIZED FLAKES (Class 6); the UT column is the sum of all utilized tools, excluding UTILIZED FLAKES (Class 6); the N column is the total sample size of the entire assemblage (the sum of Classes 1 through 18).

! Unreliable flake counts, indicating debitage either not collected or only sampled.

(E) Estimate - Shawnee-Minisink DEBITAGE counts from Eisenberg (1978:65); Shoop DEBITAGE counts from Cox (1972:20); West Athens CORE counts from Funk (1973:30).

(A) Nearly all show use as anvils (Gramly 1982:42).

TABLE 17. Frequency of functional classes by site

	Artifact class (Numbers from Table 14)												
Site	6	7	8	9	10	11	12	13	14	15	16	17	18
Barnes	10				11					5	2		26
Davis	1									2	3		5
Debert	932	1046	3	6	48	10	30		91	1587	668	50	121
Dutchess Quarry													4
Kings Road	150		1	1	14			1		101	120	7	8
Potts	7				7				1	26	24	1	2
Reagen	18				11				4	47	42	5	43
Shawnee-Minisink	+		5		4					53			1
Shoop	44	70			15		6		103	268	96		53
6LF21	24				2	1			20	1	3	2	5
Twin Fields	28				2			2	5	42	37	2	2
Vail	740!	544			48	56	1	+	+	731	246		79
Wells Cr.	3092			95	12	11		94	185	113	124	204	36
West Athens	729	5	7		75				1	92	185		34

! Includes DENTICULATES (Class 13) and GRAVERS (Class 14).

Tool technology and lithic reduction strategies

A number of authors have argued that the production of stone tools, including the kinds of tools produced and the manufacturing sequence is dependent on the proximity of the stone source to the site where the material is used (e.g. Ellis 1983; Goodyear 1979; MacDonald 1968).

Ellis (1983), for example, has shown that where severe spatial incongruities exist between the location where a stone is procured and the site where it is used, specific kinds of technologies are invoked. For the sites he studied in the Great Lakes area, standardized preforms had been produced in anticipation of subsequent reduction to a specific tool form. In other words, rather than producing at the quarry a large set of identical preforms, a series of different kinds of preforms were produced for different kinds of tools.

Unfortunately, Ellis' intriguing analysis is limited to five sites in southwestern Ontario. Given the kind of data generally available, it is difficult to determine whether the specific patterns of tool reduction that Ellis found hold true at all eastern fluted point sites, or even those located far from their stone sources. Nonetheless, the technological patterns at these sites are worth examining, particularly given the findings in the previous section.

Recall that I have demonstrated that in at least six sites cherts from non-local sources were utilized. In the other eight sites for which data were available, it appeared as though material locally available dominated the lithic assemblage. Given these arguments, one would expect to see differences in tool reduction strategies in sites close to versus those far from their stone sources.

Data on tool reduction strategies are available for a number of sites where stone raw material was locally derived - and thus abundant and in some sense "cheap". This includes the Kings Road, West Athens Hill, Thunderbird, Welling, Wells Creek and Lockhart sites (this last site is a quarry reduction station associated with the Thunderbird site). Core forms at these sites are typically blocky and irregular (Dragoo 1973:10; Funk 1973:30; Funk, Weinman and Weinman 1969:11; MacDonald 1968:66; Wall 1976:30). Unlike prepared bifacial cores, these cores are inefficient and wasteful of raw material. Flakes produced are poorly controlled, yielding "much more spoilage than useful tool preform flakes" (MacDonald 1968:66).

It is perhaps important to note that these patterns in lithic reduction are not simply a consequence of the fact that these sites are all quarry-waste stations. Certainly flakes and technological debris dominate many of these assemblages. The ratios of primary tools and debitage to utilized tools at many of these sites are well over 10:1 (Table 18). Assemblages with this much manufacturing debris in relation to actual utilized material are likely quarry-related. Wells Creek, although dominated by locally occurring, is not. If, indeed, Dragoo did "gather every object, including the smallest pieces of flint" (Dragoo 1973:7), then this low ratio indicates primary tool production was not the principal activity at the site, a conclusion emphasized by Dragoo (1976:9-10). One sees "indulgent" reduction strategies where the site is proximate to the stone source, regardless of whether the site is dominated by manufacturing activities.

TABLE 18. Ratios of Primary tools + Production waste:Utilized tools

Site	Ratio	Distance to stone source
Shoop	1.3:1	Non-local
Wells Creek	2.2:1	Local
Vail	3:1	Non-local
Debert	5:1	Non-local
Twin Fields	8:1	Local
West Athens	11:1	Local
Kings Road	42:1	Local
Barnes	49:1	Non-local
Shawnee-Minisink	95:1	Local?
6LF21	127:1	Local

Flake types in assemblages close to stone sources are generally large hard and soft hammer percussion flakes (Funk 1973; Gross 1974). Interestingly, in certain of the assemblages with high ratios of primary tools and production wastes to utilized flakes, at sites like Kings Road, Barnes, and 6LF21, the debitage is dominated by bifacial thinning flakes (Moeller 1980; Voss 1977; Weinman and Weinman 1978). Channel flakes, absent at all other sites, are present at these three sites, and particularly abundant at Barnes (Voss 1977:258).

As already noted in the preceding section, flakes of non-local origin are rare at all sites dominated by local stone sources; when they occur it is generally as small retouch flakes (Weinman and Weinman 1978:4). This is perhaps what might be expected from the resharpening of curated tools (Gramly 1980; Keeley 1982).

Data on lithic reduction strategies are available for three sites, Shoop, Vail and Debert, where lithic raw material was derived from non-local sources. At Shoop and Vail cores are absent from the assemblages (Cox 1972:20; Gramly 1982:22). Unlike the cores from sites proximate to their stone sources, the cores from Debert are largely bifacial, a more efficient core form that allows the consistent removal of useable flakes (MacDonald 1968:66; Ellis 1983).

Oddly enough, preforms are listed as occurring at Debert and Shoop, sites where, given the distance to the stone source, one would not expect to find "packages" of unmodified or unused stone raw material. On closer examination, it turns out that these preforms are in fact broken and fragmented, suggesting they were modified for use as a flake source (Cox 1972:29; MacDonald 1968:138). Further, at Shoop a number of preforms "show some edge wear and were undoubtedly carried around and used as knives" (Cox 1972:29).

The tool kits from these sites have been described as indicating an "exhausted" state (Gramly 1982:52). This is affirmed by the fact here was little useable detritus (MacDonald 1968). Ratios of primary tools and production wastes to utilized tools are extremely low (Table 18), ranging from 1.3:1 (Shoop) to 5:1 (Debert). Obviously much of the available stone was utilized. In marked contrast to the situation at Wells Creek, which also had low ratios but which was utilizing a locally available source, few tools at these sites are larger than 50-100mm (Cox 1972; Funk 1976; MacDonald 1968:73). Since stone raw material was at a premium, it is valuable to explore the possibility that other means of producing flakes, aside from those commonly discussed in the literature, existed at these sites.

Goodyear (1979, unpublished) has studied this issue in some detail. He argues that the artifacts identified as "pieces esquillees" in the literature are not wedges, the function commonly ascribed them on the basis of analogies with European Paleolithic tools (Lothrop and Gramly

1982), but are instead the remnants of bipolar cores. If correct, Goodyear has identified a process of intensive reduction and recycling of lithic raw material.

Determining if these artifacts represent bipolar cores, wedges, or both is not a simple matter. When pieces esquillees were initially recognized in New World fluted point assemblages at the Debert site, the artifact was assumed to represent a "wedge, but secondarily ... a slotting tool" (MacDonald 1968:88). However, at the same time it was recognized that they bore a strong resemblance to bipolar cores (MacDonald 1968:89; see also Lothrop and Gramly 1982). The resemblance, of course, is due to the fact that the mechanical forces acting on both cores and wedges are identical, with the result that areas of impact and damage are congruent (Hayden 1980). This makes it "difficult to distinguish between the two" (Lothrop and Gramly 1982:8).

Lothrop and Gramly (1982; see also Lothrop 1982) devised a series of tests using the pieces esquillees from the Vail site, in an effort to separate bipolar cores from tools used prehistorically as wedges. Their tests, while carefully executed, rest on two questionable assumptions. First, they assume that true bipolar cores are only derived from pebbles or cobbles and therefore must possess cortex on their non-impacted edges; and, second, that bipolar cores will never occur on flaked forms (Lothrop and Gramly 1982:8).

Their examination revealed that no pieces esquillees from the Vail site retained any pebble cortex. In fact, most of the pieces esquillees from Vail were fashioned from end scrapers (Gramly 1982:42). Nonetheless, their tests were unable to confirm any direct evidence of a wedging function. All the same, they concluded that because the Vail pieces esquillees were derived from tool forms and not pebbles that they could not have served as bipolar cores (Lothrop and Gramly 1982:19).

To support their conclusion they repeated a suggestion made by MacDonald (1968:67) that the flakes resulting from bipolar cores reduction would have been too small for use (Lothrop and Gramly 1982:19). This assertion, however, is unsupported by the ethnoarchaeological and archaeological literature (Goodyear, unpublished; Hayden 1980). More to the point, their assumption that bipolar cores must be restricted to pebbles is not a necessary a priori condition (cf. Hayden 1980).

Analysis of the spatial distribution and co-occurence of pieces esquillees with other artifact classes sheds little light on the problem. As MacDonald notes, the pieces esquillees at Debert are associated with pitted anvil stones; in fact, the pitting marks on the Debert anvils appear to match the lengths of the crushed edges of pieces esquillees (MacDonald 1968:105). The same association appears to characterize the Vail site (Gramly 1982). Such an association is characteristic of a bipolar industry (Hayden 1980), but since one cannot rule out the possibility that hammers and anvils were used to drive the wedges, this pattern is insufficient to determine tool function.

It is important to observe, however, that the presence of these artifacts in eastern fluted point sites is not random. Pieces esquillees are a relatively abundant artifact class, yet their occurrences are reported only for Debert, Shoop, Vail, West Athens Hill and Bull Brook (Grimes 1979). However, the presence of pieces esquillees at West Athens Hill is doubtful. Only five are recorded from the site, despite careful "inspection of over 12,000 waste flakes" (Funk 1973:27). The two, assumedly typical specimens illustrated in the site report (Funk 1973:Plate 15) do not look like pieces esquillees. It is quite likely these are misidentifications (Goodyear, unpublished).

Excluding West Athens Hill then, it is clear that these artifacts are absent from sites where "there appears to be an abundance of good chert" (MacDonald 1968:139). Pieces esquillees appear only at sites where raw material had become so scarce that a bipolar technique would have been necessary to drive off useful flakes: sites such as Shoop, Debert and Vail. As Gramly has observed at Vail, the pieces esquillees represent the final stage of raw material reduction:

> reworked fluted points graphically illustrate the extreme shortage of raw material for flaked tools .... Fragmentary fluted points were pressed into service as cutters, biface knives, and trianguloid endscrapers. Their final act was played out when point fragments became pieces esquillees and suffered destructive hammering (Gramly 1982:29).

But before too much is made of the non-random distribution of this artifact class among fluted point sites and their evident reduction, it must be noted too that these tools occur only at sites that were likely situated in a tundra or near tundra setting (Table 9). Their presence in such sites, given the resource probably being exploited (caribou) is not unreasonable. Pieces esquillees could have served a useful function in butchering and preparing animal products, such as bone, as they did in the Old World.

Ultimately, resolving the functional debate over the use of pieces esquillees will require finding a site on the tundra that is located near an outcrop source. If the raw material from that nearby outcrop is abundant and used at the site, and if pieces esquillees are present, then the conclusion to be drawn is that these artifacts are not bipolar cores.

All the same, one point is clear, and that is that at non-tundra sites where lithic raw material is more abundant, less "exhausted", and comes in a size sufficient for hand-held percussion techniques, pieces esquillees are absent (e.g. Funk 1976:212; Funk, Weinman and Weinman 1969:15). At Wells Creek, Dragoo observed that "with the exception of the pieces esquillees, every major tool type known ... was present" (Dragoo 1973:52). The massive, mixed assemblage at Plenge did not yield any unequivocal examples of pieces esquillees; again, this is not unexpected since the site is near a cobble source (Kraft 1973:110-111).

The data on tool reduction strategies at eastern fluted point sites indicate variation that conforms to differences in lithic raw material abundance. Mechanically, the tool reduction strategies are all percussion and pressure based, and are therefore all quite similar. Differences arise in the manner in which the reduction of the material takes place: whether there was a planned or staged reduction of the material, or whether the raw material was haphazardly reduced. The former tactic characterizes assemblages where the stone was scarce, the latter where the stone was abundant.

But what is equally important, and not unexpected, is that these differences in lithic reduction strategy also conform to differences in site location along the glaciated/unglaciated distinction derived earlier. Of the sites characterized by either a lack of cores or the presence of bifacial cores - Debert, Shoop, and Vail - two are located in the glaciated area in what was likely a tundra environment. The third (Shoop) may have been located in a periglacial environment.

A possible bipolar technology for flake reduction is also associated with these sites, although not all sites in the glaciated region that utilized non-local stone sources have pieces esquillees present. However, pieces esquillees are absent from all sites utilizing local sources of stone, in both glaciated and unglaciated regions. Sites where the tool technology was more indulgent are not restricted to unglaciated as opposed to glaciated localities.

There are other features of the tool kits that vary in conformance with the distance to the stone source. As argued earlier, the energy investment in lithic tool production is generally low among ethnographic and archaeological groups. Many tools are simply utilized natural rocks or waste products from the manufacture of other tools (Dunnell 1972:32), and are not themselves extensively modified or manufactured.

In fact, one can specify a priori the circumstances under which manufacture must occur, and where manufacture might occur. Regarding the former, Dunnell and Campbell (1977) have observed that manufacture of a tool will take place when the functional requirements of the tool class cannot be met in run-of-the-mill flakes. Manufacture occurs most often for tool classes that have rigid functional requirements. To take a more extreme example, projectile points require a point, axial symmetry, relatively uniform thickness, and a provision for hafting (Dunnell and Campbell 1977; Meltzer 1981a). These attributes rarely cooccur in flakes struck from cores, and hence must be created through post-detachment modification of the flake. In fact, manufacture in this class of tools is often so great that the original form of the flake is often completely obscured (Wilmsen and Roberts 1978:170). In this instance manufacture is a necessary consequence of tool requirements in most assemblages.

In the toolkit for eastern fluted point groups, only one class, the fluted projectile point, always and without exception exhibits extensive modification and manufacture. In effect, this indicates that the functional requirements of this tool are never met in simple flakes struck from cores. By contrast, the other tool classes have both simple flake and extensively manufactured versions of the same tool. This indicates that the required attributes for these tools can be met to varying degree in flakes struck from cores.

This raises two questions. First, are there differences between assemblages in terms of their ratios of manufactured to non-manufactured tools? Second, do those differences correlate with the nature or amount of the stone source? That is, are there properties inherent in different stone materials which preclude the production of readily useable flakes, or are heavily manufactured assemblages related to inadequacies in the stone material (such as the stone being inadequate in size to produce useable flakes or there being insufficient stone for all tools, those forcing the production of different tools from the same flake). There is insufficient information on the workability of different stone types in these assemblages to test whether manufacture and stone workability are related. However, it is possible to examine differences between assemblages in terms of manufacture:non-manufacture ratios, and whether those differences correlate with the stone supplies.

To do this requires three assumptions. First, I assume that the class UTILIZED FLAKES can serve as a rough measure of the number of tools created and utilized without extensive manufacture. Second, I assume that the remainder of the classes of utilized tools all evince some manufacture. Both of these are reasonable assumptions since the basic classification scheme used (Table 14) is based on morphology. It is unlikely that any highly manufactured item, with the resultant regular pattern, would would have been placed in the "utilized flake" category or vice versa. Third, I assume that distance to source (local versus non-local) is a reasonable proxy measure of available stone.

The center, vertical, axis in Figure 11 shows the percentage of all tools that are UTILIZED FLAKES. The percentage figure was arrived at by dividing the number of UTILIZED FLAKES by the sum of all tools minus FLUTED POINTS. FLUTED POINTS were omitted since this class cannot occur as a simple flake tool. Shoop, at the top, has the smallest percentage of UTILIZED FLAKES; Wells Creek, at the bottom, has the greatest percentage of UTILIZED FLAKES.

The lines to the right of the vertical axis denote the number of UTILIZED FLAKES divided by the total sample size. This gives a measure of the percentage of flake tools in the entire assemblage. The further the line from the center axis, the greater the relative frequency of flake tools.

The lines to the left of the vertical axis denote the number of manufactured tools divided by the total sample size. This gives a measure of the percentage of manufactured tools in the entire assemblage. Again, the further the line from the center axis, the greater the relative frequency of manufactured tools.

The sum of the distances of these lines to the right and left of the center axis gives a measure of the relative frequency of all tools in the entire assemblage. Were any of the assemblages composed entirely of tools, and no debitage, then the lines left and right of the center axis would sum to 100%. This does not occur in any of these assemblages. However,

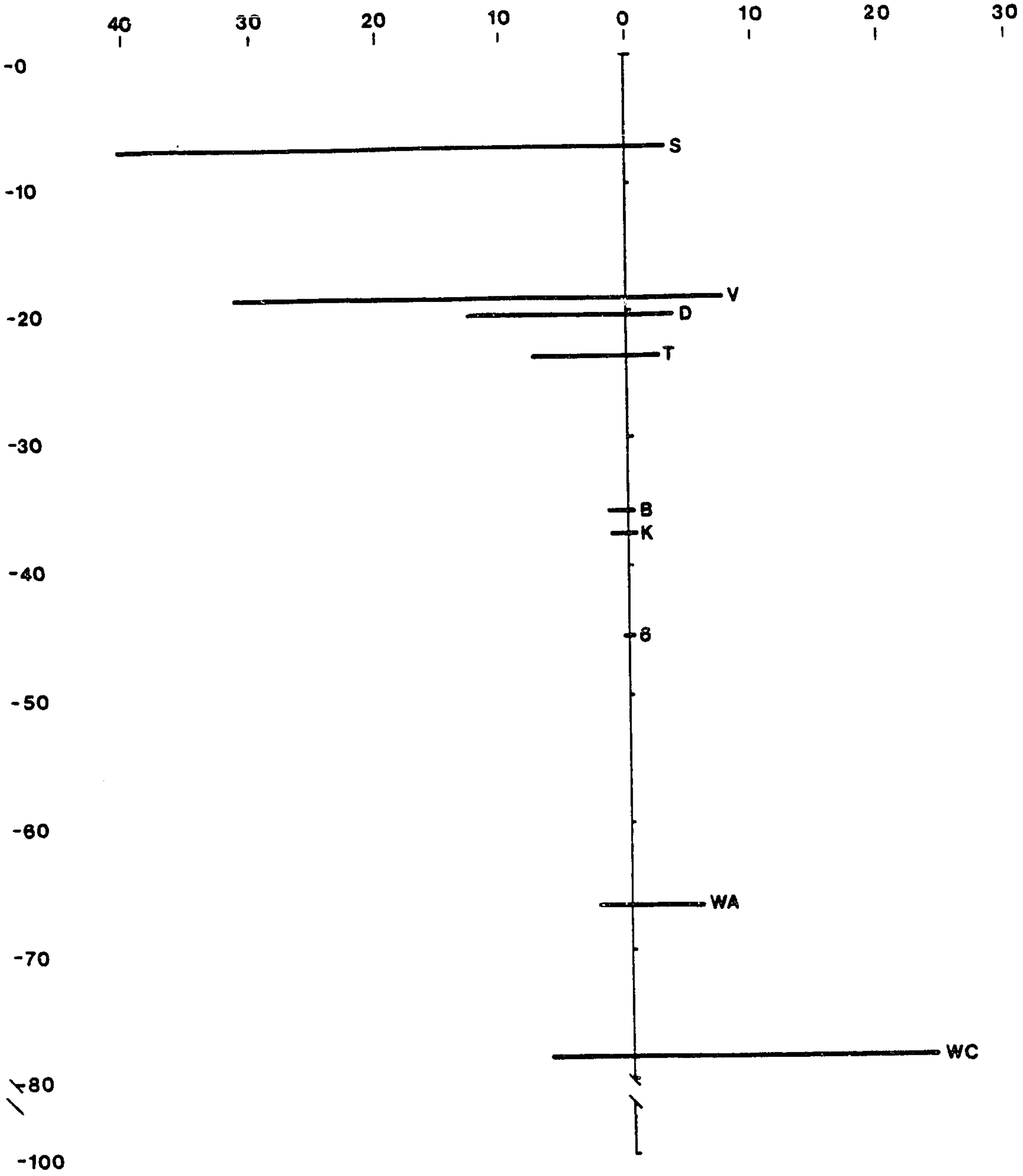

FIGURE 11. Prepared tools versus flake tools. Vertical axis = N Flake tools/N tools; Left axis = N Prepared tools/N Assemblage; Right axis = N Flake tools/N Assemblage. Key to site names:

B=Barnes	T=Twin Fields
D=Debert	V=Vail
K=Kings Road	WA=West Athens Hill
S=Shoop	WC=Wells Creek
6=6LF21	

there are clearly instances where the reverse situation occurs - there are assemblages composed almost entirely of debitage.

This figure illustrates significant variation in manufacture:non-manufacture ratios between assemblages, but before this is discussed, it is important to point out that this figure also illustrates a relationship between flake tools, manufactured tools, and proximity to stone source. Those sites at the top of the vertical axis, with low percentages of flakes tools (UTILIZED FLAKES) are all sites whose raw material sources are non-local. Conversely, sites with high percentages of UTILIZED FLAKES all have local raw material sources. Assemblages with a high ratio of manufactured:non-manufactured tools lack abundant lithic raw material, while assemblages with low ratios of manufactured:non-manufactured tools have abundant stone supplies.

Now this is not to claim that manufacture is a result of distance to stone source; manufacture is a consequence of the form and suitability of available flakes. But this does suggest that in assemblages far from their stone source the frequency of readily utilized flakes drops off, necessitating a greater investment in their production. Whether a tool is manufactured versus simply selected out of available debitage (Meltzer 1981a) may be determined in large measure by the amount of stone available. This relates to the argument of Binford (1973, 1979) and others (e.g. Gardner 1983), that curation of lithic material to areas lacking stone - thereby limiting available stone to what can be carried - will likely produce assemblages dominated by manufactured tools.

The similarities in lithic reduction strategies at Shoop, Vail and Debert, which correspond to similarities in raw material use, appear to extend into tool curation patterns. Flake tools are only a small portion of the assemblages at these sites, which are otherwise dominated by manufactured tools. The exhausted state of these assemblages, mentioned earlier, is evident here as well. Tools make up a large portion of the overall assemblage at both Shoop and Vail.

Wells Creek and West Athens Hill were previously grouped together on the basis of an abundance of raw material, the presence of large, blocky and irregular cores, large flakes of primary reduction (including cortex flakes) and, of course, large cores and tools. It is evident from Figure 11 that these assemblages are dominated by flake tools, although the proportions differ significantly between the two sites. At Wells Creek flake tools comprise 23.8% of the entire assemblage; at West Athens Hill, flake tools comprise only 5.4% of the entire assemblage. Sample sizes are roughly comparable at the two sites.

If the number of tools increased directly in response to an increase in the number of flakes or the size of the assemblage, as Binford (1977) argues, then the proportions of flake tools should be identical. That they are not is interesting. These differences indicate a contrast in the amount of manufacturing and lithic reduction in relation to other activities at these two sites. At West Athens Hill, directly on the stone source, debitage and unutilized flakes numerically dominate the assemblage. At Wells Creek, 6 km from the stone source, more of the available flake material has been transformed into tools. This is what accounts for the low ratios of primary tools and production waste to utilized tools discussed earlier. As Dragoo noted, "maximum use" was made of the flakes at Wells Creek (Dragoo 1973:37).

The high ratios of primary tools and production waste to utilized tools in Kings Road, Barnes and 6LF21 is reflected in Figure 11 as well. These assemblages are dominated by debitage; this includes, as mentioned, channel flakes, which occur in frequencies greater than needed to account for the number of fluted points found (Moeller 1980:83; Voss 1977:258). Tools, with or without manufacture, are rare at these sites.

The Twin Fields site is something of an anomaly. While the site is situated near a raw material source, and the majority of tools and flakes are made of that material, the assemblage is not dominated by flake tools. In fact, the small amount and size of the debitage - it averages only 1.6 cm (Eisenberg 1978:158) - suggests little stone working took place (Eisenberg 1978:136).

Functional variation in the toolkit

It has long been accepted that the tool assemblages in eastern fluted point sites are essentially homogeneous (Byers 1954; Cleland 1976; Funk 1976; Mason 1981; Snow 1980):

> Everywhere ... the Paleo-indian tool kit is surprisingly similar, with only minor regional variations. In addition to the fluted projectile point it comprises mainly, both uniface and biface knives; uniface end, side and spokeshave scrapers; gravers; borers; drills; flint wedges for splitting bone or wood and a few rough stone hammers and anvils (Ritchie 1983:30).

Defining the tool kit on the presence/absence of individual tool classes, as Ritchie (1983) and others have, is not uncommon in the archaeological literature. The number of artifact classes present - the richness (Rice 1981) of an assemblage - is often used to infer the diversity of activities carried out at a particular site (Jones, Grayson and Beck 1983:55; Kintigh 1984:44).

Yet richness measures alone are only part of a measure of assemblage diversity (Rice 1981) and, more to the point, are at best a blunt instrument for measuring measuring tool kit variability. Because richness is based on a nominal scale it obscures variation in frequency. Consider, for example, the two assemblages from two hypothetical sites, A and B in Table 19. In both instances, the number of classes (5) and the sample size (150) are identical. On a nominal scale, these assemblages are identical, each with the same richness values. But in terms of the abundance of the individual tool classes, these are markedly different assemblages.

Second, and along these same lines, richness alone exaggerates the importance of rare items. Since all classes are treated as "present", with no distinction made as to abundance, a rare tool class that occurs only once in an assemblage carries the same weight as tool classes in that same assemblage that are highly abundant. In Site B from Table 19, Classes 2 through 5 are given the same weight as Class 1, despite a 100-fold difference in abundance.

TABLE 19. Richness and evenness in two hypothetical assemblages

	Tool class frequency							
Site	1	2	3	4	5	N	Richness	Evenness
A	30	30	30	30	30	150	5	.80
B	146	1	1	1	1	150	5	.05

Combining richness with measures of <u>evenness</u>, the second component of diversity (Rice 1981:222), avoids these difficulties. Evenness measures the distribution of artifacts among classes. Going back to the example in Table 19, calculating evenness values for each of these assemblages (Pielou 1975) yields markedly different values. Site A is highly heterogenous (evenness = .80); Site B is nearly homogeneous (evenness =

is for these reasons that both richness and evenness are considered in the analysis of these assemblages.

Diversity measures - both richness and evenness - have been used in archaeological applications as a means of inferring the variety of activities that took place at a site (e.g. Conkey 1980; Wood 1978), monitoring changing activities and specialization through time (Rice 1981), and assessing the degree that a prehistoric subsistence pattern was dominated by one or a few resources (Grayson 1981b).

It has been argued, for example, that sites with high diversity might be indicative of multiple activities, social aggregation, a longer period of occupation, use of a variety of resources, or the existence of numerous craft producers (Conkey 1980; Funk 1976; Kintigh 1984; Rice 1981:222; Wood 1978:260; Yellen 1977:135). By contrast, sites with low diversity, where a single or a few artifact classes dominate, are argued to indicate limited numbers of activities, a smaller period of occupation, special purpose sites, restricted access to resources, or a small number of producers (Conkey 1980; Funk 1976; Kintigh 1984; Rice 1981:222; Wood 1978:260; Yellen 1977:135). Analogous arguments are made with regard to the numbers of different animal species found at a site, as indicating either specialized or generalized adaptations (Grayson 1981b).

It is, however, unlikely that one can make the simplistic assumption that there is a linear relationship between increasing diversity and increasing activity - or a longer occupation or more people (Binford 1978:359). The structure of a debris scatter or number of tools may sometimes (Yellen 1977:135), but not always or necessarily (Binford 1979:359-360) be proportional to the number of activities or the number of man-days of occupation. Some activities require one tool while others require many tools.

Perhaps more of a problem in dealing with the meaning of diversity in archaeological settings is the matter of equifinality. Just what is reflected by high/low diversity? Longer/shorter occupations? More activities/less activities per occupation? More producers/less producers? To resolve these questions requires independent information. For example, the structure of a deposit should suggest whether a site was occupied for a long or short period of time, and thus "factor" out the influence of duration of occupation on diversity. Further, analysis of usewear and overall sample sizes should reveal something about the intensity of the activities and the number of participants. Obviously this must be addressed on a site by site basis: one simply cannot make a priori statements about the cause of high versus low diversity assemblages.

Having said this, it is now useful to turn to an examination of the diversity for the eastern fluted point sites. I use these measures primarily as a means of gauging the relative complexity of different assemblages (Kintigh 1984). Then, with supporting independent data, interpret those measures in terms of functional and activity complexity and diversity. Diversity indices for eastern fluted point sites are listed in Table 20.

The calculated evenness values are, again, the reciprocal of Simpson's "measure of concentration" index (MacArthur 1972). Recall from the earlier discussion of raw material diversity that Simpson's index was designed to measure the probability that any two individuals picked independently and at random from a community would belong to the same species (Pielou 1975).

By taking the reciprocal, one derives the probability that any two individuals picked independently and at random belong to different species (MacArthur 1972:189), or in this case, different tool classes. In effect, this index measures the number of equally common artifact classes in an assemblage. Within a given sample, the higher the evenness value, the more uniformly distributed the individual artifacts are across all of the classes and the less likely that the selection of two individual artifacts would result in the selection of two members of the same class.

Two sets of richness and evenness calculations are given in Table 20. One set is the richness/evenness values for the utilized tools alone (that is, Classes 6-18); the other set includes all the primary tools (Classes 1-2), production wastes (Classes 3-4) and staging items (Class 5). These separate calculations serve a number of purposes, primarily, however, they are done to sort functional and technological complexity, and to mitigate the effects of assemblages with large DEBITAGE samples.

On this latter point, evenness values can be "driven" down if a single tool class numerically dominates an assemblage (recall the hypothetical example given in Table 19). At many of these sites, as is evident both in the raw data and in the ratios of primary tools and production wastes to utilized tools (Table 18), DEBITAGE (Class 4) makes up well over 90% of the entire assemblage. Were this class not omitted from the calculation of the evenness values, then any variation in the diversity of the functional items of the tool kit proper would be obscured. It is, nonetheless, important to know when and to what degree an assemblage is dominated by flaking and other aspects of manufacturing, and thus the two calculations. Differences between the two calculations are sometimes very informative.

Grayson (1981b:82-85) has examined diversity indices used in the analysis of archaeological faunal assemblages. One of the points he raises is that because the counting units in the faunal analysis vary with sample size, then diversity indices using those same or derived units will also vary (see also Kintigh 1984). As a consequence:

> the meaning of such indices will become clouded: it will not be at all clear whether they are measuring the diversity of an archaeological fauna, or the size of the faunal sample (Grayson 1981b:85).

The units employed in this analysis, actual counts of tools and artifacts, seem secure from the pernicious sample size effects that drive the quantitative units in faunal analysis. However, Grayson's general point is well taken: it is better to look for sample size effects than to assume they do not exist (Grayson 1981b:86).

TABLE 20. Richness and evenness in toolkits and assemblages

Site	Tool Richness	Tool Evenness	Assemblage Richness	Assemblage Evenness
Barnes	5	.6824	6	.0395
Bull Brook	7		10	
Davis	4		4	
Debert	12	.7649	17	.2947
Dutchess Quarry	1	0	1	0
Fisher	6		8	
Gainey	6		8	
Kings Road	9	.7080	13	.1078
Parkhill	5		7	
Port Mobil	9		12	
Potts	7		7	
Reagen	7		8	
Shawnee-Minisink	5	.2816	9	.0241
Shoop	8	.7632	10	.6472
6LF21	8	.6967	11	.0192
Thunderbird	12		16	
Twin Fields	8	.7251	10	.1952
Vail	10	.7675	14	.6307
Welling	5		7	
Wells Creek	8	.3843	14	.5321
West Athens Hill	8	.5433	13	.5091
Williamson	11		15	

Following this suggestion, Spearman's rank order correlation coefficients are calculated between sample size, richness and evenness. These results are given in Table 21. This table shows that there is a strong relationship between sample size and richness values (r = .87 and between sample size and evenness (r = .49 and -.18 for tool and assemblages, respectively). The marked difference in the strength of the relationship between sample size and richness on the one hand, and sample size and evenness on the other, is partly a function of the measurement scale and the fact that evenness measures can incorporate a sample size adjustment.

TABLE 21. Rank-order correlations of sample size with richness and evenness

(A) Tools

	Sample size	Richness	Evenness
Sample size	1.00		
Richness	.87	1.00	
Evenness	.49	.51	1.00

(B) Assemblage

	Sample size	Richness	Evenness
Sample size	1.00		
Richness	.90	1.00	
Evenness	-.18	.05	1.00

As has been clearly demonstrated in the paleontological and ecological literature, samples of differing size produce varying values of richness (Raup 1975; Wolff 1975):

> A large sample yields, on the average, more higher taxa than a small sample. As more specimens are discovered, more higher taxa are added but not in direct proportion. Thus, a low value for the number of higher taxa may be just an artifact of small sample size (Raup 1975:333).

The reason this relationship obtains is quite simple: abundant or common tool classes are more likely to be detected before less abundant or rare tool classes. The relationship is a probabilistic one: in any random sample of a population the abundant elements have a higher probability of being selected in a small sample than the rare elements (Wolff 1975:198-199). But regardless of the absolute size of an assemblage, everytime a new class or item is detected, the richness of that assemblage increases by one. Because all items are weighted equally, then each additional item, however rare, has a significant impact on the total richness of the assemblage. Since new items are detected as a function of increasing sample size, then richness increases as a function of sample size. The larger the collection or the sample retrieved, the larger - on average - the richness of the sample.

This point is well illustrated by the discussion in Funk (1976). He examined the kinds of artifacts found at nine eastern fluted point sites (Funk 1976: Table 31). He concluded, based largely on the richness values, that sites like Potts and Port Mobil are "simple" sites, while a site like Debert is "more complex and diversified" (Funk 1976:218; see also Funk 1972:22-23). While Debert may indeed be a more complex and diverse site than either Potts or Port Mobil, it is also a much larger site than either of these two. According to the counts given in Funk (1976: Table 31), Debert has 4518 tools, Potts 69 tools, and Port Mobil only 51 tools.

If one plots the relationship between the number of tool classes and sample size at these and the other sites in Funk's sample, a fairly strong positive correlation results (Spearman's r = +0.84). In effect, these calculations suggest that Funk's conclusions about site diversity may be reflecting sample size: Debert has more classes than Potts or Port Mobil because it is a larger sample.

By contrast, the detection of a single new item or class does not have a significant impact on evenness, since it is calculated on an interval scale, using the absolute abundance of the item. Unlike a nominal scale, a single item is not given the same weight as 10000 items; thus, when that single item is added to an assemblage of 10000, it will have hardly any effect on the overall evenness of that assemblage.

This is yet another reason to avoid relying on nominal data alone to describe tool kit variation. Nominal data, in the form of assemblage richness, is more readily biased by sampling vagaries. Evenness values, which use frequency data, are less subject to sample size effects, although, as noted earlier, this must be demonstrated and never assumed. The insignificant rank order correlations between sample size and evenness (Table 21) clear the way toward examining diversity in these terms. Variation in evenness, unlike variation in richness, is not driven by sample size in any significant manner. But in any case, sites with demonstrably unreliable samples of artifact classes (e.g. Davis, Potts and Reagen) should be omitted from analysis.

Given that the poorly controlled samples (e.g. Davis, Potts, Reagen) are omitted from analysis, is it possible to differentiate complex from simple sites, and at the same time account for differences in sample size? In other words, can one determine whether small and large sites differ along a dimension of complexity independent of sample size? Are small sites simply scaled versions of larger sites, or do small sites differ in kind from large sites? Diversity values, both richness and evenness, provide a means of answering these questions.

For example, Yellen (1977) observes that large habitation sites often contain "a sample of the society's total repetoire of activities" (Yellen 1977:135). In this instance, the large assemblages have high richness and high evenness values (Conkey 1980). If that same community disperses into smaller units, but each unit carries on the same activities in the same proportions as practiced in the larger nucleated unit, albeit on a smaller scale, then the assemblages will have lower richness values, but approximately the same values for evenness. These smaller assemblages should have artifact classes proportional to their abundance in the large assemblages; as a consequence, artifact classes that are rare in the large assemblages should be absent in the smaller sites.

By contrast, in the case of functionally specific or simple sites, evenness as well as richness values of the assemblages will be low. If the inhabitants of the site did only one activity, then very few artifact classes will be present. The tool classes present in these assemblages should be present independent of their abundance in the large, complex assemblages. In other words, a large site may not be necessary to detect so-called rare items; certain functionally specific sites may be composed entirely of items that on the whole are infrequent, or not commonly detected, in large habitation sites.

Having specified the expected behavior of evenness and richness values, and the occurrence of artifact classes, and omitted unreliable assemblage samples from the analysis, it is useful to return to the data from Table 20. For ease of discussion, the data in this table are displayed graphically in Figure 12. Evenness values are along the Y axis, sites are plotted at purely arbitrary distances along the X axis in order of decreasing <u>tool</u> evenness. Tool evenness is used to order the sites so as to avoid the impact of sites with higher versus lower percentages of debitage.

Clustered on the left hand side of Figure 12 are three sites with relatively high values for tool evenness. None of these assemblages are dominated by any single tool class. Rather, tool classes are represented evenly in the assemblages. These relatively complex sites are not necessarily the largest sites. Debert, of course, is the largest of all sites, and does have high evenness and predictably high richness values. But its evenness values are not higher than those of Vail, a significantly smaller assemblage. In fact, the tight clustering of tool evenness values for Debert, Shoop and Vail is quite remarkable since the sample sizes in these sites vary so drastically, from a high of 4592 tools at Debert to a low of 655 tools at Shoop.

Based on earlier arguments, I would suggest that these three sites differ from one another only in sample size and not diversity or assemblage complexity. There are simply more artifacts at Debert than at the other two sites, a circumstance that may result from differences in the duration of habitation at the sites, the numbers of individuals at the sites, or the amount of activity at the sites. In functional terms, the smaller sites (Shoop and Vail) are simply scaled versions of the larger site (Debert).

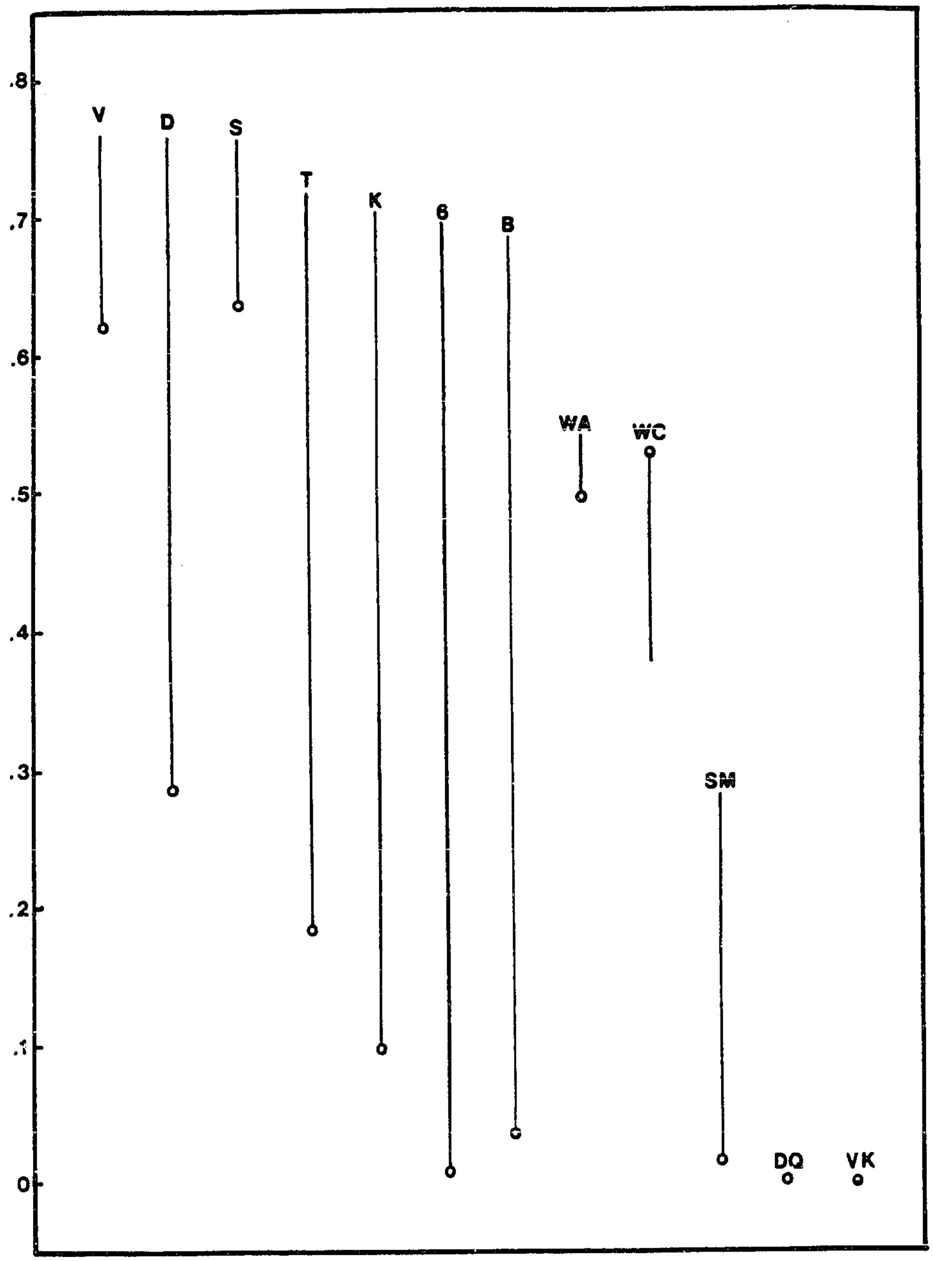

FIGURE 12. Tool and assemblage evenness. Vertical axis is evenness; sites ordered left to right according to decreasing tool evenness. Evenness value of site assemblage marked by open circle; evenness value of site tool kit at opposite end of line. Key to site names:

B=Barnes
D=Debert
DQ=Dutchess Quarry Cave
K=Kings Road
SM=Shawnee-Minisink
S=Shoop

6=6LF21
T=Twin Fields
V=Vail
VK= Vail killing ground
WA=West Athens Hill
WC=Wells Creek

But similarity in assemblage complexity in these sites is, by itself, insufficient evidence that these sites are functionally identical. The reason is simple: evenness values measure the distribution of tools among the various tool classes in an assemblage, with no information is given as to which specific tool classes drive the calculated value. A high value for evenness only means that there are a number of tool classes in an assemblage that are comparable in abundance: it does not identify which tool classes are involved. Thus, it is conceivable that two functionally distinct assemblages could produce identical values for evenness.

However, this is not the case with the similar values for tool evenness at Debert, Shoop and Vail. These assemblages are very much alike in terms of the specific tool classes dominating the assemblages. Driving the evenness values at all these sites are comparable relative frequencies for END SCRAPERS (Class 15), PIECES ESQUILLEES, (Class 7), and to a lesser extent SIDE SCRAPERS (Class 16), UTILIZED FLAKES (Class 6) and FLUTED POINTS (Class 18). These are the most abundant classes in all three of these assemblages, relative to the total number of tools; they occur in roughly the same order and relative frequency in each of these three sites.

In fact, adjusted residual values for these assemblages (Table 22), further demonstrates that these classes occur in these assemblages in numbers disproportionate to their frequency in other assemblages and the frequency of other classes within these assemblages. END SCRAPERS (Class 15), SIDE SCRAPERS (Class 16) and PIECES ESQUILLEES (Class 7) are significantly overrepresented in each of the three assemblages. FLUTED POINTS (Class 18) are overrepresented in all three assemblages,

TABLE 22. Adjusted residual values for tool classes in assemblages

A) Tool Classes 1 - 9

	Tool class						
Site	1	3	4	5	6	7	9
Barnes	-4.00	-10.86	22.46	-3.94	-12.18	-6.86	-1.68
Debert	-12.34	-40.01	12.22	-13.40	-21.46	31.14	-5.08
Kings Road	-10.62	-11.86	48.60	4.50	-30.60	-18.95	-4.39
Shawnee-Minisink	-5.24	-15.92	35.96	-6.03	-19.89	-10.47	-2.57
Shoop	-2.97	-8.07	-25.78	3.33	-4.77	9.08	-1.25
6LF21	-6.66	-17.59	40.62	-6.72	-20.94	-11.68	-2.86
Twin Fields	-2.60	-6.90	7.16	-2.56	-4.90	-4.45	-1.09
Vail	41.14	-19.62	-33.44	-7.19	12.39	35.81	-3.07
Wells Cr.	-3.79	-3.53	-54.57	17.25	94.84	-15.88	24.11
W. Athens	10.96	120.40	-49.50	12.50	-1.87	-15.89	-3.99

B) Tool classes 10 - 18

	Tool class						
Site	10	13	14	15	16	17	18
Barnes	1.93	-1.64	-3.36	-8.68	-6.14	-1.95	5.21
Debert	-2.63	-6.23	-2.74	29.92	14.13	-3.51	1.91
Kings Road	-4.58	-4.27	-9.29	-20.66	-9.59	-6.37	-7.71
Shawnee-Minisink	-2.77	-2.50	-5.13	-10.03	-9.87	-4.14	-4.65
Shoop	6.21	-1.21	39.54	33.88	15.79	-2.01	20.42
6LF21	-3.82	-2.79	-1.93	-15.70	-10.71	-4.16	-4.43
Twin Fields	-.41	.83	.14	1.26	4.84	-.61	-1.09
Vail	6.74	-2.99	-6.12	31.87	11.36	-4.95	9.07
Wells Cr.	-3.52	24.61	19.62	-15.21	-5.31	31.05	-1.17
W. Athens	8.44	-3.89	-7.82	-16.94	-1.14	-6.43	-2.34

significantly at Vail and Shoop.

It is interesting that however much these sites are identical in terms of the complexity of their tool kits, they differ in the complexity of the overall assemblages. The evenness values for the Debert assemblage drop significantly from the evenness value for the tool kit at that same site, and are much lower than assemblage evenness values for Shoop and Vail. The sharp drop between the tool and assemblage evenness values at Debert is not unexpected, given the comparatively high numbers of thinning and retouch flakes found at this site. But recall that most flakes were extremely small (MacDonald 1968:109); these are flakes that resulted from tool maintenance rather than tool manufacture. There is, then no mistaking Debert with, say, a manufacturing station site where there is a predominance of flakes, and a disproportionate number of artifacts in the assemblage are simply flakes.

A good example of just this situation are the assemblages at Kings Road, Barnes and 6LF21. All have relatively high values for evenness, clustering around .6900. Yet in all cases there is a substantial drop between tool and assemblage evenness, indicating that DEBITAGE and production tools dominate these assemblages. In effect, the high evenness values for the tools alone masks the fact that these tools are but a minor numerical component of the overall assemblage.

These sites have high absolute and relative amounts of primary tools and production waste (Figure 11). In these cases it is reasonable to read a decrease (increase) in the importance of manufacturing from a decrease (increase) in the length of the line between tool evenness and overall assemblage evenness. Although one has to exercise caution in applying this argument. As is clearly evident in the Debert case, it is important to gauge the size and kind of flakes comprising the debitage category.

As was the case with the previous cluster of similar evenness values, these assemblages are similar in the kind and frequency of tool classes driving the evenness values. Barnes, Kings Road and 6LF21 are each significantly underrepresented in nearly all artifact classes, save DEBITAGE (Class 4). FLUTED POINTS are overrepresented in the Barnes assemblage, and it is worth noting that most of these points are broken (Voss 1977:257). Whether they were broken in manufacture, which I suspect, or in use, is unclear from the reports. Kings Road has a significant overrepresentation of PREFORMS (Class 5).

Wells Creek and West Athens Hill, on the right side of Figure 12, differ somewhat in their evenness values. In a general sense, the sites are identical in size and complexity: both are large, simple sites. Unlike Kings Road, Barnes and 6LF21, these sites have relatively high values for assemblage evenness. In fact, at Wells Creek the assemblage evenness values are higher than the values for tool evenness. This results because the very high percentage of UTILIZED FLAKES at Wells Creek drives the tool evenness values down, while the addition of the primary tools and DEBITAGE classes adds classes of comparable size, thus evening out the distribution of classes and driving the overall assemblages values back up.

In any case, West Athens Hill and Wells Creek are both relatively simple sites, but for different reasons: one (Wells Creek) is dominated by UTILIZED FLAKE and flake tools, the other (West Athens Hill), by primary tools. The adjusted residual values for Wells Creek indicate an assemblage significantly overrepresented by PREFORMS (Class 5), as well as UTILIZED FLAKES (Class 6), CHOPPERS (Class 9), DENTICULATES (Class 13), GRAVERS

(Class 14) and SPOKESHAVES (Class 17). West Athens Hill, by contrast, has less specifically functional items. Numerically dominating this assemblage are HAMMERSTONES (Class 1), CORES (Class 3) and PREFORMS (Class 5), all of which are significantly overrepresented (Table 22).

Discussion of interassemblage variability

Analysis of technological patterns in eastern fluted point sites has demonstrated that there is significant variation among the sites in terms of the kinds of reduction strategies. There are, on the one hand, indulgent strategies, which take place in site settings close to stone outcrops or sources. These indulgent strategies are characterized by blocky and irregular cores, a significant amount of debitage composed predominantly of large hard and soft hammer percussion flakes, a high ratio of primary tools and production debris to utilized tools, and a high proportion of flake tools as opposed to manufactured tools. Sites exhibiting this indulgent lithic reduction strategy include Wells Creek, West Athens Hill, Kings Road, Barnes and 6LF21. Twin Fields and Shawnee-Minisink may fit this pattern as well.

On the other hand, there are sites evincing more conservative lithic reduction strategies. These conservative strategies are characterized by the use of bifacial cores (most of which are found in a highly utilized form), relatively small amounts of debitage consisting of small pieces of bifacial thinning flakes, a possible bipolar technology, a low ratio of primary tools and production debris to utilized tools, and a high proportion of manufactured as opposed to flake tools. Sites exhibiting this conservative reduction strategy include Debert, Shoop and Vail.

These differences in indulgent versus conservative lithic reduction strategies correspond quite well with patterns in raw material derivation and use. By and large, sites practicing indulgent strategies utilize local stone sources, sites practicing conservative strategies utilize non-local stone sources. But as pointed out earlier, assemblages with indulgent strategies are not necessarily situated directly on the quarry or stone source, as seen in the case of Wells Creek.

Results of analysis of functional patterns in these assemblages follow along similar lines. Assemblages with indulgent tool reduction strategies are, by and large, dominated by flake tools, what Binford (1973) would term expedient tools. There is often a great deal of associated production material: tools to make tools. Situational implement manufacture and use of flake tools are the dominant themes at these sites, although the importance of these two activities varies between the sites.

The relatively low assemblage evenness values for sites like West Athens Hill, Kings Road, Barnes and 6LF21 suggest that manufacturing activities dominated. The low evenness values for Wells Creek are something of an anomaly. The large number UTILIZED FLAKES implies a greater assemblage complexity than is evident in the evenness values, but then this may simply be a function of the classification device. As pointed out earlier, the nominal category of UTILIZED FLAKE, a necessary evil of this analysis, likely masks a great deal of functional variability. It is sufficient to observe that Wells Creek is likely a more complex assemblage than is readily apparent.

Assemblages with more conservative reduction strategies are alike in their functional patterns as well. These sites are relatively diverse (a point explored in further detail below), and are dominated by tool use and maintenance activities. Manufactured, or what Binford (1973) has termed curated, tools dominate this assemblage.

Determining the aboriginal uses of the tools in these assemblages is difficult under the best of circumstances (Dunnell 1977; Frison and Bradley 1980), and doubly so in a case like this where one is forced to deal with morphologically defined tool classes. With that caveat in mind, I offer some conjectures on prehistoric activities indicated by these tool kits. The dominance at Debert, Shoop and Vail of END and SIDE SCRAPERS, BIFACIAL KNIVES, PIECES ESQUILLEES (assuming, for the sake of argument, that some served as wedges) and FLUTED POINTS (many of which show impact damage), suggests a high intensity of hunting and processing of animals (MacDonald 1968). While difficult to test directly, this does imply that kill sites should be associated with these sites; and there is evidence that just such an association exists.

In close proximity to the Vail site, approximately 250 meters to the west, is an assemblage interpreted as a killing ground (Gramly 1982:54-58). There are no organic remains, nor butchering tools, only a cluster of projectile points, some of which are broken and conjoin with basal fragments in the main Vail site area. This cluster of projectile points is plotted on the far right side of Figure 12.

If, indeed, Shoop and Debert are smaller and larger versions respectively of Vail, as the diversity indices seem to demonstrate, then it may be safe to infer that they too are residential camps supporting a satellite hunting station. Only at these sites the killing grounds were never found, or, if found, were never recognized. The Vail killing ground suggests that kill sites may be marked by nothing more than a simple cluster of projectile points not in direct association with other tools, but perhaps in association with a specific topopographic feature (as discussed in the section on site situation).

As an aside, this suggests the existence of a uniquely eastern kind of site. In the plains and west kill sites are discovered and delineated as a consequence of a pile of bones; in the east, where organic preservation is poor, kill sites may have to be delinated on the basis of a cluster of projectile points. This, of course, has important implications for the study of isolates. If a simple spatial cluster of isolates is, indeed, a site type in its own right, then it behooves eastern archaeologists to pay stricter attention to the location of these finds, and their association with other like material. Unfortunately the record of isolates, as it stands, cannot provide sufficiently fine-scale data on the precise locations of finds, but certainly a worthwhile endeavor in the future would be to map finds precisely, instead of locating them on the scale of the county of province.

There is additional, circumstantial evidence supporting the interpretation that Debert, Shoop and Vail are sites associated with hunting activities, specifically caribou hunting activities. Debert, Shoop and Vail, along with Bull Brook, are unique among eastern fluted point sites in having evidence of multiple and spatially discrete artifact concentrations. At Debert, artifacts were clustered in 11 loci, ranging in size from 70 to 200 meters square (Snow 1980:148). The surface patterns at Shoop appeared to reveal 11 artifact clusters generally less than nine meters in diameter but more than 90 meters apart (Witthoft 1952:467). At Vail eight major artifact concentrations were discovered, spread over 1.25 acres (Gramly 1982:46).

Data on the artifact concentrations at Bull Brook and Shoop are lacking, but the assemblages in the clusters at Debert and Vail are well documented. Both Gramly (1982:52) and MacDonald (1968:23) observed that the artifact concentrations within each cluster were roughly equivalent in relative frequencies of tools and waste, indicating that these activity areas are homogeneous with respect to one another.

It has been inferred that the patterns of internal site structure at these two sites, along with Bull Brook and Shoop, are indicative of successive and functionally identical occupations and reoccupations of the sites (Cox 1972; Gramly 1982:52-54; Grimes 1979:117; MacDonald 1968:22-23). This suggestion is certainly fortified by the similarity in kind and diversity of tool kits in the activity areas within these sites. Although direct evidence is lacking, it is reasonable to suggest that the cycles of occupation are seasonal (Gramly 1982; MacDonald 1968), and tied to the migration of caribou. This, of course, would conform with the patterns evident in lithic reduction strategies, given the logistical disparity between the stationary and predictable resource (stone), and the mobile and only roughly predictable resource (caribou).

There is less to be said about the assemblages characterized by more indulgent strategies. Certain of these, such as Barnes, Kings Road and 6LF21, are almost surely very short term use sites where tool kits were refurbished. This would account for the high proportion of production debris, the scarcity of prepared or utilized tools (which were presumably carried off the site), the occasional abandonment of non-local lithic material in the form of heavily curated tools and thinning flakes (at Kings Road in particular), and the overall low diversity of these assemblages.

Barnes has been interpreted as a hunting camp (Ford 1974), but it seems more likely that it is simply a re-tooling station (Mason 1981), as there is a great deal more debris (such as channel flakes) than can be accounted for by the tools at the site. Barnes and 6LF21 in particular are only segments, and rather functionally restricted segments, of larger subsistence and settlement systems. It is certainly conceivable that these assemblages represent way stations on a larger seasonal round.

Twin Fields may be a similar kind of site, insofar as this assemblage also seems to manifest a temporary occupation (Eisenberg 1978). Eisenberg (1978:136; see also Snow 1980) has interpreted this site as a temporary work camp for the processing of plant materials, and certainly there is nothing in the tool kit to deny this.

Kings Road, which has much greater frequencies of utilized materials, is not as functionally restricted as Barnes and 6LF21. One might speculate that the length of occupation at this site was longer, as it involved much more in the way of non-manufacturing activies (Funk 1976:219). It does not seem likely, however, that this site was either a "base camp" (Ford 1974) or a hunting site (Snow 1980), as the diversity of the assemblage is comparatively restricted. A quarry workshop with a brief habitation is the most parsimonious interpretation (Funk 1972, 1976; Salwen 1975).

Flake and unifacial tools dominate the utilized segment of the assemblages at West Athens Hill and Wells Creek. The apparent complexity of the flake tools at Wells Creek (Dragoo 1973) implies a greater mix of functional activities than is evident in the evenness values in Table 20 (for reasons detailed earlier). Dragoo (1976) has always maintained that Wells Creek is more than a quarry station, and is in fact a long term habitation site. I see no reason to doubt this conclusion. The high incidence of large cutting and scraping tools at the site (some 95 choppers, along with many massive scrapers and flake knives) indicate a substantial woodworking industry.

By contrast, at West Athens Hill quarrying and the wide range of lithic manufacturing activities dominate the assemblage. There are comparatively more cores and hammerstones in this assemblage. Funk (1976:219) has suggested that West Athens Hill is a quarry workshop and associated habitation site. The relative lack of projectile points, also characteristic of Wells Creek, bespeaks a lack of emphasis on hunting activities. Presumably subsistence activities associated with the occupation of the site are more directly related to plant processing, a supposition not refuted by the high incidence of flake and unifacial tools. The lack of prepared tools implies that much of the material being manufactured at the site was likely transported off the site.

One final comment on the apparent homogeneity of the tool kit of eastern fluted point groups. The tool kit in eastern fluted point sites is rather simple in comparison with later and more elaborate technologies. But its simplicity should not be confounded with standardization, for there is significant variation in the frequency and diversity of the classes within each assemblage. While all assemblages have fluted projectile points (sites are identified on this basis), and nearly all have bifacial knives, endscrapers, sidescrapers, and utilized flakes, they have them in varying proportions. There is a significant amount of between-assemblage variation. The next step is to relate that variation to differences in site age, environmental setting, and location: the subject is treated in the final section of this chapter.

Conclusions

Analyses of the radiocarbon and geochronological record for eastern fluted point sites yielded a series of eight age groupings (Table 6), six of which (Groups 3-8) were open-ended, or based on maximum ages only. The ages of the sites within these groups are thus subject to change, and probably substantial change in many instances. Sites in the other two groups are more firmly dated. These sites fall into two well-bracketed temporal periods: 9900 - 10400 B.P. (Group 1), and 10600 - 11200 B.P. (Group 2). Sites in the first group are Fisher, Gainey and 6LF21; sites in the second group are Debert, Shawnee-Minisink, Vail and Whipple (and may include Bull Brook as well).

Analysis of site location and the paleoenvironmental setting of eastern fluted point sites shows that sites are not scattered evenly across the area of occupation, as evidenced by a comparison of the distribution of sites and the distribution of isolates. There are an inordinate number of sites located in the glaciated region (Tables 7 and 8).

The paleoenvironmental record for these sites indicate significant differences in the environmental setting for these sites that roughly correspond with the division between glaciated and unglaciated areas. In the northern glaciated region there was a periglacial tundra and tundra-forest environment; in the southern, unglaciated region a mixed boreal-deciduous forest (Table 9).

Tying the paleoenvironmental record together with the data on site location highlights the potential differences in land use between glaciated and unglaciated regions. In tundra regions, subsistence resources - the caribou - are spatially isolated, point resources. Because their semi-annual migrations are roughly predictable, particular locales have the potential to be used and reused. In the forested, unglaciated regions, subsistence resources are extensive and dispersed; there is a low potential for locality reuse, except in the case of stone sources (which, of course, are immobile, and frequently quite restricted in extent). These differences help explain why four of the five sites in the unglaciated region are quarry-related, and why there are a great deal more sites in the glaciated region, and not all of them are quarry related.

While the age and environmental setting of many of the eastern fluted point sites is unknown, in those sites where information for one or the other of these variables is available, some interesting patterns emerge. For one, there is a group of sites in the glaciated region of eastern North America whose ages are firmly set at around 10600 B.P. (Debert, Vail, and Whipple). At two of those sites (Debert and Vail), the reconstructed environmental setting is tundra or near tundra (Chapter 4; Table 9). Given the similarity in the projectile points of Whipple and Bull Brook with Debert and Vail, it seems reasonable to speculate that these sites are part of the same tundra or near tundra occupation.

In the areas south of these sites there are two sites, 6LF21 and Shawnee-Minisink, with similar absolute dates (10400 B.P. and 10600 B.P., respectively). Both of these sites are located in the glaciated portion of eastern North America, yet both of these sites are clearly situated in an environment of mixed boreal and deciduous forests (which corresponds with their relatively late ages).

The Thunderbird, Wells Creek and Williamson sites are of unknown age, but all were situated in the mixed boreal/deciduous forests of eastern

North America. The minimum age for these occupations is approximately 9900 B.P.; the maximum age is unknown, but given their location, in the unglaciated region of North America, these sites have the potential for significant antiquity. There were no barriers to occupation in these areas, as there were in the glaciated region, and the environmental setting the sites were situated in was present at least as far back as 16000 B.P. (Chapter 4).

In the Great Lakes region, the Gainey and Parkhill sites are thought to have been situated in a forested environment as well. The absolute ages of these sites are unknown, but in the case of Gainey probably postdate 10400 B.P. (Table 4). At another of the Great Lakes sites, Barnes, the potential age is greater, 12500 B.P., and thus the environmental setting may have been tundra or near tundra. Environmental settings and ages for the remainder of the sites cannot be determined with any accuracy. There are simply too many unknowns. However, the existing groups can be more sharply defined as well as expanded when the analysis of other aspects of interassemblage variability in eastern fluted point sites are taken into account. In other words, it is possible to utilize information on site setting, subsistence remains, raw material use, and interassemblage technological and functional variability to assign on a provisional basis sites whose ages and environmental setting are unknown to groups of known age and setting, or to more firmly define already established groups.

There are a number of features common to many sites in terms of site setting, and these include establishing sites in close proximity to stone outcrops, glacial lake beaches, or rivers and streams. These features for the most part appear to cross-cut known variation in site location, age and environmental setting, and thus are not altogether useful for assigning sites of previously unknown age or environmental setting. However, there is one feature of site setting that is restricted to only a very few sites, and that is the situation of a site for the interception of migrating herd animals. This feature is evident at three sites, Debert, Vail and Whipple, thus further supporting the integrity of this grouping.

The inclusion of Whipple as well as Bull Brook in the group of tundra or near tundra sites is given additional support by faunal remains recovered from these sites. Though the evidence is somewhat controversial (Bull Brook) or poorly reported (Whipple), it does seem as though caribou remains have been recovered from these sites. Dutchess Quarry Cave has firm evidence of caribou remains in association with artifacts; the age of this site is controversial, owing to the nature of the material (bone collagen) on which the radiocarbon dates were run, but the presence of caribou suggests that this site can be provisionally included with the tundra or near tundra occupation. Subsistence remains from Shawnee-Minisink confirm that the occupants of this site practiced an adaptation to the forest resources, a finding in keeping with the known age and environmental setting of the site.

Patterns in lithic raw material use conform quite well with variation in age and environmental setting. In most instances, an assemblage was manufactured of a single raw material, and in most instances that raw material was derived from a primary or outcrop source. This allowed the tentative identification of the stone source, and thus a measure of the distances stone was transported. When that information was divided along an arbitrary line of proximity (local versus non-local, defined as a stone source either within or outside 10 km from a site), it is clear that not all eastern fluted point groups were as moving lithic material as great a distance as traditionally thought (Table 11). In fact, the majority of the assemblages are dominated by locally occurring raw material (Table 12).

But what makes these data on lithic raw material use especially provocative is the fact that apparent differences in mobility conform to differences along geographic and environmental lines. All site assemblages in the unglaciated region that are known to have been situated in forest environments are composed entirely of locally occurring lithic raw material (Table 13). The significance of this is offset by the fact that three of the four sites in question (Tunderbird, Welling, and Williamson) are quarry sites. Wells Creek, however, is not (Dragoo 1976).

A quite different situation obtains further north. The majority (5/6) of the sites dependent on non-local sources are located in the glaciated region (the one exception is the Shoop site). These include Barnes, Debert, Gainey, Parkhill, and Vail (Table 13). The fact that Debert and Vail are again in the same group suggests that use of non-local stone sources might be a pattern associated with tundra or near tundra settlement systems. There are insufficient data to determine whether the Bull Brook and Whipple assemblages are dominated by non-local raw material sources. But if they are indeed part of the same adaptive pattern as evidenced at Debert and Vail, as independent evidence would suggest, then I predict that these sites will also be dominated by non-local material (Grimes [1979] implies this might be the case).

Technological and functional patterns in the tool kits in these assemblages conform with variation in raw material use, as discussed in detail above, and also with certain patterns in the age and environmental setting of these sites. Assemblages characterized by use of non-local raw material sources, conservative lithic reduction strategies, a dominance of prepared (curated) tools, a high proportion of scraping and cutting tools, the presence of pieces esquillees, high intraassemblage diversity, and complex site structure are (with the exception of the Shoop site) located in glaciated regions, in tundra or near tundra settings. These sites date to approximately 10600 B.P.

On the basis of this evidence, and the evidence from subsistence remains and site setting just summarized, I conclude that Bull Brook, Debert, Shoop, Vail and, probably, Whipple are all likely habitation sites associated with a specialized subsistence activity - specialized caribou hunting.

Evidence of caribou remains are found in only two of those sites (Bull Brook and Whipple), but this meager evidence should not be taken as an indication that there were significant alternative food resources being exploited within this environment. The ecological literature makes clear the fact that food chains have, on average, three trophic levels, and that in physically controlled environments, such as a tundra (Odum 1971), the number of species is quite low, sometimes equalling the number of trophic levels (Pielou 1975). Thus, a forager at the top trophic level in a tundra environment has very few choices of food items.

Certainly this can be seen in modern aboriginal populations exploiting the tundra (Coombs 1980; Fitzhugh 1972). Diets consist of a very few species, generally caribou, with occasional fish, and ground squirrel (Campbell 1977:189). But clearly the caribou is the critical element in the diet: "the caribou was so important that without it nearly all of interior Arctic Alaska would have been unihabitable in recent Aboriginal times" (Campbell 1968:14). In the late Pleistocene tundra, fishing as an alternative subsistence strategy was evidently not practiced in any systematic fashion (Cleland 1982).

The settlement pattern associated with this tundra subsistence is not altogether clear, however certain conclusions can be drawn. This was a highly mobile settlement system, evidenced by the clear-cut dependence on non-local raw material types. This mirrors the pattern seen ethnographically (Campbell 1968; Heffly 1981), and is readily explained by the logistical disparity between two critical resources: the stone and the caribou. The former is immobile and predictable, the latter mobile and only roughly predictable. Getting the necessary lithic material from the site of the former to the location where the latter are exploited results in the lithic reduction strategies described earlier.

There is little data on the associated settlement type. Debert and Vail do not appear to be permanent sites (Gramly 1982); rather there are indications of multiple recurrent seasonal occupations and reoccupations. These sites appear to be mosaics of small occupations. What the remainder of the annual system looks like is obscure, but there are some hints.

As Gramly (1982:75-77) points out, there are no small sites in this region that would suggest population dispersion. Rather the associated small encampments, and I suspect Barnes, 6LF21, and Twin Fields are some of them, appear to be simple way-stations, indicating a very brief stopover to refurbish the tool kit. Given the proximity of these sites to the larger habitation site, I infer, following Gramly (1982) that these groups practiced a large scale seasonal pattern, north to the retreating ice in the summer, and south to the forest in winter. Such a pattern is common among ethnographic caribou hunters (Smith 1978; Heffley 1981). Further evidence is required to determine the precise season of occupation at these sites.

A final note on the Shoop site. While the age and environmental setting of Shoop is unknown, there is ample reason to include the site among the proposed caribou hunting sites. If this assignment is correct, then this has some intriguing implications. Its location south of all the other sites of this complex suggests Shoop represents either a winter occupation, or one of the earliest manifestations of caribou hunting as an adaptive strategy.

If the latter, then the Shoop site has great antiquity, since tundra vacated that region well over 12000 years ago. This would imply that the Shoop site was the progenitor to the adaptive patterns seen 1500 years later and further to the north. If, however, the Shoop site is a winter encampment (a suggestion supported by the fact that the raw material used at the site comes from outcrops 200 miles north of the site), then less can be inferred about the age and environmental setting of the site. The site may not be of great antiquity, since it need not have been situated in a tundra setting.

Assemblages characterized by the use of local stone resources, indulgent lithic production strategies, a dominance of expedient or flake tools, a high proportion of simple scraping tools and a low porportion of tools associated with hunting and butchering, low intrassemblage diversity, and relatively simple site structure are mostly located in forested environments of both glaciated and unglaciated eastern North America.

Certain of these sites, such as Kings Road and West Athens Hill, are possibly associated with the tundra sites. I have inferred this based on the fact that, despite a dominance of locally occurring raw material at these sites, there are trace amounts of non-local material. This non-local material is routinely in the form of exhausted curated tools and thinning flakes (Funk, Weinman and Weinman 1969). This suggests that West Athens Hill and Kings Road served as quarry stations for a mobile settlement system, which returned to these sites to replenish the tool kits. The absence of significant amounts of habitation debris, and the low diversity of the tool kits and assemblages, implies that the visits were brief.

Other sites with the characteristics just mentioned, sites such as Shawnee-Minisink, Thunderbird, Wells Creek, and Williamson, rely nearly exclusively on the locally occuring raw material. There are no non-local materials at Thunderbird, Wells Creek or Williamson, which implies that the settlement systens associated with these sites are rather restricted and non-mobile. The fact that core preparation was so lax implies that the stone was simply used to produce flake tools, and that the material was not being transported great distances.

Not coincidentally, all of these sites are located in the unglaciated region of eastern North America, and were situated in the complex late glacial forests. The associated tool kits, the lack of evidence for a hunting economy, and the relative scarcity of these kinds of sites supports, or at least does not refute, the argument that the subsistence base for these groups was generalized foraging for plant and animal resources. The fruits, nuts and fish remains recovered from Shawnee-Minisink support this interpretation as well.

The settlement type associated with these sites is again difficult to discern, except circumstantially. Returning to the observations made earlier about the relationship between numbers of species and trophic levels, in the case of biologically controlled environments (such as the late Pleistocene forests), the number of species far exceeds the number of trophic levels. As a consequence of this, the numbers of individuals per species is greatly reduced. Dispersion would have been the optimal strategy for settlement in this kind of species rich environment (Harpending and Davis 1977).

This is supported by the scarcity of habitation sites, and the fact that most of the sites in these environments are quarry or quarry related sites. Stone was likely the only resource of sufficient density and spatial constancy to promote reuse of a particular locality. Otherwise, the foragers in this case "mapped on" (Binford 1979) to the extensive resources which, given the nature of the environment, were probably not particularly dense.

CHAPTER 6

VARIABILITY IN EASTERN FLUTED POINTS

Fluted points appear to differ in two important ways from other aspects of the Paleo-indian tool kit. Those differences are manifest in distribution and technology.

Individual fluted points are routinely found in "non-site" contexts: on the surface unassociated with other elements of the Paleo-indian tool kit (Brennan 1982; Mason 1962); points occur both singly and in clusters (e.g. Mayer-Oakes 1955). This is not a claim that of the artifacts in the Paleo-indian tool kit only fluted points have such a distribution. Such a claim is biased by the high visibility of fluted points. Because the form and technology of fluted points is obvious and uniquely Paleo-indian, they are recognizable when they occur in isolation and independent of a site context. Not so with the other elements of the Paleo-indian tool kit, like bifaces, endscrapers, sidescrapers or utilized flakes. Some of these may also have a distribution independent of a site context, but such occurrences are not recognized because none of these artifacts are obviously and uniquely Paleo-indian. What can be stated then is that fluted points, which are distinctively Paleo-indian and are immediately recognizable, have a significant non-site distribution independent of site settings.

This "non-site" distribution of fluted points might be suggestive of a hunting economy, the points representing drop or loss while engaged in subsistence pursuits. However, there is evidence, both from the points and their environmental setting, that belies this suggestion. In fact, these isolated point localities may represent foraging stations, unassociated with the usual habitation debris. This suggests the existence of a class of Paleo-indian sites composed solely of isolated fluted points, occurring either singly or in clusters. This, in turn, suggests that the details of point location and context might prove to be a valuable clue to adaptive strategy. It also has more general implications to which I return in the final chapter.

Technologically, fluted points are also distinctive among Paleo-indian materials in that there are no simple, unmodified flake, fluted projectile points. Fluted points are always extensively manufactured. As a result, there is a great deal of formal variation within this class of artifacts (Adovasio 1983; Ford 1977; Griffin 1977; Haynes 1980; Ritchie 1957). Much of this formal variation is likely stylistic in character (Close 1978; Dunnell and Campbell 1977; Wilmsen 1970). As argued by Wilmsen:

> Projectile points ... are passed through a number of transformational stages in each of which one or more of several manufacturing alternatives may be imposed. The scope for social input in the form of stylistic constraint (whether conscious or subliminal is immaterial) should, therefore, be greater than it is for other chipped stone artifacts ... (Wilmsen and Roberts 1978: 26-27).

This suggests that an analysis of the formal variation in these fluted points might inform on the spatial distribution and age of eastern Paleo-indian groups.

These distinctive distributional and technological properties of eastern fluted points have long been recognized, as has their potential to inform on the age of the eastern fluted point occupation, and adaptive variation within that occupation (e.g. lithic raw material use, settlement patterning, and ecological correlates [Brennan 1982; Haynes 1970, 1983; Mason 1962; Moeller 1983]). Nonetheless, efforts to utilize these data have been hampered by two major constraints.

First, the distributional data is markedly limited in detail. By and large, the location of individual points is known only to the state and sometimes county level, and not to the level of the specific locale (or, for that matter, to topographic setting, proximity to raw material source or ecological/paleoecological setting; Moeller 1983). In fact, only recently have there been studies that closely examine the spatial distribution of points on a local scale (e.g. Deller 1976; Jackson 1983). The result is that the distributional data on eastern fluted points cannot be correlated with topography or ecological setting in anything but the broadest terms (Moeller 1983:27). This means that an important source of information on Paleo-indian "non-site" settlement patterning is being neglected.

Second, there is confusion surrounding fluted point typologies. It is quite clear that the classification of the formal variation in these points is "highly subjective" (Haynes 1983:24), and includes a combination of both stylistic and functional attributes (Roosa 1965). As Funk suggests, "much work has to be done on the description and classification of eastern fluted points, to enable us to sort them into meaningful types" (Funk 1983:19).

These limitations set a number of constraints on eastern fluted point studies. The lack of detailed spatial and environmental data - which can only be improved by the addition of new data - prevents a detailed analysis of functional variability and its relationship to the ecological setting of the "non-site" settlement patterning (Funk 1983:18; Moeller 1983:27).

The ambiguities in the existing classification constrain our efforts to resolve one of the major problems in eastern fluted point studies: the development of a fine-scaled chronology for these occupations. Few sites exist, fewer still are dated, and most appear concentrated in the glacial regions. The Paleo-indian occupation in vast areas of eastern North America is manifest only by the isolated fluted point. The age of these materials is unknown. It has been suggested that certain types are "late", but such chronological assignments are based neither on firmly dated isolated points nor on a careful consideration of the distribution of the types. The lack of a well defined classification of points exacerbates the problems in achieving an internal chronology for the fluted point occupation. As Haynes (1983:25):

> If we could come up with an objective and definitive means of classifying the various types of fluted points, we could then plot distributions by type. This would be a great step forward in its own right, but eventually when time-calibrations from types in stratigraphic association with radiocarbon dates are attained, we will have a real basis for enlightenment.

Unlike the poorly controlled spatial data, ambiguous point classifications can be evaluated and improved using existant point data. The focus of this chapter then is on analyzing and developing a new classification of eastern fluted points.

More specifically, since my concern is with the chronological variation in fluted points, my aim is to produce a stylistic classification, one sensitive to temporal and spatial variability. The use of the term style here follows Dunnell (1978:199) as those "forms that do not have detectable selective values". Independent of external conditions, stylistic attributes can provide historical and non-repetitive classes that can tell time (Dunnell 1978:199). It is the purpose of this chapter to determine what stylistic attributes or classes of eastern fluted points, if any, inform on the chronology of the fluted point occupation.

This requires a two-step analysis. The first step is identifying the stylistic attributes in these points. While it seems obvious, it is nonetheless important to note that not all attributes of formal variation are stylistic ones. Without a doubt there is functional variation in the morphology of these points as well. The development of a stylistic classification must therefore include a consideration of the functional and technological variability in eastern fluted points, if only to eliminate the effects of this variability on the classification.

To aid in the first step - developing a stylistic classification - I examine in detail the known dimensions of variability in eastern fluted points, and evaluate the classification schemes that have been used in the past (e.g. Gardner 1974, 1983; Gardner and Verrey 1979; Hyde 1960; Prufer and Baby 1963; Rolingson 1964; Roosa 1965; Roosa and Deller 1982; Witthoft 1952).

The second analytical step is determining which of the identified stylistic attributes and resulting point classes tell time. While it may also seem obvious, it is equally important to note that the specification of stylistic attributes is not per force an identification of temporal variation. Styles vary over space as well as time, varying in the former dimension as a result of different cultural groups, different raw materials and thus a distinctive technology, and so on. Moreover, temporal and spatial variation is often intertwined. The age of a particular attribute or class of points in one region may not be the same in another region, although many assume just that.

For example, recall from earlier chapters that it has long been assumed that fluted points in the West and East are contemporaneous. Yet there is neither empirical evidence nor theoretical reason to support this. In fact, one would expect precisely the opposite. The diffusion of a style class across space must take time, no matter how mobile the populations may appear, and the larger the area, the less one can assume that an apparent stylistic identity indicates synchronous occupations.

Attributing stylistic variation in fluted points to a temporal or spatial dimension is difficult, since there are no independently dated isolated fluted points, and thus no clear-cut temporal meaning can be assigned to particular attributes or classes. Resolving the chronological problem requires, as Haynes (1983) noted, the less exact procedure of plotting the distribution of attributes and classes on a map, and relating those distributional patterns to geological features of known age. I have adopted this procedure in the pages that follow.

One can use a set of expectations about the behavior of stylistic point classes along temporal/spatial gradients as an interpretive framework for such an analysis. Consider, for example, the possibility suggested by Mason (1981) among others, that because fluted point groups were highly mobile there was no stylistic or spatial/temporal variability in point styles. One would expect that all points should fall into the same stylistic class, and a map of the distribution of that single class should cover the entire area of fluted point occupation.

There is a second possibility that there were different yet contemporaneous fluted point occupations in eastern North America. In this instance, a stylistic classification of fluted points should produce clearly defined classes and a map of their spatial distribution should show each class in a unique area, with abrupt spatial boundaries. Class distribution will not correlate with geochronological features.

There is a third possibility that the only variation in fluted points is that which occurs over a temporal dimension. This also implies that a classification of fluted points will produce clearly defined classes but that a map of those class distributions will show overlap among the classes. Class boundaries will be graded and diffuse. Class distribution should be correlated with geochronological features, in that classes should be time-transgressive south to north, with more point classes in the south than the in the north (since the southern regions were available for occupation over a longer period of time). Different classes should correlate with time-transgressive glacial or geological features. For example, a particular class will be associated with a specific glacial lake feature, while another class will be associated with subsequent or precedent glacial lake features.

Finally, there is a fourth possibility that a combination of spatial and temporal variability is present in fluted points. A stylistic classification of fluted points will produce clearly defined classes, but a map of the spatial distribution of those classes will show well-defined regional variants as well as time-transgressive class distributions.

Given the level of spatial detail available for isolated fluted points in may not be feasible to examine some of the more spatially-specific implications just outlined. Nonetheless, there is sufficient information that these expectations can serve as a broad outline to illuminate the variation - or lack of variation - in eastern fluted points.

On fluting and fluted points

The development of a stylistic classification of fluted points requires careful consideration of the kinds of variability that exist within a particular artifact class. Most importantly, it requires distinguishing between those features that are random in their behavior (stylistic attributes), and those that are a consequence of artifact use (functional attributes). I therefore begin the process of identifying the potential stylistic attributes with a consideration of the technology and function of fluted points.

To avoid any potential ambiguity, a fluted point is defined as a "lanceolate-shaped stone projectile point, with at least one flake detached from the base longitudinally onto a face leaving a flake scar that is [often] longer than any other flake scar on the point" (Stoltman and Workman 1969:191). Like Tunnell (1977:144), I exclude from this category lanceolate points that are basally thinned, or points that lack a long, distinctive flake scar. Points from the Holcombe Paleo-indian site in Michigan, for example, fall in the category of basally thinned points (Griffin 1977).

Origins

Incorporating a longitudinal channel, or flute, on projectile points has unknown origins. Two hypotheses have been suggested: that the technique derives from Eurasian Upper Paleolithic groups, and was carried into this continent by the early colonizers; or, second, that the technique is a uniquely American phenomenon, invented on this continent (Judge 1974). Proponents of the first view have pointed to a limited number of fluted points found in Alaska as support of their position.

For example, Humphrey (1966) has argued that certain of those Alaskan fluted points are associated with Upper Paleolithic type industries of European Russia, in what he has referred to as the "Driftwood Creek Complex". In his own words, this complex "strongly suggests a northern origin for the Paleo-indian technique of fluting projectile points" (Humphrey 1966:353).

While this suggestion has met with some approval (e.g. Chapman 1975), it is far from satisfactory. As Hall (1969) notes, the area in which Humphrey (1966) defined his Driftwood Creek Complex is a heavily travelled corridor, and as a consequence has a "welter of lithic material representing cultures far apart in time" (Hall 1969:353). Since Humphrey's Driftwood Creek Complex is defined solely on the basis of undated and mixed surface assemblages (Humphrey 1966:586-588), the associations of fluted material and Eurasian blade complexes are quite doubtful.

More recently, Haynes (1980) suggested that the two fluted points from the Putu (Alaska) are "probably related to a charcoal date of 11,470± 500" (Haynes 1980:119). According to Dumond (1980:989), these fluted point materials are part of a mixed surface assemblage, making it premature to draw any conclusions regarding a northern or Siberian origin for fluted points.

Relevant here is a point raised by Wormington (1957). The earliest date that might be assigned to the fluted points found in Alaska would be too recent to account for the even earlier dates on this material in the lower continental United States (Wormington 1957:83; Clark and Clark [1983] argue sufficiently early dates probably exist, but as yet no dates have been forthcoming). Not even Martin's "wave front model" (Martin 1973) has people moving so fast across Beringia that they arrive in North America before they left Siberia.

For that matter, Paleoarctic assemblages in Alaska (as defined by Dumond 1980:989) that are roughly contemporary with Clovis material on the Plains and fluted point materials in the eastern woodlands (ca. 11000 - 10000 B.P.), are technologically and stylistically distinct from those latter assemblages. The Paleoarctic industry of the terminal Pleistocene in Alaska is a microcore and microblade complex, the Clovis and eastern fluted point materials are a flake-based technology (Cox 1972; Jelinek 1971; Krieger 1954; cf. Griffin 1977, Haynes 1980).

Perhaps most telling of all for the hypothesis of an Eurasian origin for fluting, is that no fluted points have ever been found in Asia or Siberia (Krieger 1954, 1964; Wormington 1957:83). As Kreiger noted thirty years ago, it is a "well-known fact that [no fluted points] have yet been found in Asia!" (Krieger 1954:275). Krieger further suggested that the few fluted points in Alaska could be accounted for by the "not at all improbable" suggestion that they were invented in America and reached the Arctic with hunters who followed game northward with the retreat of the ice (Krieger 1954:275; see also Krieger 1964:55). All evidence that we have to date affirms the essential correctness of Krieger's position (Bryan 1969; Dumond 1980:991; but compare Clark and Clark 1983).

In addition to being invented in North America, fluting is also a uniquely Paleo-indian attribute. It is absent from points of all subsequent cultural periods. For that matter, as pointed out earlier, fluting is not even present in all Paleo-indian projectile points (Frison 1978; Wormington 1957).

On the function of fluting

Shortly after the discovery of the first Folsom points, Roberts (1935) commented on the apparent purpose of fluting. Evidently summarizing current opinion, he wrote "perhaps the most logical [explanation] is that [flutes] were to facilitate hafting the head to the shaft of the spear or arrow" (Roberts 1935:17-18). The logic involved was spelled out by Shetrone (1936:16):

> Since the fluted blades lack notches, stems or other means of attachment to a shaft or handle, it seems entirely obvious that the channeling, in connection with the basal concavity, served this purpose.

Fluting would secure a point in the haft, and minimize the "sideplay" of the point while in use (Shetrone 1936:16; see also Wilmsen 1974:52).

Roberts (1935) recognized too that fluting could have served other purposes. For example, fluting might have served "to reduce the weight, to improve the penetrating qualities, to permit the point to break off in the animal, to allow the head to slip out of the fore-shaft, and to promote bleeding" (Roberts 1935:17-18). Wormington (1957:29) and Frison (1982) suggest that fluting may have had no functional significance. Yet most would argue that, indeed, fluting was a means of facilitating the hafting of a point to a shaft (e.g. MacDonald 1968:76; Mason 1980:84; Snow 1980:124; Wilmsen 1974; Wilmsen and Roberts 1978:176-177).

Certainly there is ample independent evidence that these points were hafted, rather than hand held. Virtually all eastern fluted points, and for that matter many of the western fluted points, are ground on their basal and lateral edges (the extensive distribution of grinding in eastern fluted points was already evident to Roberts in 1935 [Roberts 1935:21]).

Lateral or edge grinding generally extends from the base of the point distally to approximately midway up the blade or sometimes to the widest point of the blade. The generally accepted interpretation is that grinding prevents the edges of the point from cutting the ties that bind the point to the haft (Goodyear 1974:32; Mason 1958:9; Roberts 1935:20-21; Shetrone 1936:16; Tunnell 1977:151; Witthoft 1952:484). There is, however, an additional hypotheses suggested for the function of grinding.

Judge (1973) argues that edge or lateral grinding was used instead of "pressure modification" to attain a desired basal width (Judge 1973:263-265). His argument is based on the observation that Clovis points with above average basal width are significantly associated with heavy grinding (Judge 1973:Table 17). Unfortunately, his conclusion is marred by the fact that pressure flaking is a much more efficient method of reducing the width of a point. Although the data are unavailable, I would predict, based on the information Judge presents, that the significant association of heavy grinding with above average basal width is in fact a manifestation of a more significant association between grinding and overall point size.

Based on studies of manufacturing sequences of Folsom points, Tunnell (1977:151) and others (Frison and Bradley 1980:51) suggest that grinding is one of the last stages in point production. The presence of this attribute can thus serve to distinguish finished from unfinished points: "preforms do not have obviously ground lateral edges, and points do" (Tunnell 1977:151).

An interesting variation on the theme that fluting served to haft the points, and one with possible implications for the origins of the technique, is the suggestion by Wilmsen (1974; Wilmsen and Roberts 1978) that fluting was an attribute borne out of necessity while traversing extensive, treeless tracts. According to Wilmsen (1974:52), attachment of a lanceolate point to a haft could have been accomplished in one of three ways: with fasteners, with adhesives, or by friction. There is no archaeological evidence for fasteners, and certainly much of the area occupied by Paleo-indian groups was treeless, thus Wilmsen (1974:52) suggests that friction was the most readily available holding agent. According to him, fluting, which increases and smoothes the contacting surfaces, would have expedited friction attachments (Wilmsen and Roberts 1978:177).

While I agree with Wilmsen that fluting would have made friction-hafts more efficient, I disagree that this reveals anything concrete about the environment in which this technique originated. Paraphrasing Gould and Lewontin (1979:587), one must not confuse the fact that an attribute can be used for some purpose with the primary historical reason for its existence and conformation.

Regardless of the origins of the fluting technique, Wilmsen still regards the function of fluting as a means of facilitating hafting. Yet, as mentioned, it has been suggested that fluting actually had little or no utilitarian purpose, that it was, perhaps, "purely aesthetic" (Snow 1980:124; Wormington 1957:29). After experimenting with hafting of all kinds of Paleo-indian points Frison (1982; see also Frison 1978) drew the conclusion

> that fluting must be related primarily to something other than functional utility in either the improvement of weaponry or as a response to a lack of adhesive material with which to attach a point to a shaft" (Frison 1982:451).

Frison's view of fluting, particularly as it occurred on Folsom points, was that it was extremely wasteful of the finest raw material, added little to the lethal qualities of the point, and therefore "was not done for functional purposes alone and may have become something more esoteric, such as an art form" (Frison 1982:451). The cost involved in fluting - the loss of stone and, more importantly, the high potential for breakage while fluting - suggests that ultimately there was a functional purpose behind fluting.

There are many lanceolate forms of approximately the same dimensions as fluted points, yet which lack fluting (e.g. the two distinctive western types, Midland and Plainview points, and the eastern form, Holcombe points). There are many forms of points with fluting on one side only. Mason (1981) raises the argument that "while fluting would seem to have facilitated hafting, it is not essential, to judge from later projectile points of similar _shape_ which lack it" (Mason 1981:84, emphasis mine). Mason's observation is well taken, but to my mind, the crucial variables are size and shape, not shape alone: his argument would be convincing were he able to demonstrate that later projectile points of similar shape _and size_ (particularly thickness) lacked fluting.

On the function of fluted points

It is generally assumed that the fluted points in eastern North America were "the armament on thrusting or throwing spears" (Mason 1981:85; see also Callahan 1979; Roosa 1977b). This functional interpretation is based on aspects of the point morphology and technology, as well as the implicit, and occasionally explicit, assumption that there is a high correlation between artifact form and artifact function (Ahler and McMillan 1976:166; Frison and Bradley 1980:59). It is curious, however, that different attributes and conflicting observations of the same attribute are sometimes cited in reaching the conclusion that these artifacts were projectiles.

For example, both Mason (1981:85) and Snow (1980:124-125) specify fluting, to haft and hold the blade, and grinding, to protect the lashing, as necessary indicators of a projectile function. Yet for Snow (1980) the "absence of barbs or even pronounced shoulders on the points ... indicate that the weapon was designed to penetrate deeply and retract easily" (Snow 1980:124, emphasis mine). For Mason, on the other hand,

> fluted points always exhibit sharply defined corners, or "ears", where basal and later edges meet. These would have functioned as very efficient barbs, and they can only indicate that the projectile points were not intended to be easily pulled out (Mason 1981:85, emphasis mine).

The question of whether these points were meant to be embedded in an animal or used for repeated stabbing (different functional activities that have implications for possible hunting tactics), distracts from a more important functional consideration. Shetrone, in his important early (1936) study of fluted points granted that "in the main the Fluted Blade served as a projectile point", but that after careful study of the Ohio fluted points he argues "they may have had an additional important function" as knife blades (Shetrone 1936:15-16). This conclusion is fortified by analysis of artifact wear. Snow (1980) offers the demurrer that "analysis of wear on fluted points suggests that some of them were used as knives" (Snow 1980:125; see also Lepper 1983c).

The interpretation that these tools have an added function as hafted knives is also supported by the heavy grinding these points exhibit on their bases and lower edges. Grinding, as noted above, is a means of prolonging the life of a haft, by preventing the edges of the hafted tool from cutting the bindings that attach the tool to a handle, spear shaft, or whatever. As Goodyear (1974:32; Goodyear et al. 1983:55) and others (Ahler and McMillan 1976:166) have argued, heavy grinding is necessary where a biface is used in a cutting mode. Goodyear (1974:32) notes that when a tool functions as a knife, the haft area is under severe stress from the working back and forth of the point in the process of cutting. If the point were hafted, using animal or vegetable wrappings, then "grinding would be more crucial than ever" (Goodyear 1974:32).

By contrast, the limited use life of a point that functions solely as a projectile does not present the same demands on the haft. In this instance the haft has only a split second of critical use-life and, more to the point, the stress on the haft works against the base, not against the sides.

The possibility that many of the eastern fluted points are multipurpose, hafted knives is supported by a number of other lines of evidence, direct and circumstantial. For one, the incidence of impact fractures, or flakes driven longitudinally from the distal tip of the point (Ahler and McMillan 1976:166; Goodyear 1974:32), is quite low in the overall sample of eastern fluted points (Meltzer 1983b), except for the points in particular localities and sites. Yet impact fractures are common in western bison kill sites (e.g. Frison et al. 1976:46).

Second, Ahler and McMillan (1976) make the argument that specialized hafted cutting tools are lacking in the early assemblages of the midwest and Plains, thereby making it more likely that "the earliest points ... were actually multipurpose, generalized implements" (Ahler and McMillan 1976:170).

Third, most of these artifacts, or at least the many isolates that I have examined, are generally not sharp at all. For comparative purposes it is useful to note that fluted points in the specialized kill sites of the west are extremely sharp, both on the point and blade edges, suggesting that these were designed to penetrate and kill large animals (Frison 1978:323, 337-338). As Frison (1978) argues,

> The attributes necessary for the proper functioning of a projectile point as a device to kill a large animal such as a bison are these: sharp point to penetrate the hide, sharp distal blade edges to open a hole for the remainder of the point and shaft, and a hafting element designed to absorb the thrust without splitting the shaft (Frison 1978:337-338).

These features are rare in eastern fluted points.

There is, then, ample reason to suppose that eastern fluted points may not have functioned solely - or at all - as projectiles. As was the case with "virtually all" the early (Dalton age) lanceolates and points from Rodgers Shelter (Ahler and McMillan 1976:167), it may be that the eastern fluted points are also combination projectile points and hafted cutting tools. In any case, a strict interpretation of these as projectile points alone is unwarranted, and this weakens the argument that the thousands of isolated points are remnants of widespread hunting.

Techniques of fluting

There are at least three fluting techniques commonly distinguished in studies of eastern fluted points; these are referred to as Enterline fluting, straight-based fluting (sometimes called Clovis fluting), and Folsom fluting (Grimes 1979:114-115; Mason 1958:12-14; Prufer and Baby 1963:7-9; Roosa 1965:90-92, Roosa 1977b:87-88; Storck 1983:86-87; Witthoft, in Byers 1954:347).

The technique of Enterline fluting was outlined by Witthoft in the early 1950s (Witthoft 1952, 1954). After an analysis of the lithic material from the Shoop site, Witthoft defined the "Enterline Chert Industry" (Witthoft 1952:464), one aspect of which was a unique means of fluting projectile points:

> When the thick-based blank had been roughed out and the preliminary shaping completed, basal thinning was started. In most cases, this began with the removal of two smaller channel flakes from one face of the blank .... The removal of these flakes served to isolate the central part of the base as a striking platform for removal of the central channel flake [flute] (Witthoft 1952:482).

In Witthoft's opinion, the Enterline industry had close ties to Denbigh material from the Arctic and Old World paleolithic industries, which in his view indicated considerable antiquity for the Shoop site and thus for the Enterline technique of fluting points (Witthoft 1954:271-272). On this evidence he in turn suggested that the Enterline multiple-flaked point preceded the Clovis type (Witthoft 1954:272).

Krieger (1954:274-275) subsequently rebutted the "Shoop-Denbigh-Old World Paleolithic axial relationship", and the notion that the presence of multiple fluting necessarily indicated great antiquity. Further, he argued Witthoft's "trend" of multiple fluting to Clovis to Folsom

> cannot be true because many Clovis points are themselves "triple-flaked"; that is, the flutes were made first with two parallel longitudinal flakes removed, followed by a central flute (Krieger 1954:274).

The notion that the Enterline fluting technique was somehow a technologically ancestral fluting form is invalid.

There are also serious doubts about the nature of the Enterline technique itself. In his important reanalysis of the original Shoop projectile points, Cox (1972:22) "searched diligently" for evidence of the Enterline chipping technique. He was unable to find it. Instead, he determined that multiple fluting was likely the result of reworking or possibly refluting of the points (Cox 1972:26), or perhaps correlated with the thickness of the blanks produced (Cox 1972:25-26). Certainly the former suggestion is compatible with the nature of the lithic industry at Shoop, as discussed in the previous chapter.

Grimes (1979:115) and Storck (1983:87) have elaborated on the latter suggestion. For these authors the necessary conditions requiring use of the multiple fluting technique were determined by "the degree of plano-convexity which persisted in the preform cross-section" (Grimes 1979:115). Multiple, lateral "guide" flakes would have been necessary on preforms with a relatively flat face, in order to isolate the course of the intended flute (Grimes 1979:115). Where a ridge sufficient to guide the flute existed on the preform, multiple fluting was unnecessary.

This would explain why certain points, particularly in the Bull Brook series with which Grimes was working, have multiple flutes on one side, and single flutes on the other (a pattern noted at Bull Brook by Byers [1954:347]). By the same token, it is not the complete explanation for, as Cox (1972:26) and others (Prufer and Baby 1963:9) observe, in some cases the lateral flutes were drawn after the main one (Cox 1972). Reworking and refluting may indicated in these cases. Mason (1958) has also raised the possibility that multiple fluting may reflect degree of proficiency: "many of the points showing multiple channel scars may really reflect subsequent attempts at fluting after the first had been somehow aborted" (Mason 1958:14).

The implication of all these observations is that there is no Enterline or multiple fluting technique per se, but that multiple fluting is a technological adaptation to a particular piece of stone or is a derivative of another procedure, such as fluting from a straight base (Grimes 1979; Storck 1983). Fluting from a straight base, as described by Mason (1958:12), begins with preparation of the fluting striking platform by means of beveling the base over to the plane of one of the faces (thus creating the striking platform). At this prepared point, the flute is detached from the face of the point. It appears that the original basal edge of these prefluted projectile point is straight, or even sometimes slightly convex (Mason 1958:12). The procedure is repeated for fluting the opposite face.

Fluting from a straight base has been referred to as Clovis fluting (Witthoft, in Byers 1954:347), but as Storck (1983:87) observes, there is no clear cut evidence for the Clovis fluting technique. Hence, the label is best ignored. The majority of the points in the Michigan and Ohio series are produced by fluting from a straight base (Mason 1958:14; Prufer and Baby 1963:9).

The third type of fluting technique present in eastern fluted points is Folsom fluting (Roosa 1965, 1977b, Roosa and Deller 1982). It is known, of course, that true Folsom projectile points are absent in the eastern Woodlands (except on the far western edge); however, a technique of fluting reminiscent of Folsom is present in a number of eastern fluted point forms.

The first detailed description of the original Folsom fluting technique was by Roberts (1935), based on the Lindenmeier Folsom assemblage. Although varying slightly in the details, his description has since been shown to be an essentially accurate account of Folsom fluting (Frison and Bradley 1980; Tunnell 1977). As briefly described by Roberts, in Folsom fluting

> a hump was left in the center of the concavity when the base was chipped. This formed the "seat" [platform] for the implement used to eject the flake.... Indirect percussion was employed .... When the groove had been obtained on one side, the nubbin was retouched, if necessary, and the process repeated on the other side (Roberts 1935:19).

The diagnostic feature of Folsom fluting is the carefully prepared, convex or nipple shaped, striking platform (Roosa 1965:93; Storck 1983:87). But in the absence of this feature, which is often lost in production, there are other attributes useful in distinguishing Folsom from straight-based or Enterline fluting (I continue to use the term Enterline for heuristic purposes as a synonym for points with multiple flutes; nothing more is implied by the use of the term).

Enterline fluting, of course, yields a series of flutes, each of approximately the same length and width; in Folsom fluting, there is a single flute and, distinct from fluting with a straight base, this flute is relatively long and wide, the length being "usually much greater than the basal width of the point" (Roosa 1965:92). Folsom fluting routinely produces blade-like flute scars, while Enterline and straight-based fluting produce flake scars (Roosa 1977b:87).

The three fluting techniques have no mutually exclusive or, for that matter, distinctive effects on the morphology of the base. Basal concavity is a function of the "length, and particularly, width and depth of a fluting scar" (Mason 1958:11; Witthoft 1952:484), as well as the initial form of the preform base, and the finishing techniques involved (Mason 1958:11). MacDonald (1968), for example suggests that the deep-based Debert points were produced with a variant of Folsom type fluting, and that the fluting and subsequent retouch of the base of these points led to their deeply concave base (MacDonald 1968:75; deep bases and Folsom fluting are also present at Bull Brook, see Grimes [1979:115]).

Typologies of eastern fluted points

There have been a number of attempts to develop typologies of eastern fluted points. These include the work of Dorwin (1966), Fitting (1965a, 1965b), Mason (1958), Prufer and Baby (1963), Rolingson (1964), and Roosa (1965; Wright and Roosa 1966) in the late 1950s and early 1960s, and more recently Gardner and Verrey (1979), Kraft (1973), and Roosa (1977a,1977b Roosa and Deller 1982). Despite the attention paid the problem, little agreement exists on either the various typological products (Haynes 1983:24-25) nor, for that matter, on the proper strategy for classification (Roosa 1965; Gardner and Verrey 1979).

For example, Prufer and Baby (1963) establish a typological scheme using "two main criteria - morphology and technology" (Prufer and Baby 1963:13). Six types result: Convex-parallel sided (which they label "Clovis"); Concavo-convex sided; Ross County; Pentagonal or shouldered; Triangular or convergent sided; and Cumberland points (Prufer and Baby 1963:13-18). Many of these same types are used by Dorwin (1966:152-165) and, partly, by Hyde (1960), Mason (1962), and Rolingson (1964:18). The first five types Prufer and Baby derive generally exhibit fluting from a straight base or Enterline fluting; the last exhibits Folsom fluting (Prufer and Baby 1963:7-9).

The approach used by these authors, and in more recent schemes (e.g. Kraft 1973), is, of course, based predominantly on overall blade morphology (Gardner and Verrey 1979:14). It is important to note, however, that blade morphology or shape has liabilities as a diagnostic criterion.

For one, there are the "nuances in form" (Mason 1958:14) that make difficult the precise assignment of points to types (see also Dorwin 1966). Second, and more important, Roosa (1965, 1977b; see also Gramly 1982:70) rightly calls attention to the effects of reworking and resharpening on the assignment of a point to a type. As he notes, the

> pentagonal fluted point "type" [of Prufer and Baby] consists primarily (if not entirely) of re-sharpened points while many of [their] triangular "type" fall in the same class. I might add that all of [their] "types" with the exception of the Ross County and Cumberland types ... are suspect because they deal only with outline shape (Roosa 1965:90).

Having had, myself, the opportunity to examine some of the very same points which Prufer and Baby illustrate as type specimens for the Pentagonal and Triangular types (e.g. Prufer and Baby 1963: Figure 6, middle, Figure 7, second and fourth from the left), I can only concur with Roosa's observation. Recent morphologically derived type schemes (Kraft 1973) are more cognizant of the effects of reworking on point typologies (Kraft 1973:66).

Roosa makes the additional argument that unfinished points also make outline shape an unreliable criterion for sorting fluting points (Roosa 1965:89). As he points out, many unfinished points have outlines that "vary substantially from that of the finished points of the same type" (Roosa 1965:89). A good example of this is Kraft's so-called "Pumpkin seed" points (Kraft 1973:67, Type 5b). McConaughy (1976), based on analysis of manufacturing sequences (Painter 1973; Prufer and Wright 1970) suggests that these points are preforms in an intermediate stage of manufacturing (McConaughy 1976:18). In support of McConaughy, it is interesting to observe that Gramly (1982:Plate 10:E) identified similarly shaped points as abandoned in manufacture. I am puzzled, however, by the apparent presence of basal and lateral grinding on Kraft's original "Pumpkin seed" points (Kraft 1973: Table 4), a feature unexpected were these points abandoned preforms. Nonetheless, the general argument, that preforms need not resemble finished products and thus might skew morphological typologies, is well taken.

Metric variability, particularly point size, is also used to distinguish point classes and points from various regions (e.g. Dorwin 1966:177; Fitting 1965a, 1965b; Gardner and Verrey 1979; Kraft 1977a, 1977b; Mason 1958). It has been observed that fluted points in the eastern and northeastern portions of North America tend to be smaller than their Great Lakes and midwestern counterparts (Dorwin 1966:177; Fitting 1965b:369; Mason 1958:44). As Mason observes, "northward and eastward from the St. Louis area fluted blades tend to become progressively smaller, not only in average size but in their minimum maximum length range" (Mason 1958:44).

In addition, analysis of fluted points from New Jersey localities indicates modality in point size classes (Kraft 1977a:272-273). Distinctly small stubby points occur throughout New Jersey (Kraft 1977a), at sites in New York (Kraft 1977b), and in Connecticut (Moeller 1980).

It is difficult to infer what meaning, if any, can be attributed to this variation (Mason 1958:44). MacDonald observes that "size is evidently a poor attribute for establishing temporal or spatial relationships between fluted point finds over a broad area" (MacDonald 1968:76-77). The multi-modality that Kraft (1977a) observes in the New Jersey points may reflect only different stages in the manufacture or use life of these tools. The reason for this is, as Roosa (1965:90) notes, because many fluted points have been resharpened.

Goodyear et al. (1983:53) in their study of Florida points observe that the blade, and particularly the tip, is the area of the point that receives the greatest maintenance. A similar conclusion was reached by Judge (1973:83). This is "in contrast with later Dalton and notched point forms of the Early Archaic, the hallmark of which is intensive resharpening of blade edges, often leaving a shoulder" (Goodyear et al. 1983:53; see also Goodyear 1974). In the case of fluted points, resharpening means length will be poorly correlated with other point attributes (Judge 1973:83).

Kraft (1977a), however, has suggested that the small points were not reworked, but instead were deliberately made small despite "access to some of the finest lithic materials" (Kraft 1977a:279). It may be, as Tunnell (1977) suggests, that small points also resulted when various types of breakage during the manufacturing process reduced the length of the preform (Tunnell 1977:143-144).

In contrast to the views that size is a consequence of technological processes, Dorwin (1966:177) subscribes to the hypothesis that the smaller points were deliberately fashioned to kill smaller game. Kraft partly follows this line (1977a:279), but recognizes too that small points would have been equally serviceable against large game (Ahler and McMillan 1976:166; Frison 1978). This is clear by the varying sizes of the Clovis points at Naco and Lehner.

It is intriguing to note in this regard the suggestion by Goodyear et al. (1983:53-55), that small points were actually more likely to have served as projectiles than large points. They base this suggestion on the assumption that relatively large points would not allow "the penetration required for spearing and thrusting" (Goodyear et al. 1983:53).

A third criterion commonly utilized for sorting fluted points into types is fluting technique. This strategy is partly used, as mentioned, by Prufer and Baby (1963) and others (Mason 1958; Dorwin 1966; Rolingson 1964), but it is given greatest attention in the schemes formulated by Roosa (1965; Roosa 1977a, 1977b; Roosa and Deller 1982). The rationale for paying close attention to fluting techniques is that

> each fluting technique involves a cluter of attributes which are related to culturally transmitted motor habits. Thus the fluting techniques should be of considerable cultural-historical significance (Roosa 1965:90).

Gardner and Verrey (1979) contest this, arguing that fluting technique is highly idiosyncratic, varying "from site to site, within one site, and even possibly between points made by one flint knapper" (Gardner and Verrey 1979:19). Nonetheless, there is sufficient evidence to indicate that useful spatial/temporal patterns exist in the broad distribution of fluting techniques (Wright and Roosa 1966).

A fourth and final criterion for classifying fluted points is basal finishing techniques (Roosa 1965:90). There is good reason to suppose that these features may prove to be the most valuable in determining useful stylistic variation in these points. As Wilmsen and Roberts (1978:108) argue:

> only those parts of points that remain relatively unaffected by breakage and reformation can be supposed to present a reasonably accurate indication of original shape (see also Gramly 1982:70).

Invariably the most "unaffected" part of a projectile point, the part best protected from the vagaries of use, resharpening and reworking, is the proximal or basal end. Buried in the haft, this end survives "even after heavy reworking" (Gramly 1982:70). Variation in the depth of basal concavity, the presence/absence of ears, and other aspects of basal preparation have great potential for indicating spatial and temporal types (Funk 1972:18; Gramly 1982:70-71; Roosa 1977b:95; Roosa and Deller 1982).

A stylistic classification of eastern fluted points

The preceding discussion has illuminated a number of facts that are valuable in developing a classification of eastern fluted points.

1. Fluted points are hafted; the point features directly related to haft use are fluting and lateral and basal grinding.

2. While fluting has a hafting function, and occurs in all points, there are various alternative procedures by which a flute can be produced, and those differences include both the kind of flute produced and the number of flutes produced. It may be that those fluting types are potentially stylistic in character (Frison 1982).

3. Not all eastern fluted points, perhaps not even a majority, were used as projectiles. This is supported by evidence from tool wear, grinding, the absence of impact fractures, absence of other specialized hafted cutting tools, and the fact that the edges of these points are extremely dull.

4. Because many of these tools were used as knives, there is a great deal of resharpening and reuse of the blade portion of the point. Blade resharpening and reuse is likely the factor that introduced ambiguity into many of the existant classification schemes based on overall shape.

A stylistic classification of fluted points must avoid attributes related to the blade portion of the points, for these attributes will be dominantly functional in character. As an aside, it would be extremely valuable to develop a <u>functional</u> classification of eastern fluted points, now that it is clear that such variation exists. But such a classification is beyond the scope of this thesis, since the relevant data on point reworking and blade reduction is reported irregularly at best, it is quite difficult to discern such information from photographs and, as pointed out earlier, necessary data on the environmental setting of isolated fluted points is lacking.

A stylistic classification should therefore be directed toward the proximal portion of the point, where the original morphology of the point would have been buried and thus protected in the point haft. To illustrate how well protected the proximal portion of the point is from the vagaries of use, I note the fact that the most common breaks on eastern fluted points are lateral snaps that occur approximately midway up the point (Meltzer 1983b). Such snaps are likely breaks that took place when a point was levered in its haft. Breaks in the proximal or basal region of these points, such as broken ears or corners, are relatively uncommon, despite the fact that corners and ears are among the thinnest and thus structurally among the weakest areas of the points.

Of the features on the proximal end of the point, basal and lateral grinding are probably of little value in a stylistic classification. The presence of grinding can be used to distinguish finished and unfinished points, but since grinding is present on all finished points, with little apparent variation between points, its ability to distinguish style classes is limited.

Fluting, however, should be more important. While it too is present in all points, the kind of flute varies. In eastern fluted points there are a number of distinct fluting techniques, which produce, in essence, two kinds of fluting scars: blade-like fluting scars, and flake-like fluting scars. Roosa (1965, 1977b) has suggested these exhibit historical patterning. Regardless of the function fluting may have served, it is clear that different techniques of fluting are potentially useful attributes in a stylistic classification.

Single versus multiple fluting is likely a feature related to the specific constraints imposed by a particular piece of stone, and thus would be expected to show essentially individual variation among fluted points. Nonetheless, because the number of flutes do vary across the population of fluted points, and potentially exhibits significant variability within a single assemblage of fluted points, it is useful to include this measure in a stylistic classification. In a large and spatially well-documented sample of points the number of flutes may prove valuable in fine-scale sorting of fluted point classes. On the other hand, in a small sample the number of flutes may mask important variability, by dispersing points across many different classes. Since quantitative data can always be reduced to qualitative categories, and never the reverse, the efficient analytical strategy is to include the more detailed information, then condense it later if it proves an obstacle in analysis.

The basal concavity of fluted points does not appear to be dependent on the kind of fluting technique used, and therefore is also a potentially valuable attribute in a stylistic classification. The depth of basal concavity, as Gramly (1982) has suggested, is purposely set by manufacture, and not as a consequence of fluting.

Lateral morphology of the proximal end of the point varies as well among eastern fluted points (Roosa 1965) and, in fact, is considered diagnostic of particular forms (Gramly 1982). There is no apparent functional derivation of this feature.

Three other features of the proximal portion of fluted points, not yet discussed, may prove valuable in a stylistic classification. These are features that, after having personally examined a few hundred points, appear to differentiate certain point forms. These features are the morphology of the corners of the point, the post fluting retouch or finishing of the point base, and the flaking pattern evident on the surface of the point. These were not attributes that varied significantly across all points; instead, they seemed to be useful in distinguishing particular kinds of points. Without getting ahead of myself, let me simply state here that these features nicely sorted the traditional Cumberland forms from other fluted point types, but were not especially valuable in distinguishing among the many other forms of fluted points.

These various features of the point base can be included in a stylistic classification as quantitative or qualitative variables. My initial attempt at deriving a classificatory scheme for eastern fluted points focused on a set quantitative variables. On all the points I personally examined, I measured point length, width and thickness; fluting length, width and frequency (both faces); basal width and distance from the base to the point of maximum width; basal concavity; and extent of lateral grinding.

Unfortunately analyses of the variation in these quantitative variables proved inconclusive (Meltzer 1983b, unpublished). Groupings of any sort, let along groupings with significant spatial or temporal patterning were not detected. Whether this was a consequence of the measurements used or the nature of the sample is unknown.

Subsequently, I turned to the analysis of a series of qualitative attributes related to basal morphology and fluting technology of fluted points. Based on the information just reviewed, I developed a paradigmatic classification (Dunnell 1971) with 6 dimensions and 39 modes. The classification is as follows:

DIMENSION A: Lateral edge morphology of the haft region.

1. Parallel - the edges of the haft region are parallel, with the basal width being the same as the width at the top of the haft;
2. Tapering - the edges of the haft region converge toward the base, with the basal width being less than the width at the top of the haft;
3. Triangular - the edges of the haft region diverge outward from the base, with the basal width being greater than the width at the top of the haft;
4. Incurvate - the edges of the haft region describe concave lines from the base to the top of the haft;
5. Stem - the edges of the haft region form a shoulder at the top of the haft;
6. Excurvate - the edges of the haft region describe convex lines from the base to the top of the haft;
7. No information.

DIMENSION B: Morphology/technology of the flute scar. As defined above, blade flute scars are those twice as long as they are wide, while flake flute scars are less than twice as long as they are wide.

1. Single, blade flute scar each side;
2. Multiple, blade flute scars each side;
3. Single, flake flute scar each side;
4. Multiple, flake flute scars each side;
5. Single blade scar/multiple blade flute scars;
6. Single blade scar/single flake flute scar;
7. Single blade scar/multiple flake flute scars;

8. Multiple blade scars/single flake flute scar;
9. Multiple blade scars/multiple flake flute scars;
10. Single flake scar/multiple flake flute scars;
11. Unfluted/single blade flute scar;
12. Unfluted/multiple blade flute scars;
13. Unfluted/single flake flute scar;
14. Unfluted/multiple flake flute scars;
15. No information.

DIMENSION C: Basal morphology:

1. Straight - the basal edge describes a straight line between the corners;
2. Elliptical - the basal edge describes a concave line between the corners, with the length of a perpendicular line constructed from the cord to the apex of the arc not exceeding one-fourth the length of the cord drawn between the corners (Binford 1963:208);
3. Circular - the basal edge describes a concave line between the corners, with the length of a perpendicular line constructed from the cord to the apex of the arc exceeding one-fourth the length of the cord drawn between the corners (Binford 1963:208);
4. Triangular - the basal edge describes a bivectorally concave line between the corners, the vectors being relatively straight and connected by a short arc (Binford 1963:208);
5. No information.

DIMENSION D: Corner morphology:

1. Ears absent - no projections, or projections less than 3 mm in width from the main portion of the base;
2. Ears present and project downward - projections of greater than 3 mm in width downward from the main portion of the base;
3. Ears present and project outward - projections of greater than 3 mm in width outward from the main portion of the base;
4. No information

DIMENSION E: Post fluting retouch or basal finishing:

1. Present on one face - fine finishing flakes present along the base of the point and flute scar present on one face;
2. Present on both faces - fine finishing flakes present along the base and flute scar on both faces;
3. Absent - base and flute scar shows no flaking subsequent to fluting;
4. No information.

DIMENSION F: Flaking pattern

1. Regular parallel - flakes on point face of uniform width, perpendicular to edge, and parallel in alignment (Crabtree 1972:80);
2. Collateral - flakes on point face irregular in size expanding from edge but regular, collateral alignment (Crabtree 1972:52);
3. Random - flakes on point face multidirectional and multi-form (Crabtree 1972:86);
4. No Information.

The dimensions and modes in this classification are mutually exclusive, so that each point is assigned to one and only one attribute within a dimension. As is the case with all dimensional classifications, the label for a class is derived from the numbered mode scores on each dimension, in order. For instance, a point identified to class 1032133 has parallel sides (1), single flake fluting on each side (03), an elliptical base (2), no ears (1), lacks post fluting retouch (3), and has random flaking (3).

Applying the stylistic classification

The sample

The sample of isolated fluted points analyzed here is a combination of data from published and unpublished sources. In compiling this sample, I excluded fluted points from site contexts. I included only finished fluted points, as recognized by the presence of basal or lateral grinding (Frison and Bradley 1980:51; Tunnell 1977:151). This was done to avoid the problem, raised by Roosa (1965), that many unfinished points vary substantially in morphology and technology from finished points of the same type. Finally, I included only those points from the published literature where I could determine - whether from the text, photograph or line drawing - the fluting patterns on each face of the point.

There are 1039 fluted points in my sample, and all are grouped in Table 23 according to the state in which they were found. All subsequent discussion and analysis of the fluted point data use the state as the minimal spatial unit, since this is the smallest common spatial unit in which these data can be arranged.

Each of the isolated points in the sample, along with points from certain of the sites for which I was able to obtain data, are listed in Appendix I. It is important to admit at the outset that this is a grab-bag sample, dictated by the exigencies of the classificatory scheme, the limitations in the published literature, and the limited opportunities I had to visit collections. As such, no claims are made that the state by state counts in Table 23 are a valid statistical representation of the abundance of fluted points in the various eastern states.

TABLE 23. Frequency of fluted points by state in sample.

State	Number of points	State	Number of points
Alabama	3	New York	57
Delaware	10	North Carolina	97
Georgia	9	Ohio	116
Illinois	3	Pennsylvania	34
Indiana	5	South Carolina	13
Kentucky	19	Tennessee	95
Maryland	2	Virginia	382
Michigan	70	West Virginia	12
Mississippi	3	Wisconsin	69
New Jersey	35	State unknown*	5

* Museum collection points that lack information on discovery locality

In fact, it is even difficult to estimate the representativeness of the sample, since so little is known of the relevant population parameters. The only proxy measure of the population that one might conceivably use for such purposes are the 6000 fluted points reported from the various eastern states (e.g. Brennan 1982; Seeman and Prufer 1982). But even these state by state counts may not be a reliable model of the frequency distribution of the population of eastern fluted points. Like my smaller sample of points, these counts are also a consequence of the varying levels of collection and reporting detail of fluted points across the east (e.g. individual isolated points from Virginia are well reported, individual isolated points from Kentucky are not), and the access to those materials.

Regardless of whether my sample is numerically representative of the distribution of eastern fluted points, which it may or may not be, it is almost certainly representative of the different types of fluted points. That is, there are no apparent biases in the collection and reporting of fluted points that would tend to result in collections of certain kinds or types of fluted points and not others.

If there is a bias in the collection or reporting of fluted points, it is the tendency to report only whole, unbroken points. Unless certain point types break more often than others - which is unlikely - then this bias should not have a significant effect on the kind of points that make their way into the literature and compose my sample.

The data in this sample are thus useful for a stylistic analysis of fluted point types, and of the spatial and temporal variability in fluted points. Nonetheless, due to the sample vagaries it will be necessary to pay careful attention to the relationship between the presence/absence of a point type in an area and the size of the sample of points from that same area. For with samples of such varying size, the meaning of the presence/absence of a particular point type will vary with whether the sample from which that point type is derived is large or small. For example, the absence of an uncommon type may have little meaning in a state with a particularly small sample, but would be quite significant in a state with a large sample. The reverse of this is also true. A relatively high frequency of a point type in a state with a small sample is not nearly as informative as would be the relatively high frequency of a particular type in a state with a larger sample of points.

Classifying points in the sample

In the course of the analysis and classification of the points in the sample it became evident that there was insufficient data in the published record to include one of the dimensions - Dimension F (Flaking pattern). However I did note that in the sample that I was able to examine personally, 80% of the points were assignable to Mode 2 (Collateral flaking).

Eastern fluted projectile points, or at least most that I have studied, are dominantly flaked by soft-hammer percussion techniques. This makes parallel flaked points quite rare, which in turn makes this dimension a poor attribute for discriminating within my sample. Hence, irrespective of the value this dimension might have, it was excluded in the first instance from further analysis. Future applications of this classification to a larger and better described sample could profitably utilize this dimension as there is no immediately apparent functional significance or variability in this dimension.

Excluding Dimension F, the classification yields 3024 possible classes (6x14x4x3x3=3024). Only 336 (32%) of the 1039 points can be identified with one of these 3024 classes. The remaining 703 points cannot be identified to class because they lack certain data required by the classification for assignment. The distribution of points by class is uneven. The majority of classified points (287/336) are in classes having less than 10 members (on average, each of these classes has only 1.67 members). Only a small portion of the points - 49 altogether - are in large classes, classes with more more than 10 members each (Classes 103323, 110213, 201323 and 203323).

This uneven distribution of points across classes poses some significant analytical and interpretive problems. The goal of the classification is a set of categories that are stylistic in derivation and that can be used in partitioning eastern fluted points in time and space. Yet a map of the 172 classes having less than 10 members each would be, at best, difficult to interpret. Indeed, such a map would be little more than an index to the location of individual fluted points, informing little on significant patterns of attribute variation across the eastern states. A map of the 49 points in the four large classes would also not be of great value, since this would reflect only 5% of the total sample.

If the classification of the points in a sample such as this is to have value, then one must aim to create the largest number of mappable categories by maximizing the number of points treated and maximizing the number of classes with numbers sufficient for mapping. To accomplish this requires either the addition of points to the sample, impossible under the present circumstances, or the modification of the classification so as to reduce the number of possible classes and thus increase the totals of each class.

In this analysis I took the latter approach, and derived a classification using Dimensions A, B, C, and D with a modified form of Dimension B. This was accomplished in a straightforward manner. First, I examined the distribution of points across classes when various combinations of dimensions were used. These data are shown in Table 24. This table includes for each combination the number of potential classes (POT), the number of classes actually filled by at least one member (ACT), the frequency and percentage of points in large classes (LC), the frequency and percentage of points in small classes (SC), and the frequency and percentage of points that could not be assigned to classes (NA). For comparative purposes, I included the data for all five dimensions (just discussed).

The various combinations were evaluated to determine which of the combinations maximized the number of dimensions, and at the same time maximized the number of points in large classes (defined, again, as those with greater than 10 members), had high average membership within those large classes, minimized the number of points in small (less than 10 member) classes, and minimized the number of points that could not be assigned to a class for want of information. Meeting these criteria would serve to produce the largest number of mappable classes.

TABLE 24. Distribution of projectile points across classes, various combinations of dimensions

			NUMBER OF POINTS	
DIM	POT/ACT	LC (%)	SC (%)	NA (%)
ABCDE	3024/176	49 (5%)	287 (28%)	703 (67%)
ABCD	1008/147	170 (16%)	318 (31%)	551 (53%)
ABDE	756/114	104 (10%)	234 (23%)	701 (67%)
ABCE	1008/140	91 (9%)	247 (24%)	701 (67%)
ACDE	216/60	183 (18%)	162 (16%)	694 (66%)
BCDE	504/114	127 (12%)	215 (21%)	697 (67%)
ABC	336/116	244 (23%)	248 (24%)	547 (53%)
ABD	252/92	287 (28%)	206 (20%)	546 (53%)
ABE	252/80	162 (16%)	179 (17%)	698 (67%)
ACD	72/48	774 (74%)	78 (8%)	187 (18%)
ACE	72/35	250 (24%)	97 (9%)	692 (66%)
ADE	54/29	269 (26%)	78 (8%)	692 (66%)
BCD	168/85	292 (28%)	203 (20%)	544 (52%)
BCE	168/67	190 (18%)	154 (15%)	695 (67%)
BDE	126/64	188 (18%)	156 (15%)	695 (67%)
CDE	36/26	293 (28%)	58 (6%)	688 (66%)

Examination of the Table 24 data indicates that combinations which include Dimension E (post fluting retouch) show a significant increase in the number of points that cannot be assigned to classes. Irrespective of its value, this dimension is not particularly helpful here since information is missing on most items in the sample, and thus this dimension was excluded from further analysis.

Of the various other combinations, ABCD appeared to best fit the stipulated criteria. It retained most of the original dimensions; it had lower numbers of points unassignable to classes; and it had the highest number of large classes of the four dimension combinations. However most of the points fell into the small classes. Since this combination had an inordinately high number of classes as a consequence of the inclusion of Dimension B (with 14 modes), this suggested that a further reduction of the modes in Dimension B might be useful.

Toward this end, I modified this Dimension into 4 basic modes: blade fluting, flake fluting, mixed (blade and flake fluting), and unknown, as shown in Table 25. In essence, I removed the quantitative aspect of Dimension B by excluding the data on the number of flutes.

TABLE 25. Modification of modes in Dimension B

Mode numbers	Modified mode number - description
1, 2, 5, 11, 12	1 - blade fluting
3, 4, 10, 13, 14	2 - flake fluting
6, 7, 8, 9	3 - mixed blade and flake fluting
15	4 - fluting type unknown

Recall that I earlier made the argument that the number of flutes was likely a result of a number of factors, which included such things as the degree of plano convexity of the preform, the skill of the knapper in executing a flute or, simply, the thickness of the preform (Cox 1972; Grimes 1979; Mason 1981; Meltzer 1983b; Storck 1983). I included a measure of the number of flutes in Dimension B on the assumption that in a large sample it might prove useful in distinguishing fine-scale style classes, but included the caveat that it might be later modified if it proved to be of little use. While it has not proved to be of little use, it is an obstacle to the application of the classification, and is thus excluded. On a larger, better documented sample, a measure of this sort has potential value.

Using this modified version of the classification has its advantages, insofar as it increases the number of mappable classes. Unfortunately, it has its disadvantages as well. There is no way to know what effect modifying the classification has had on efforts to discriminate time/space, because the value of the deleted elements cannot be ascertained. Larger numbers of points and a better distributed sample might have allowed the use of more variable elements that discriminate far better.

The modified combination ABCD produces a possible 216 classes, of which 75 have members. As was the case with the unmodified combination ABCD, there are only 551 points that cannot be assigned to classes. But in contrast to the unmodified ABCD, the number of points in large and small classes is reversed. Of the remaining 488 points, 323 fall into the 15 large classes, while 165 fall into the 60 small classes.

The focus of subsequent analyses in this chapter is on the 323 points in the 15 large classes (which represent 31% of the entire sample of points). I am approaching the analysis in this manner since the larger the individual class, the more realistic the generalizations that can be drawn regarding spatial variation in projectile point classes. Sixty maps of the small classes showing, on average, only 3 points each, would not be especially informative.

But this brings up an interesting issue: what is the relationship between the set of 323 points in 15 large classes, and the 165 points in 60 small classes? And what accounts for the many small classes? Do these large and small classes differ in kind as well as degree?

In terms of their spatial distribution, the large and small classes do not appear to be distributed across the states in different proportions. Table 26 gives the frequencies of points in large classes (LC) and small classes (SC) across the states in the sample. Those two frequency distributions are highly correlated (r= .93), suggesting that rarer items (small classes) have a spatial distribution similar to more abundant items.

TABLE 26. Distribution of points in large and small classes, using modified dimensions ABCD

State	Number of points LC	SC	State	Number of points LC	SC
Alabama	0	1	New York	33	16
Delaware	1	0	North Carolina	56	32
Georgia	6	3	Ohio	62	23
Illinois	2	1	Pennsylvania	17	9
Indiana	4	1	South Carolina	9	2
Kentucky	9	7	Tennessee	48	33
Maryland	2	0	Virginia	53	17
Michigan	1	1	West Virginia	4	1
Mississippi	1	1	Wisconsin	1	1
New Jersey	1	5	Unknown	2	3

However, the large and small classes have significantly different distributions of modes. Table 27 uses the chi-square and adjusted residual statistics to compare the distribution of modes across the large (LC) and small (SC) classes. In each case, the distributions are significantly different from one another.

In the case of Dimension A, large classes contain a disproportionate number of parallel sided points, and significantly underrepresent points with incurvate, stem or excurvate sides. For Dimension B, large classes are disproportionately flake fluted, and underrepresented by mixed blade and flake fluted points. With Dimension C, large classes have a disproportionate number of points with circular bases, and are underrepresented by points with triangular bases. Finally, with Dimension D, large classes are under-represented for points lacking ears, and overrepresented for points with ears projecting downward.

These patterns can perhaps be best summarized by stating that, as might be expected, the large classes are generally underrepresented in terms of the less frequent modes - such as incurvate, stem and excurvate sides, blade and flake fluting, and triangular bases.

What these data indicate is that the points in the large classes are probably not representative of the range of modes present in eastern fluted points, but rather they load heavily into certain modes. Now precisely what this means is obscure. For it may be that the modes which are rare or underrepresented in these large classes are, in fact, generally rare in all eastern fluted points. On the other hand, while common in the places poorly represented in the sample (Table 26), they might be common in particular periods of time not well represented by the sample either by accident or by virtue of rapid change. Given the nature of my sample, and its unknown relationship to the population of eastern fluted points, such a matter cannot be resolved. But as mentioned earlier, I have no reason to believe that the sample I am dealing with is biased by type. Hence, it seems reasonable to treat the mapped products from the 15 large classes as informing on those points being mapped, and perhaps representing the main forms of eastern fluted points.

This in turn raises the issue of what the small classes mean. For if the 15 large classes are reasonably construed as marking important stylistic classes, then what of the points that do not fall

TABLE 27. Distribution of modes in large (LC) and small (SC) classes.

DIMENSION A

	Mode					
	1	2	3	4	5	6
LC	171	98	27	27	0	0
SC	35	44	20	50	3	13

Chi-square = 96.22 p<.001

	6.71	.84	-1.33	-6.29	-2.43	-5.11
Adjusted Residuals:	-6.71	-.84	1.33	6.29	2.43	5.11

DIMENSION B

	Mode		
	1	2	3
LC	103	220	0
SC	54	91	20

Chi-square = 39.98 p<.001

	-.18	2.81	-6.38
Adjusted residuals:	.18	-2.81	6.38

DIMENSION C

	Mode			
	1	2	3	4
LC	12	140	160	11
SC	7	68	58	32

Chi-square = 38.61 p<.001

	.28	.45	3.02	-5.89
Adjusted Residuals:	-.28	-.45	-3.02	5.89

DIMENSION D

	Mode		
	1	2	3
LC	95	201	27
SC	66	78	21

Chi-square = 10.18 p<.01

	-2.35	3.15	-1.53
Adjusted Residuals:	2.35	-3.15	1.53

into these categories? Are they simply variations on certain formal themes? Again, the limitations of my sample make it difficult to draw firm conclusions on this matter, but three possibilities are apparent.

First, it may be that the many small classes represent forms manufactured for only a brief period of time, or forms that are highly localized in space. This possibility implies a genuine sampling problem exists: there may be extremely rare forms of points that likely will not appear to be significant or detected in sufficient quantities except in the very largest of samples. If these small classes are short-lived or transitional forms, a larger sample of points when mapped should show these classes to be markedly restricted in their spatial distribution.

Second, it may be that the many small classes are a consequence of technological variation - such as differences in raw material or idiosyncratic variation among knappers. This kind of variation is irrelevant to the purpose of the this classification, but a detailed technological analysis of the points in these classes should reveal whether the myriad of forms are situational to particular rock forms or places.

Finally, the many small classes may simply be random outliers, which for reasons unrelated to either technology, raw material, or temporal/spatial patterning do not conform to the major types. In this case the variability is again irrelevant to the goals of this analysis, but one can suggest that when larger samples are obtained and examined in detail it should be possible to discern whether the variability is random.

The 15 large classes produced by the modified combination ABCD are listed and described in Table 28.

TABLE 28. Description of the 15 large classes: modified ABCD

Class	Description
1121	Parallel-sides with blade fluting, elliptical base but no ears. (n=10).
1132	Parallel-sides with blade fluting, circular base with ears projecting downward (n=16).
1211	Parallel-sides with flake fluting, straight base and no ears (n=12).
1221	Parallel-sides with flake fluting, elliptical base but no ears (n=51).
1222	Parallel-sides with flake fluting, elliptical base with ears projecting downward (n=27).
1232	Parallel-sides with flake fluting, circular base with ears projecting downward (n=44).
1242	Parallel-sides with flake fluting, triangular base with ears projecting downward (n=11).
2132	Tapered-sides with blade fluting, circular base with ears projecting downward (n=35).
2221	Tapered-sides with flake fluting, elliptical base but no ears (n=22).
2222	Tapered-sides with flake fluting, elliptical base with ears projecting downward (n=17).
2232	Tapered-sides with flake fluting, circular base with ears projecting downward (n=24).
3132	Triangular-sides with blade fluting, circular base with ears projecting downward (n=15).
3232	Triangular-sides with flake fluting, circular base with ears projecting downward (n=12).
4123	Incurvate-side with blade fluting, elliptical base with ears projecting outward (n=13).
4133	Incurvate-sides with blade fluting, circular base with ears projecting outward (n=14).

Mapping the distribution of the large classes

As suggested earlier, if spatial/temporal variation exists in point classes it should be evident in a map of the distribution of the classes. I have mapped the distribution of the 15 large classes across the eastern states, but before those maps are discussed in detail some comments on their derivation are in order.

The basic data for the maps are given in Tables 29 and 30. The former lists the absolute frequency of point types by state, the latter the percentage of each type within a state. Maps based on the percentages of types within states (Table 30) are the primary focus of analysis, for the simple reason that my samples vary markedly in size, and that size variation cannot be construed as representing actual differences in the density of points. Were one to consider just the frequency data (Table 29), it would appear as though all types were concentrated in North Carolina, Ohio, Tennessee and Virginia, the states with the largest samples.

While using the percentage data will suppress the sample size vagaries, the percentage data alone are not without problems. The major problem is that the percentage data inflate the apparent concentration of types in small samples. For this reason, while discussion centers on the percentage based maps, I freely utilize the frequency data from Table 29. In addition, each map includes a reduced inset showing the frequency distribution. These will serve as checks as to whether the evident patterns are a consequence of sample size or closed arrays.

TABLE 29. Frequency of large classes by state: modified ABCD

	7	9	11	12	15	18	20	22	28	30	31	33	36	38	40	44	46	47	99	
CLASS	DE	GA	IL	IN	KY	MD	MI	MS	NJ	NY	NC	OH	PA	SC	TN	VA	WV	WI	UN	SUM
1121	1	0	0	0	0	0	0	0	0	0	0	1	0	1	5	0	1	0	1	10
1132	0	0	0	0	1	0	2	0	0	3	2	5	0	0	2	1	0	0	0	16
1211	0	0	0	0	1	1	0	0	0	0	5	0	1	1	1	2	0	0	0	12
1221	0	2	0	1	2	0	2	0	0	1	11	10	2	1	6	12	0	0	1	51
1222	0	2	0	0	0	0	0	0	0	2	4	5	3	2	2	7	0	0	0	27
1232	0	0	1	1	2	0	1	0	1	4	6	8	4	1	7	7	0	1	0	44
1242	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	3	1	0	0	11
2132	0	0	1	0	0	0	3	1	0	11	5	10	1	1	1	0	1	0	0	35
2221	0	0	0	1	1	0	1	0	0	2	5	2	1	0	3	5	1	0	0	22
2222	0	0	0	0	0	0	1	0	0	1	3	3	1	0	0	8	0	0	0	17
2232	0	0	0	0	1	0	1	0	0	2	7	8	1	0	0	4	0	0	0	24
3132	0	0	0	0	0	0	1	0	0	2	5	3	1	0	3	0	0	0	0	15
3232	0	1	0	0	0	0	0	0	0	3	2	0	1	1	0	4	0	0	0	12
4123	0	1	0	0	0	0	0	0	0	1	0	3	0	0	8	0	0	0	0	13
4133	0	0	0	1	0	0	0	0	0	1	0	3	0	0	9	0	0	0	0	14
SUM	1	6	2	4	9	2	12	1	1	33	56	62	17	9	48	53	4	1	2	323

TABLE 30. Percentage of large classes by state: modified ABCD

	7	9	11	12	15	18	20	22	28	30	31	33	36	38	40	44	46	47	99
CLASS	DE	GA	IL	IN	KY	MD	MI	MS	NJ	NY	NC	OH	PA	SC	TN	VA	WV	WI	UN
1121	100	0	0	0	0	0	0	0	0	0	0	2	0	11	10	0	25	0	50
1132	0	0	0	0	11	0	17	0	0	9	4	8	0	0	4	2	0	0	0
1211	0	0	0	0	11	50	0	0	0	0	9	0	6	11	2	4	0	0	0
1221	0	33	0	25	22	0	17	0	0	3	20	16	12	11	13	23	0	0	50
1222	0	33	0	0	0	0	0	0	0	6	7	8	18	22	4	13	0	0	0
1232	0	0	50	25	22	0	8		100	12	11	13	24	11	15	13	0	100	0
1242	0	0	0	0	11	50	0	0	0	0	2	2	6	11	2	6	25	0	0
2132	0	0	50	0	0	0	25	100	0	33	9	16	6	11	2	0	25	0	0
2221	0	0	0	25	11	0	8	0	0	6	9	3	6	0	6	9	25	0	0
2222	0	0	0	0	0	0	8	0	0	3	5	5	6	0	0	15	0	0	0
2232	0	0	0	0	11	0	8	0	0	6	13	13	6	0	0	8	0	0	0
3132	0	0	0	0	0	0	8	0	0	6	9	3	6	0	6	0	0	0	0
3232	0	17	0	0	0	0	0	0	0	9	4	0	6	11	0	8	0	0	0
4123	0	17	0	0	0	0	0	0	0	3	0	3	0	0	17	0	0	0	0
4133	0	0	0	25	0	0	0	0	0	3	0	3	0	0	19	0	0	0	0

The maps were produced by a computer cartographic system, the SYMAP mapping package (for an evaluation of this package and its archaeological application, see Jermann and Dunnell 1979). All of the maps are contour maps, representing the density of point classes by state. It is important to recognize that any maps produced are only one set "of an infinite series of possible maps that can be drawn from the same data" (Jermann and Dunnell 1979:32). That is to say, the maps that follow are not, in themselves, the only possible spatial representations of the data. There are decisions made in producing these maps that make these solutions meaningful for the data at hand and useful for analysis.

In the SYMAP program, one can select a number of features that directly determine the structure of a map. The two that most significantly effect the product are the selection of the number of classes and the selection of the limits of those classes. Given the size of the classes in the sample, and the large number of states with zero values, the decision was made to use 4 intervals; in non-numerical terms, the intervals are zero, low abundance, medium abundance and high abundance. The limits of those intervals were established using geometric progressions (Jermann and Dunnell 1979: Table 1). The geometric class selection algorithm was selected owing to the low frequency of class membership and the high number of zero or low data values.

The same intervals were utilized for all percentage-based class maps. The map intervals were set in relation to 100 percent. This means that for all percentage maps, the intervals are as follows: Interval 1 = zero (class absent from state); Interval 2 = 1 to 4.64% (class comprises between 1 and 4.64 percent of the classes in that state); Interval 3 = 4.64 to 21.54% (class comprises 4.64 to 21.54 percent of the classes in that state); Interval 4 = 21.54 to 100% (class comprises 21.54 to 100 percent of the classes in that state). Setting standard intervals makes all the percentage maps directly comparable. In the reduced inset frequency maps, geometric class selection was also used, with values set in relation to the highest value.

While points from eastern fluted point sites are excluded from the data in Tables 29 and 30, and thus from the distributional maps, it is nonetheless of interest to examine the relationship between the distribution of classes of isolates and the occurrences of classes in the sites. Table 31 lists the points in large (LC) and small (SC) classes by site. As was the case with the non-site points, excluded from consideration are all fluted point materials that are unfinished or manufacturing rejects, in addition to those that are otherwise unassignable to a specific class.

The data for the Shoop and Thunderbird fluted points are based on my direct examination of the collections from these sites; the remainder of the data in this table are based on examination of published descriptions and photographs. Where it was impossible to get an accurate count of the total number of points in a particular class, a minimum number was listed; where it was impossible to estimate even a minimum number then only presence (+) was noted. Where assignment of a point to a class is in doubt, the assignment was so noted (e.g. "cf."). In many cases, only "typical" or "representative" points from the collections were shown or described, and while this makes it difficult to determine the range of classes at a site, it probably gives a reasonable approximation of the important classes at the site.

TABLE 31. Identifiable point classes from eastern sites.

Site	LC	No.	SC	No.	Reference
Barnes	2132	+			Wright and Roosa 1966
Bull Brook	1132	6			Byers 1954:Fig. 91
	2132	+			Grimes 1979:Fig. 9
	3132	+			
	1222	+			
Dutchess Quarry			cf.4132	4	Funk et al. 1969: Kopper et al. 1978:
Fisher	1132	+			Storck 1983:Pl. 5
	2132	+			
Gainey	cf. Bull Brook				H. Wright, personal communication, 1984
Parkhill	2132	+	4132	+	Roosa 1977b
Shawnee-Minisink	1222	1			McNett et al. 1977 Fig. 5
Shoop	1121	1	1321	1	Meltzer, Appendix I
	1211	1	1341	1	
	1221	1	4231	1	
	1222	3	6142	1	
	1232	6			
	1242	2			
Thunderbird	1211	1	2121	1	Meltzer, Appendix I
	1232	1	4122	1	
Twin Fields	2132	1			Eisenberg 1978:Pl. 1
Vail	1132	19			Gramly 1982:Table 2
	2132	7			
	3132	2			
Wells Creek	1221	2	2211	1	Dragoo 1973:Fig. 5,6
	1222	1			
	2221	1			

Examination of resulting distribution maps reveals a number of interesting patterns. Many of the point classes exhibit clear geographic patterning. The classes do not occur in random non-contiguous clumps; some are extensive in their distribution, while others appear to have distributions that correspond with particular geochronological regions.

If one arrays the distribution of the various classes by latitude, there are a number of classes that share both stylistic features and overlapping distributions. I examine these clusters beginning with those in the far north then preceding southward. Classes 1132, 2132 and 3132 (Figures 13, 14, and 15), points sharing blade fluting, deep circular bases and ears pointing downward, have a generally northern distribution, one concentrated in and around the Great Lakes. In terms of both relative and absolute frequency these classes predominate in New York (accounting for a total of 48% of the New York isolates), Ohio (29% of all Ohio isolates), Michigan (50% of all Michigan isolates).

On the Atlantic Coast, these classes are rare in Pennsylvania and nearly absent in Virginia, both states having samples of sufficient size (n=17 and n=53 respectively) that they should readily detect such classes if they occured in frequencies comparable to those further north. To the west, concentrations drop off south of Kentucky (Figure 13). At face value these data suggest that the concentration of these point classes decreases steadily as one moves southward. There are anomalies to this interpretation, not all of which can be explained.

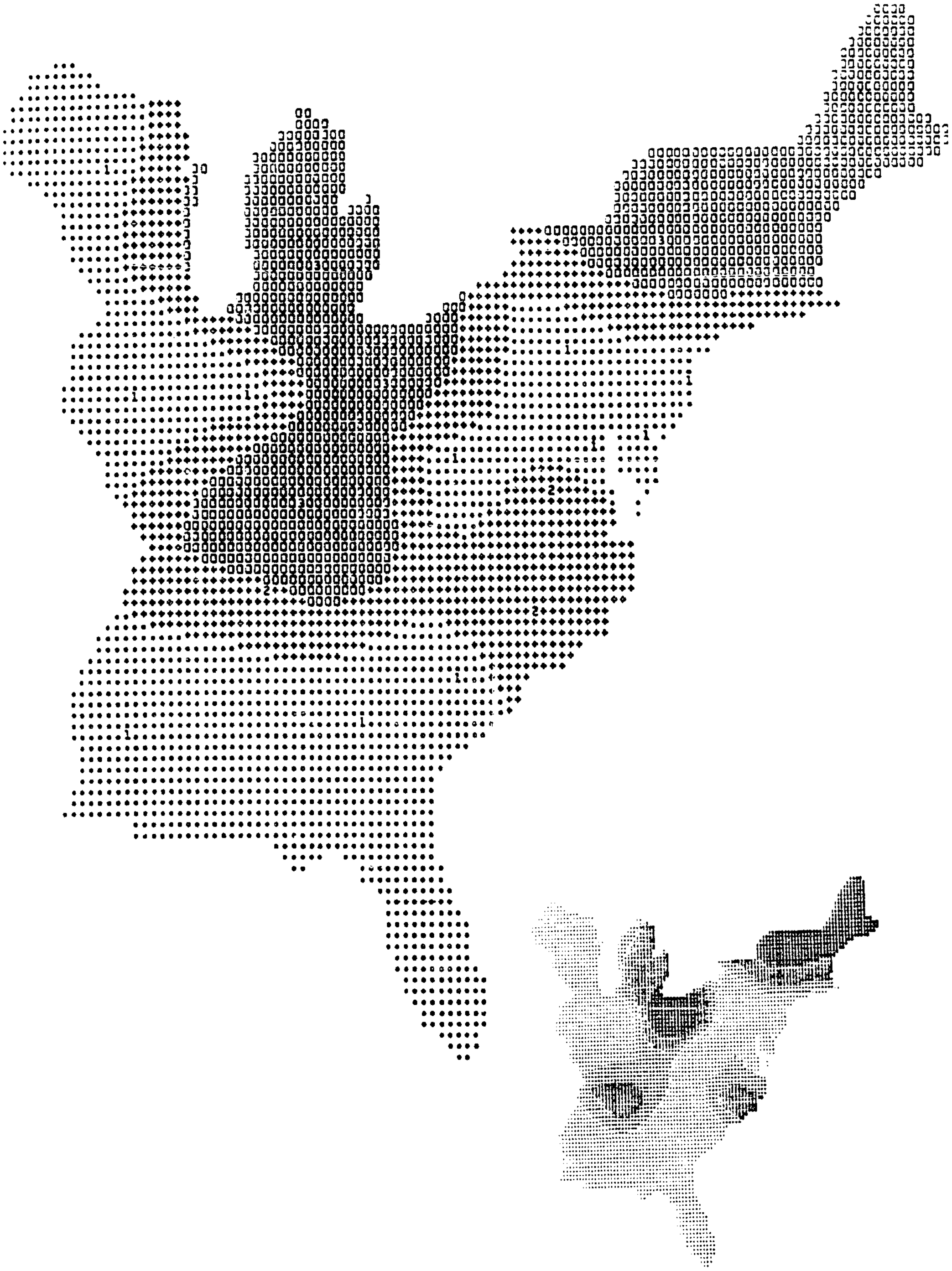

FIGURE 13. Percentage distribution of fluted point class 1132
(absolute frequency distribution in inset)

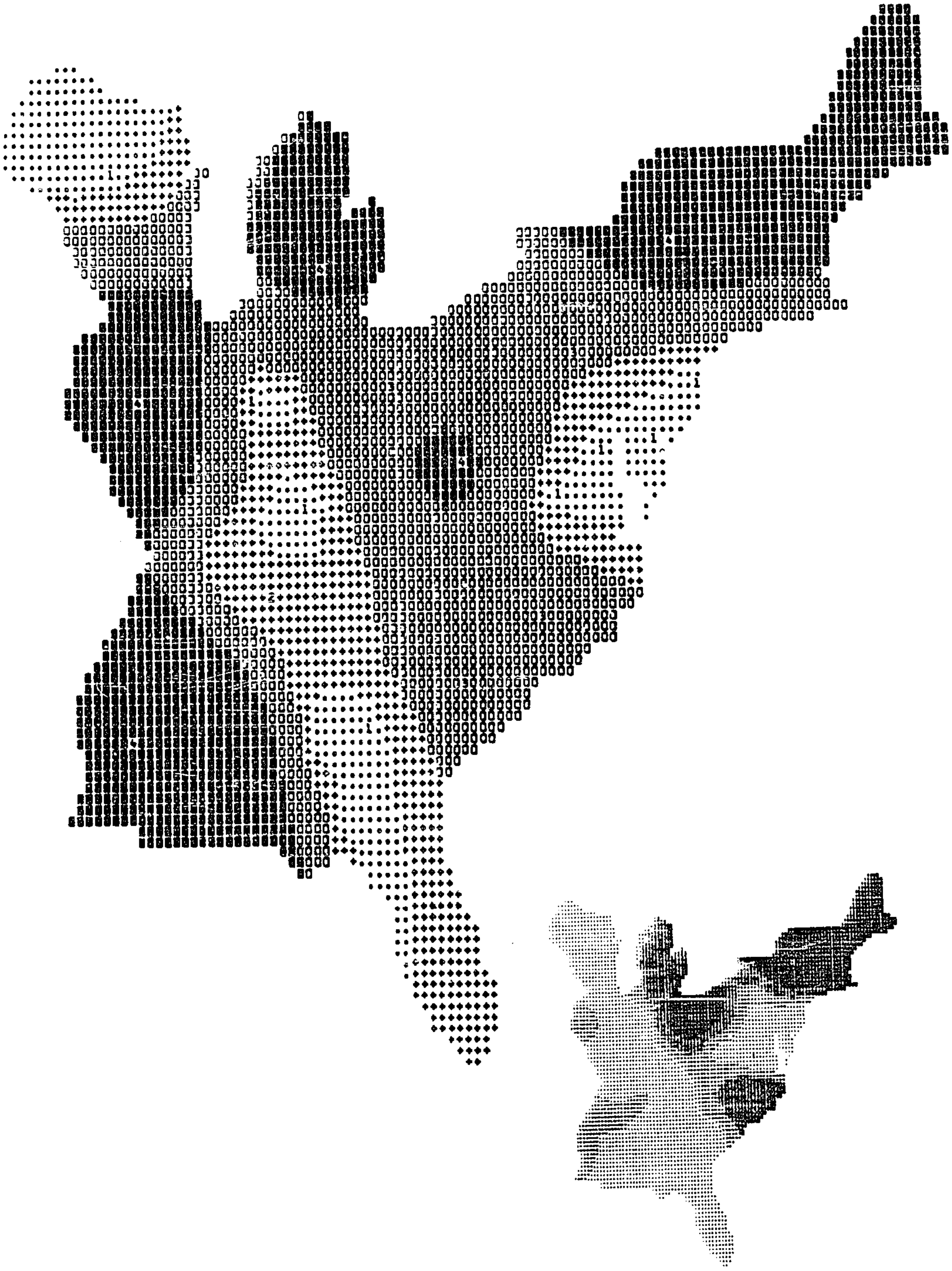

FIGURE 14. Percentage distribution of fluted point class 2132 (absolute frequency distribution in inset)

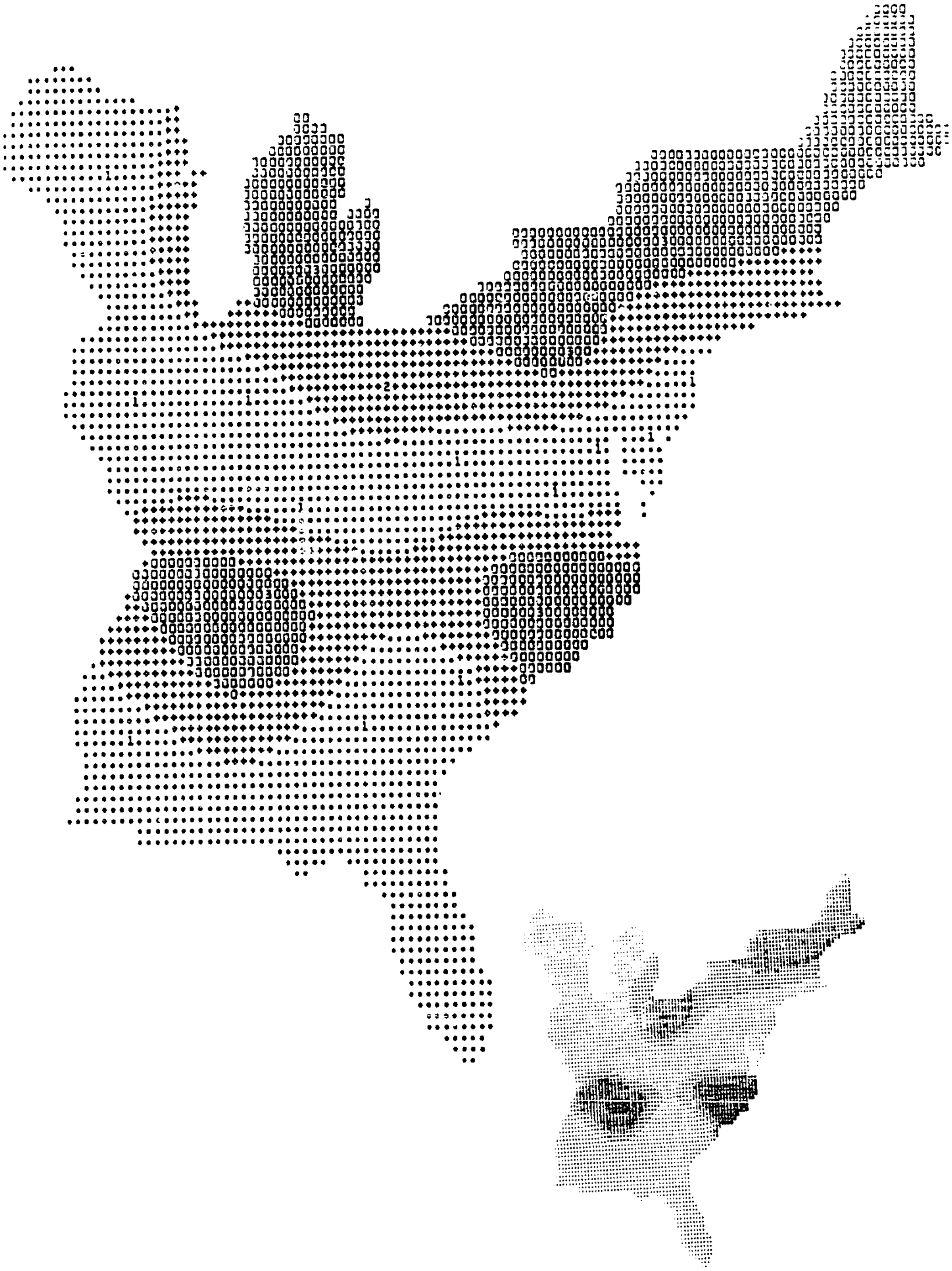

FIGURE 15. Percentage distribution of fluted point class 3132
(absolute frequency distribution in inset)

I am puzzled by the concentration of all three of these classes in North Carolina - where they account for 21% of the 56 North Carolina isolates. For, as mentioned, they are nearly absent in the sample of points from states immediately to the north of North Carolina (and this includes West Virginia as well, whose apparent concentration in Figure 14 is a likely result of a small [n=4] sample). Given the large sample of points from North Carolina, the high concentration appears to be real, yet this introduces a disjunction into the distribution of these classes. No explanations for this anomaly come immediately to mind.

Easier to explain is the concentration of Class 2132 in Illinois and Mississippi. These concentrations are more apparent than real: the samples for these states are quite low - 2 and 1 respectively - and thus the percentages when the type is simply present are 50 and 100% respectively.

It is intriguing to note that these very same point classes are present in the Great Lakes sites such as Barnes, Fisher, Parkhill and, evidently Gainey (H. Wright, personal communication 1984) in addition to the Twin Fields site in the Hudson Valley of New York (Table 31). What is more provocative is that these classes, but especially Class 1132, are the dominant form at the Vail and apparently Bull Brook sites (Table 31), as well as the Debert and Whipple sites (MacDonald 1968, 1983).

These isolated points and sites are in periglacial regions, regions that had to have been occupied late in the fluted point sequence (Tables 4 and 6). This is, of course, corroborated by the radiocarbon dates from Debert, Vail and Whipple, all of which are around 10600 B.P.

Another northeastern form, though with a distribution to the south of Classes 1132, 2132 and 3132, is Class 1232 (Figure 16). This class is

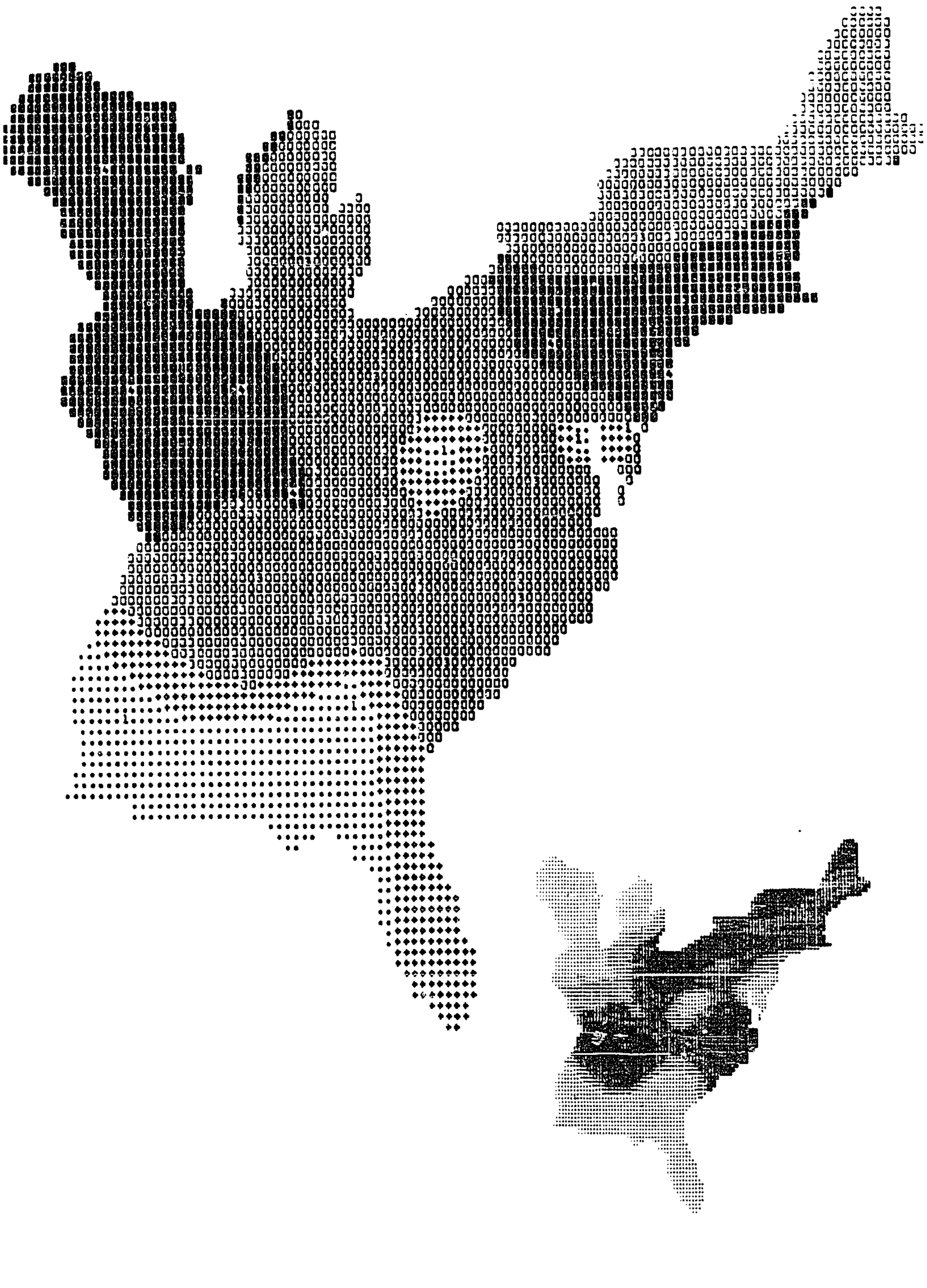

FIGURE 16. Percentage distribution of fluted point class 1232 (absolute frequency distribution in inset)

concentrated in Michigan, Ohio, Pennsylvania and New York, south to Virginia, the Carolinas, Kentucky and Tennessee. The area of greatest concentration is Pennsylvania, with percentages of the class decreasing in all directions from this state.

The "hole" in the center of Figure 16 is West Virginia which, given its sample size (n=4), has only a 50% probability of detecting items if they occur in the population at concentrations of greater than 25% (1/n). Since the concentration of this class in the states around West Virginia ranges from a low of 11% to a high of 24% the absence of this class is likely not a true absence but instead a consequence of a small sample. That is to say this class should be present in a larger sample from West Virginia. The apparent concentration of points in Wisconsin, Illinois and Indiana is a also a consequence of small sample size, though in a different way: in these states because the samples are small the mere presence of the class dominates the percentage values.

It is important to observe that in addition to being the dominant isolate point class in Pennsylvania, Class 1232 is the dominant point form at the Shoop site. As can be seen in Table 31, 6/18 (33%) of the assignable points at Shoop are members of Class 1232.

The northern aspects of the distribution of this class are relevant to the hypothesized relationship between Shoop and the tundra sites, as are the certain morphological similarities in the projectile points. The Shoop points have the deep circular bases and downward projecting ears found at Vail and Debert. The major difference, of course, between the points from Shoop and the points from the tundra sites is in the manner of fluting technique: the Shoop points appear to be flake fluted, while the Vail and Debert points are blade fluted. But the Shoop points are heavily reworked and many have been refluted (Cox 1972). In my own examination of these points, it was clear that some of the points may have been blade fluted, but the reworking of the blade has obscured this evidence. So the arguments made earlier that the Shoop material may also reflect a periglacial adaptation are not refuted by the evidence from the projectile points.

Further to the south and west and with an overlapping distribution are Classes 2221, 2222 and 2232 (Figures 17, 18 and 19). The apparent concentration of these points with tapered sides, flake fluting, and an elliptical or circular base is an axis between Michigan and Virginia/North Carolina, that extends south to Kentucky and Tennessee, with concentrations dropping off significantly as one moves north and south. There are no appparent disjunctions in these distributions; the absence of these classes in New Jersey, Maryland and Delaware are all likely not true absences, but a reflection of the fact that the samples in these cases are inadequate to detect a class that appears to occur in less than 15% of the population.

Note the high density values for Indiana and West Virginia (Figure 17) are a consequence of the presence of the class in small samples (n=4 in both cases). Since Class 2221 does not occur in concentrations as great as 25% in the states surrounding Indiana and West Virginia one can reasonably construe that its apparent concentration in these states at these levels is a result of using percentage values from small samples.

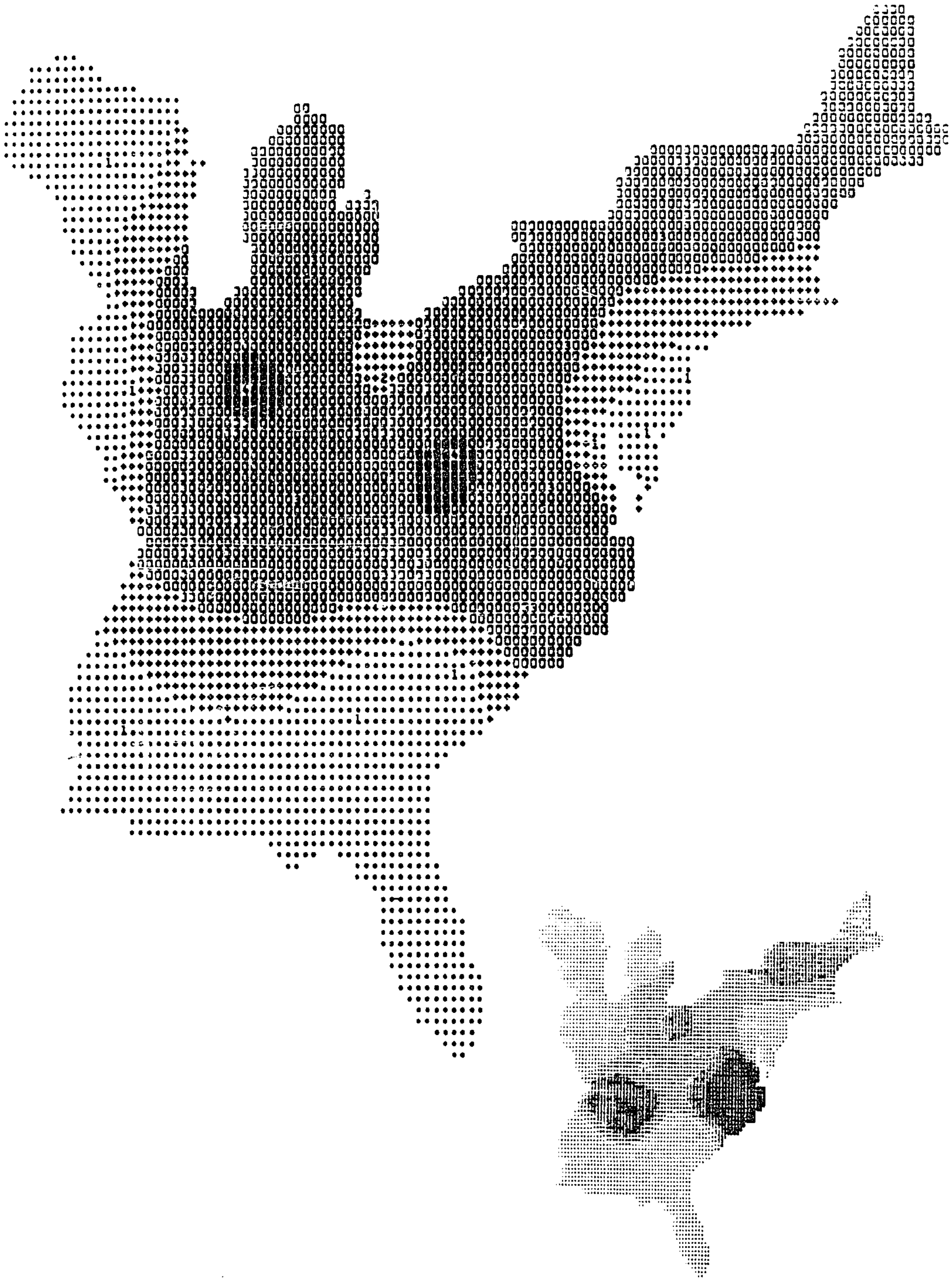

FIGURE 17. Percentage distribution of fluted point class 2221 (absolute frequency distribution in inset)

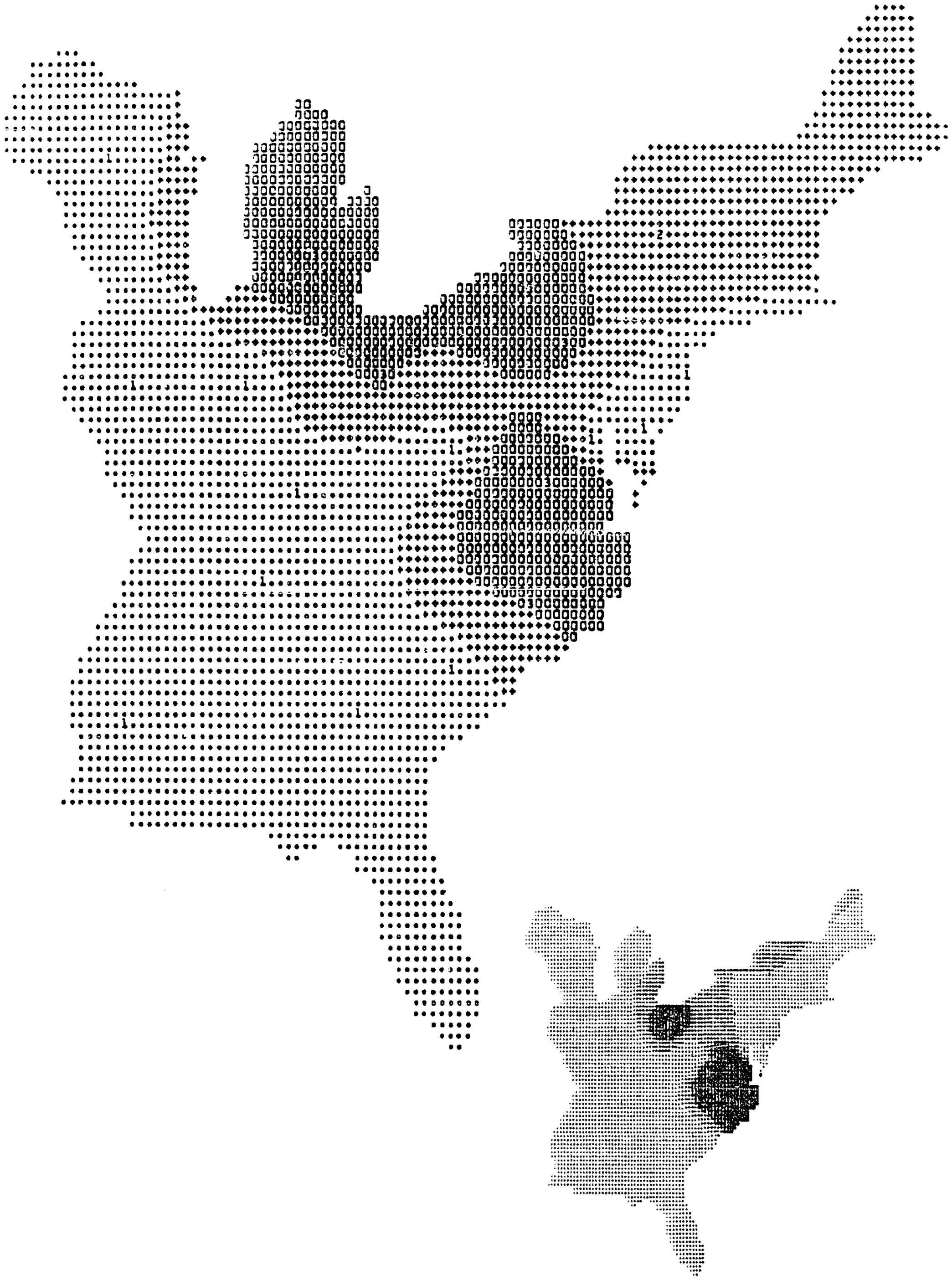

FIGURE 18. Percentage distribution of fluted point class 2222 (absolute frequency distribution in inset)

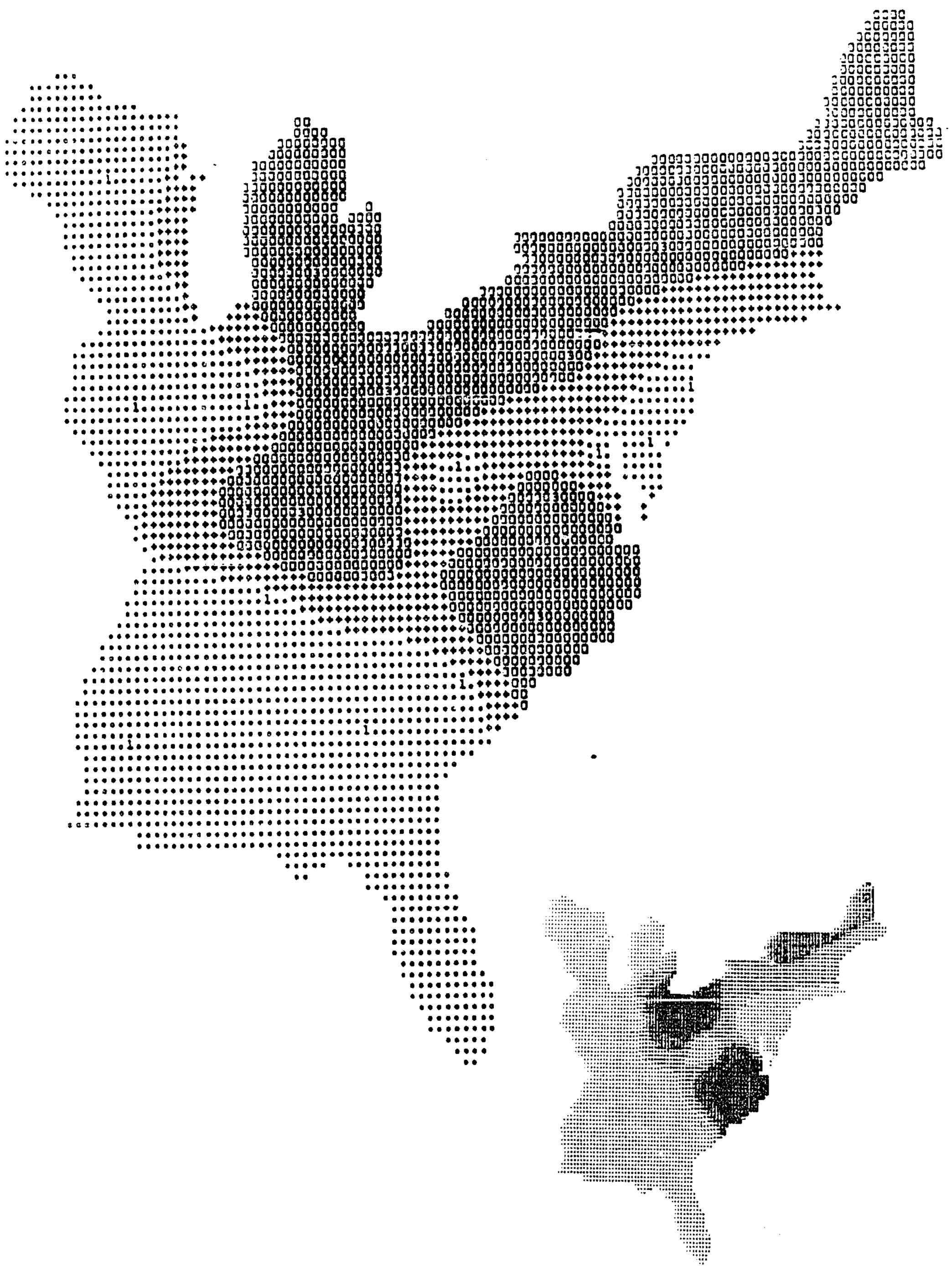

FIGURE 19. Percentage distribution of fluted point class 2232 (absolute frequency distribution in inset)

One of the assignable points from the Wells Creek site (Table 31) is a member of Class 2221, which is the only example of these three classes to occur in Tennessee (Figure 17).

Classes 1211, 1242 and 1121 (Figures 20, 21 and 22) are low membership classes that appear to be concentrated in the mid-south, between Kentucky and Tennesee on the west, and the Carolinas and Virginia on the east. These classes are absent or significantly diminished in the northern states. The apparent concentrations in Maryland, Delaware and West Virginia in these distributions are likely statistical artifacts of taking percentage values from small samples. That is, the fact that the highest concentration of these points in any of the larger samples is only 11% makes one suspicious of values of 50% and 100% in states with samples of only 1 or 2 points.

The overlapping distribution of points that are morphologically similar yet exhibit different fluting techniques (blade versus flake fluting) has important implications for the age of these fluting techniques. These are discussed below.

Classes 1221, 1222, both of which are parallel sided, flake fluted, and have elliptical bases are nearly pan-eastern in distribution, save for the far northeast. These classes have their densest absolute and relative concentration in Michigan, Ohio, Virginia, North and South Carolina, Tennessee and Kentucky (Figures 23, 24). The apparently extreme concentration of these classes in Georgia and Indiana is perhaps misleading, as the samples from these states are quite small (Figure insets; Table 29).

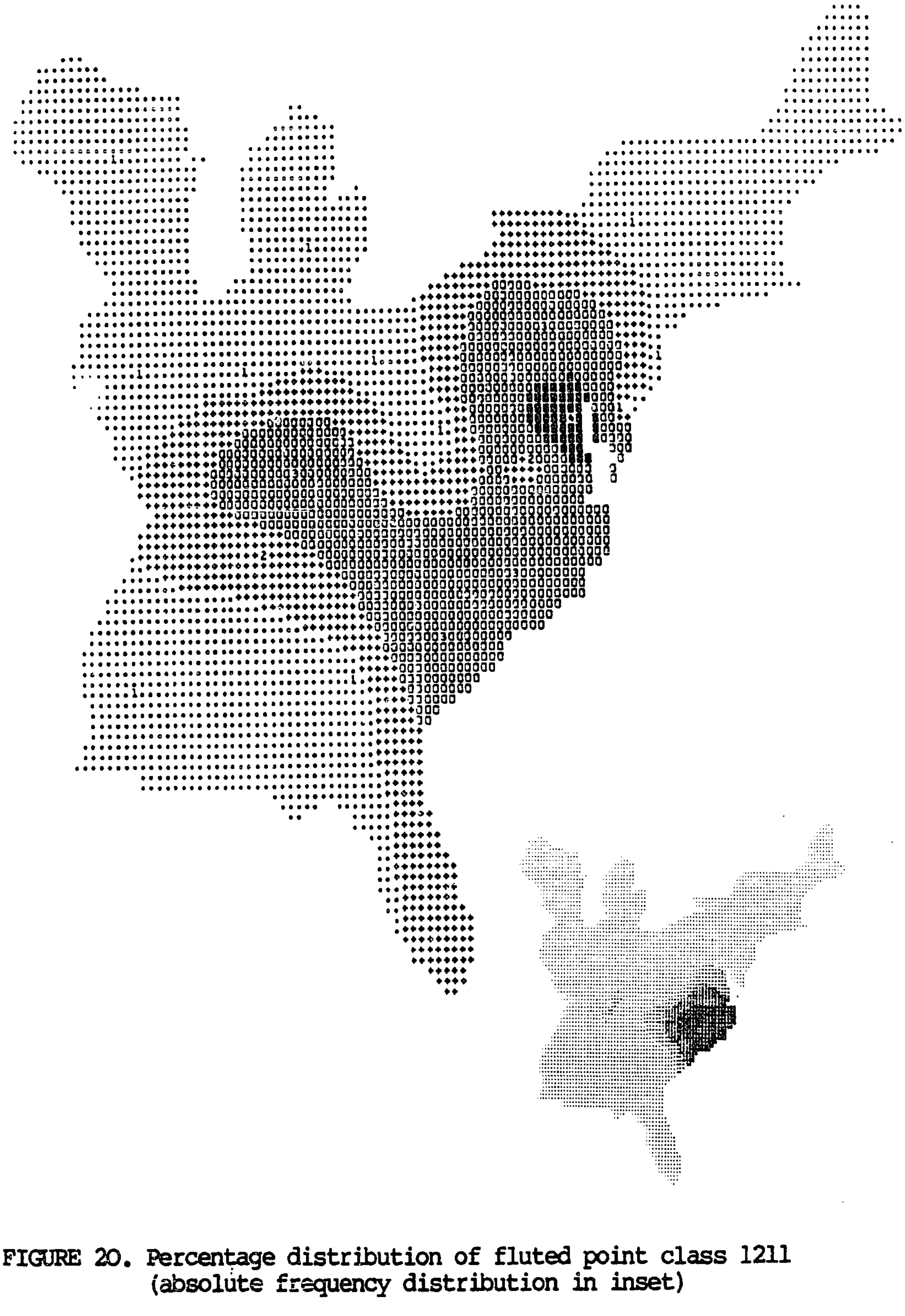

FIGURE 20. Percentage distribution of fluted point class 1211
(absolute frequency distribution in inset)

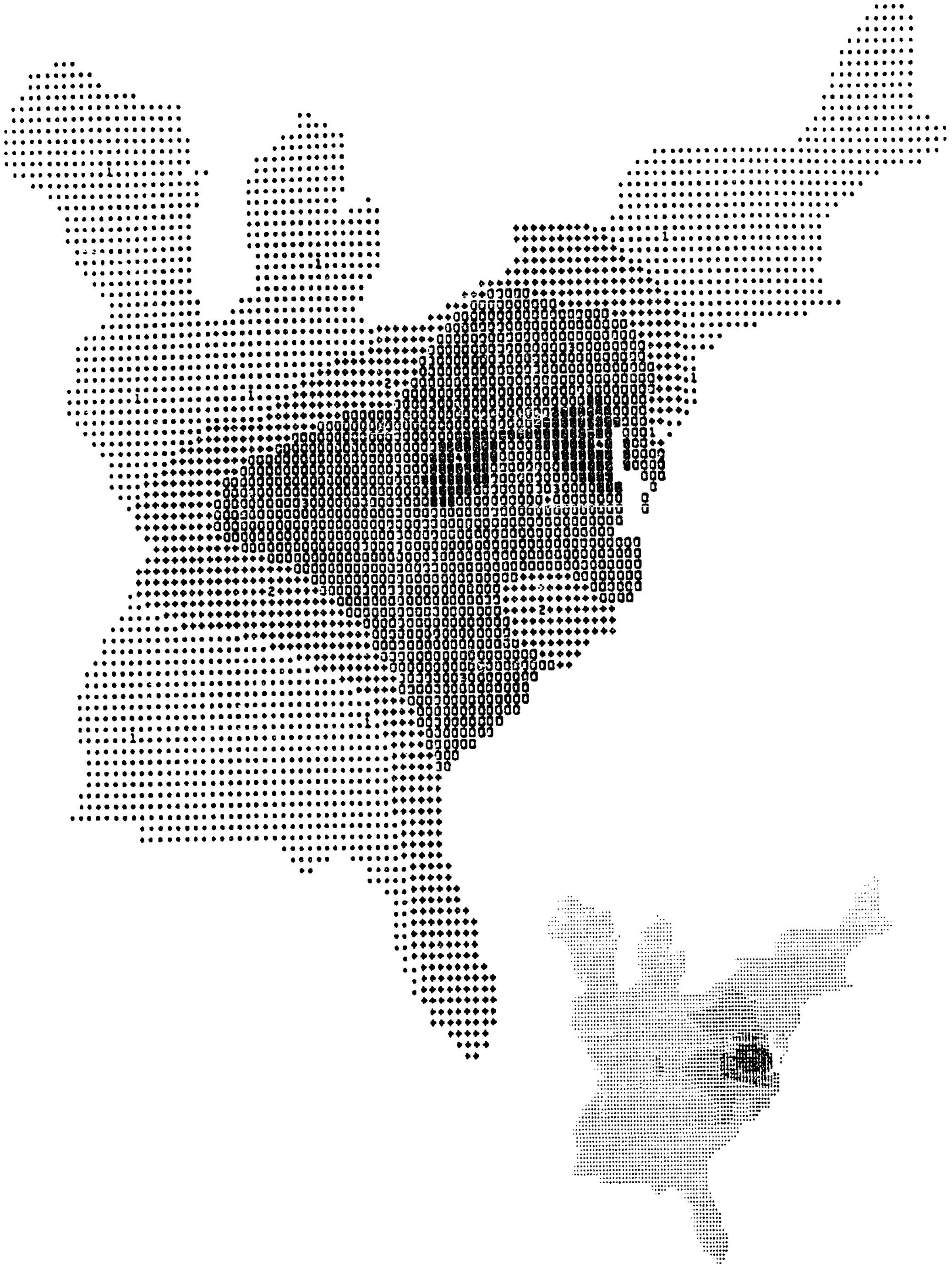

FIGURE 21. Percentage distribution of fluted point class 1242 (absolute frequency distribution in inset)

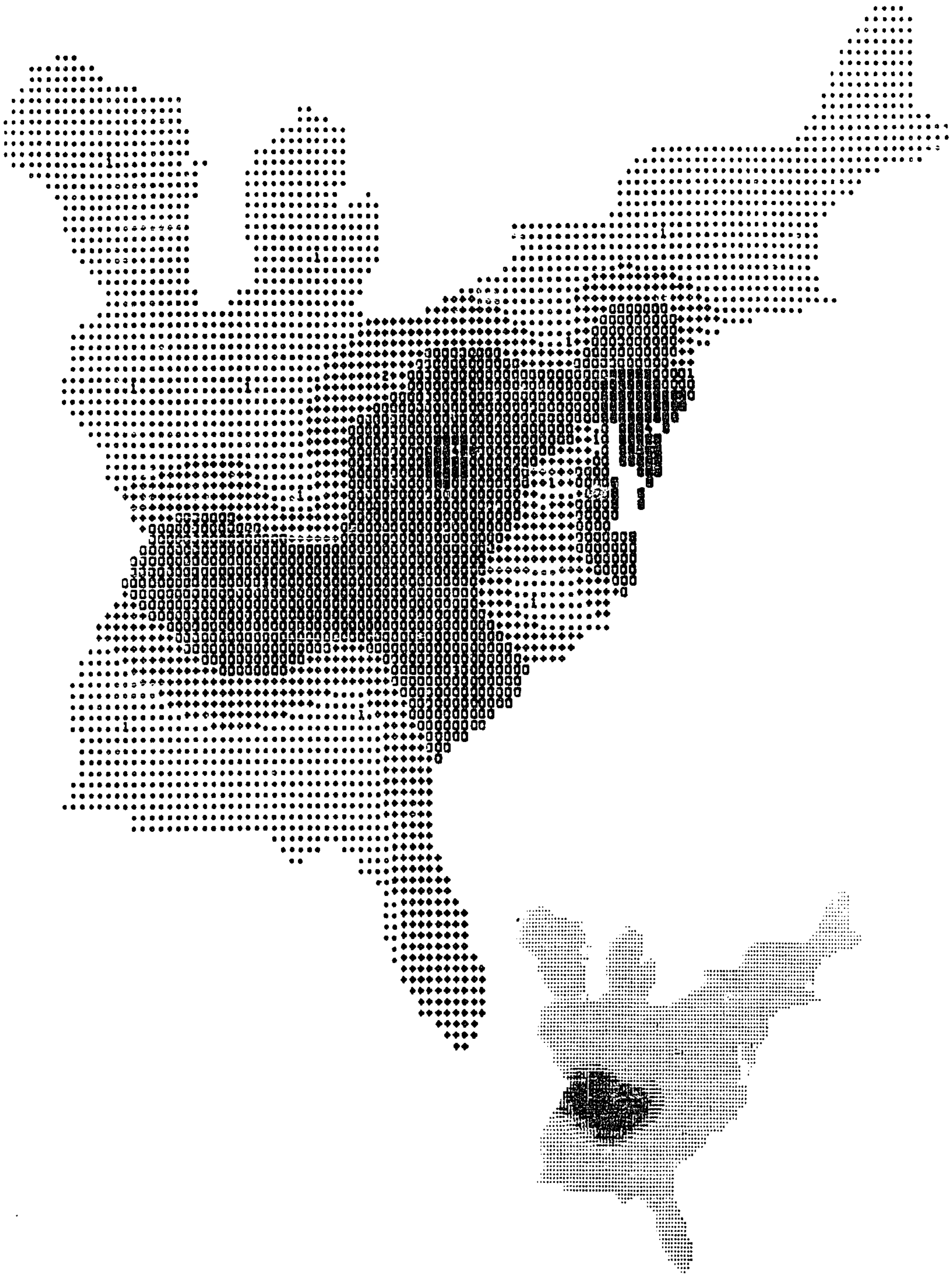

FIGURE 22. Percentage distribution of fluted point class 1121
(absolute frequency distribution in inset)

The distributions of these classes, particularly Class 1221, are intriguing, since these classes include the points that would commonly be placed under the heading of eastern Clovis (e.g. Rolingson 1964). These are the most abundant and widespread of all the large classes in my sample and, most significantly, they diminish in abundance or are absent from the far northeastern states, save Michigan. Three of the five identifiable Wells Creek points are members of these classes (Table 31), as is the one point from the Shawnee-Minisink site (Table 31; McNett et al. 1977:Fig. 5:R). The age of the Shawnee-Minisink site is approximately 10,600 B.P., but for reasons that I discuss below I think the main distribution of this class is significantly older.

The distribution of Class 3232 (Figure 25) is oriented north-south along the eastern seaboard states, with areas of concentration in New York, Pennsylvania, Virginia, the Carolinas and Georgia. At first glance this distribution appears to be discontinuous, however this may be a consequence of the size of the samples. This class comprises 6% and 8% of the samples in Pennsylvania and Virginia. The states in the intervening regions, Maryland, Delaware and West Virginia, have samples would only have a 50% chance of detecting these points if they occurred in percentages ranging above 25%. Hence, their absence should not be considered a true absence, but an artifact of the samples.

Finally, Classes 4123 and 4133 (Figures 26 and 27) incurvate-sided, blade fluted points with out-turned ears are also found in the southern latitudes, but their distribution is concentrated in the western part of the region, in Tennessee decreasing north into Ohio and New York, and east

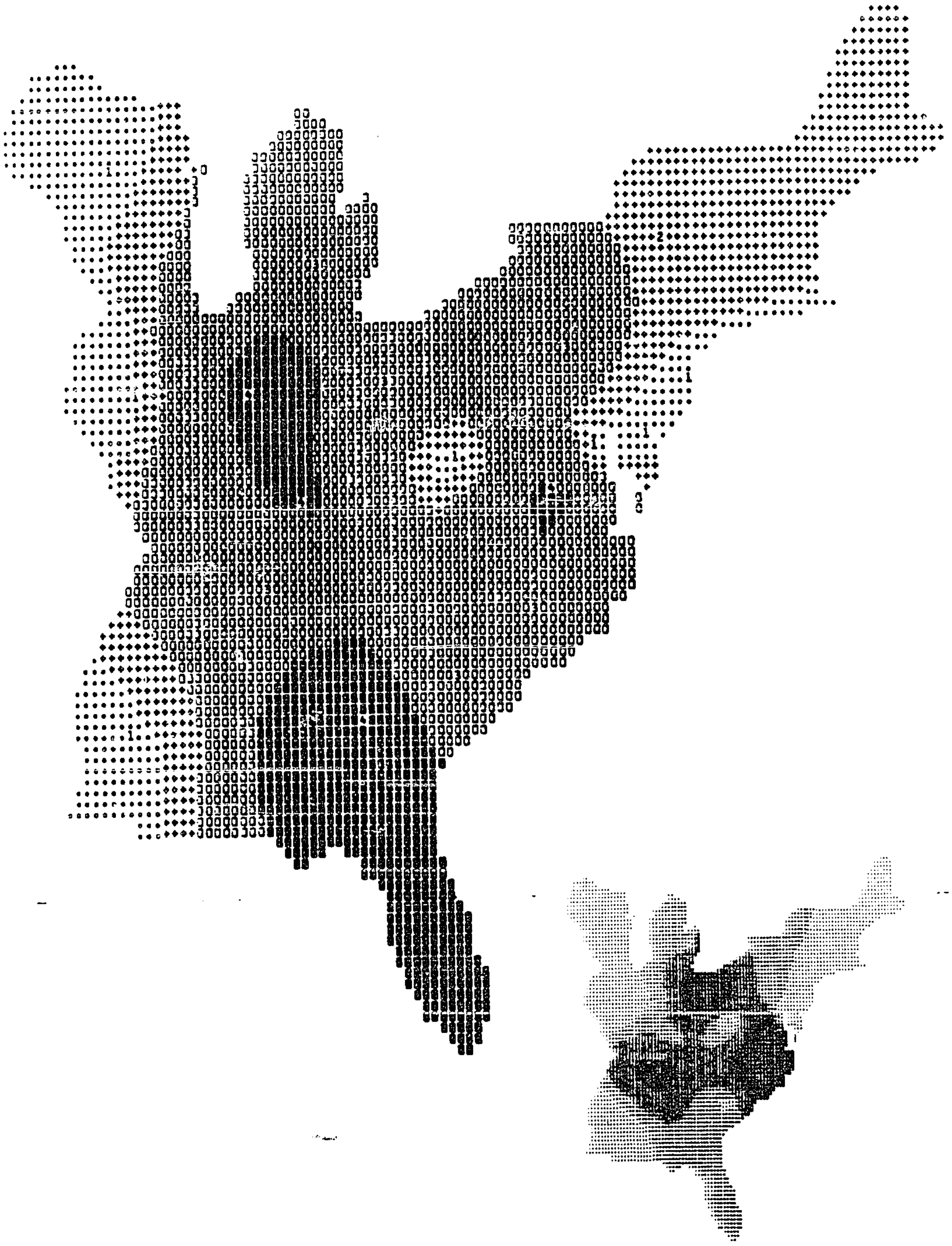

FIGURE 23. Percentage distribution of fluted point class 1221 (absolute frequency distribution in inset)

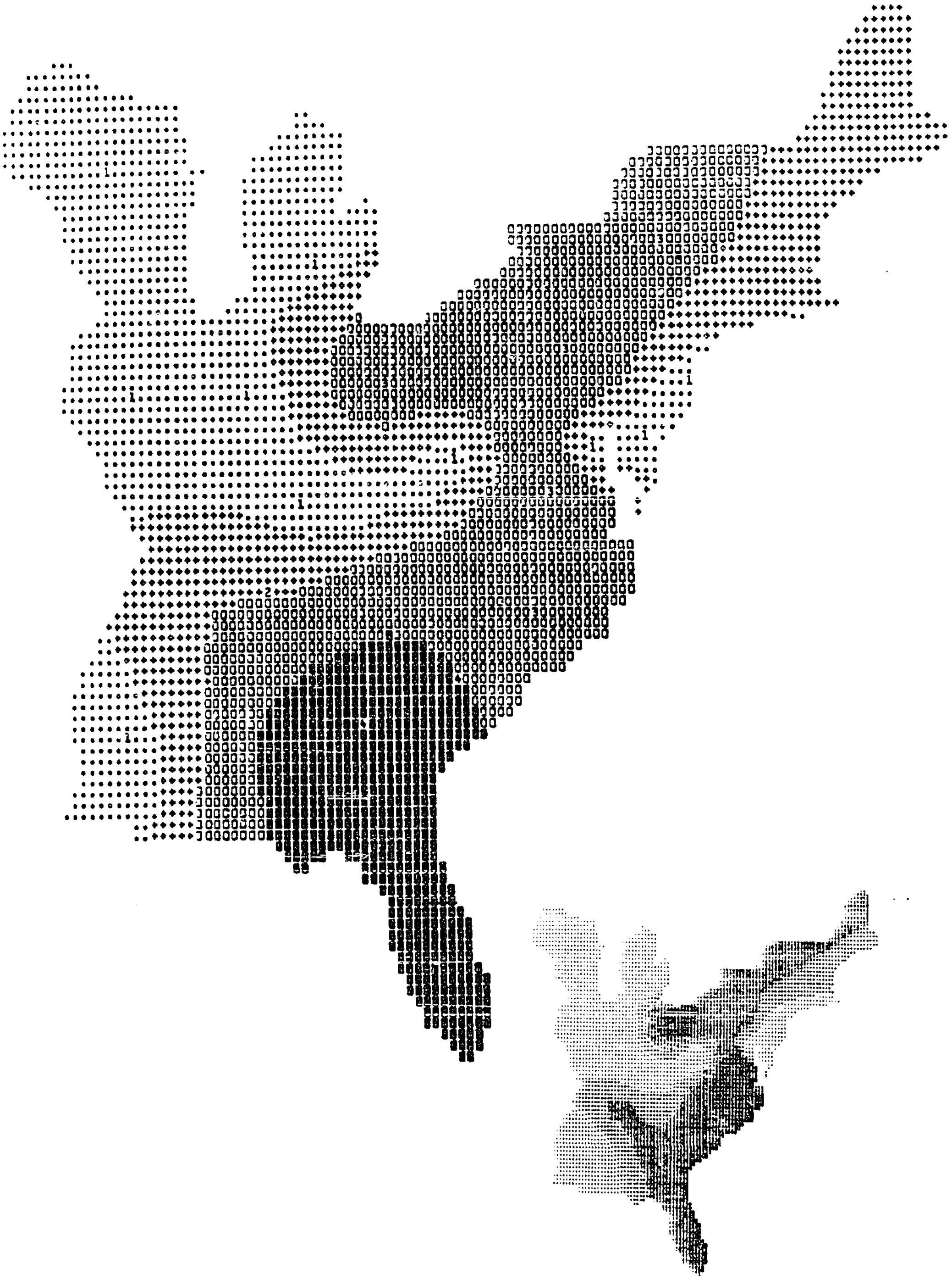

FIGURE 24. Percentage distribution of fluted point class 1222
(absolute frequency distribution in inset)

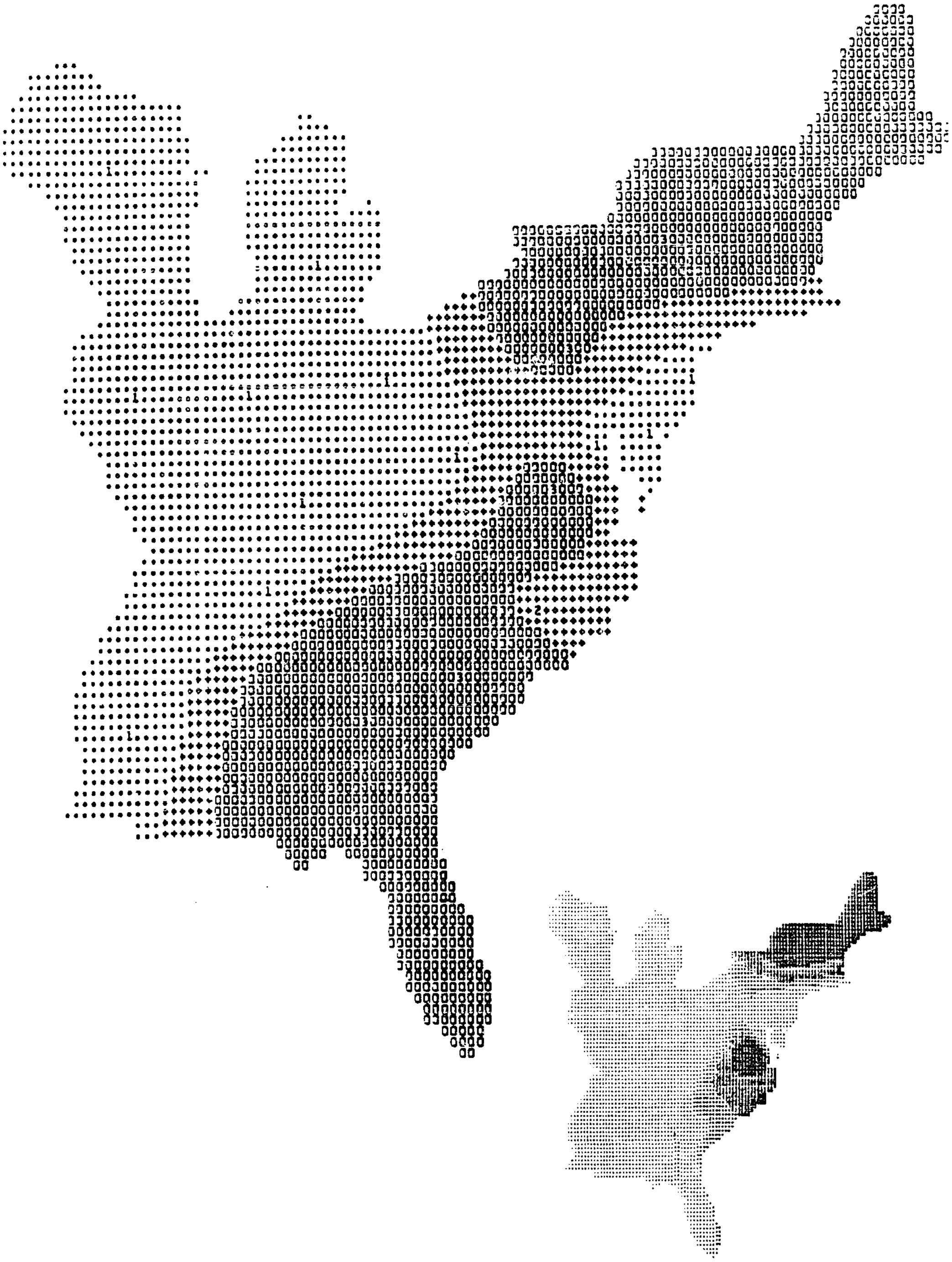

FIGURE 25. Percentage distribution of fluted point class 3232
(absolute frequency distribution in inset)

into Georgia. The concentration of these points in Indiana is a consequence of the small sample size. These point classes are of the kind commonly referred to as Cumberland points.

And as Cumberland forms, their absence from Kentucky in these maps is puzzling: Cumberlands are present in that state. Rolingson (1964) notes that Cumberland points comprise 14% of the 276 Kentucky Paleo-indian points, which for her includes the Clovis and Cumberland forms as well as such non-fluted types as Quad, Meserve and "Lanceolate" points. Putting this in terms of the way the sample is aggregated here, this means that Cumberland points actually comprise 23% (40/170) of the fluted (Clovis + Cumberland) points. The sample from Kentucky is sufficiently large (n=11) that it should have detected a form that occurs in such high proportions. That it did not is curious, and I can offer no explanation.

Because of the distinctiveness of the Cumberland form, there exists an independent measure of the proportion of Cumberland points in Kentucky, I have used this value in producing a separate composite map of the distribution of the Cumberland type (Figure 28). This map combines the counts (Table 29 and 30) from Classes 4123 (Figure 26) and 4133 (Figure 27), which differ only in the degree of their basal concavity and, following Rolingson (1964) uses the value of 23% for the concentration of Cumberland points in Kentucky. This figure (Figure 28) is probably a reasonably accurate rendition of the distribution of the Cumberland form.

It is important at this juncture to call attention to the points found at Dutchess Quarry Cave, referred to as Cumberland points (Funk et al. 1969; Snow 1981). Given the apparent distribution of this form (Figure 28), the presence of a true Cumberland in New York would seem unlikely,

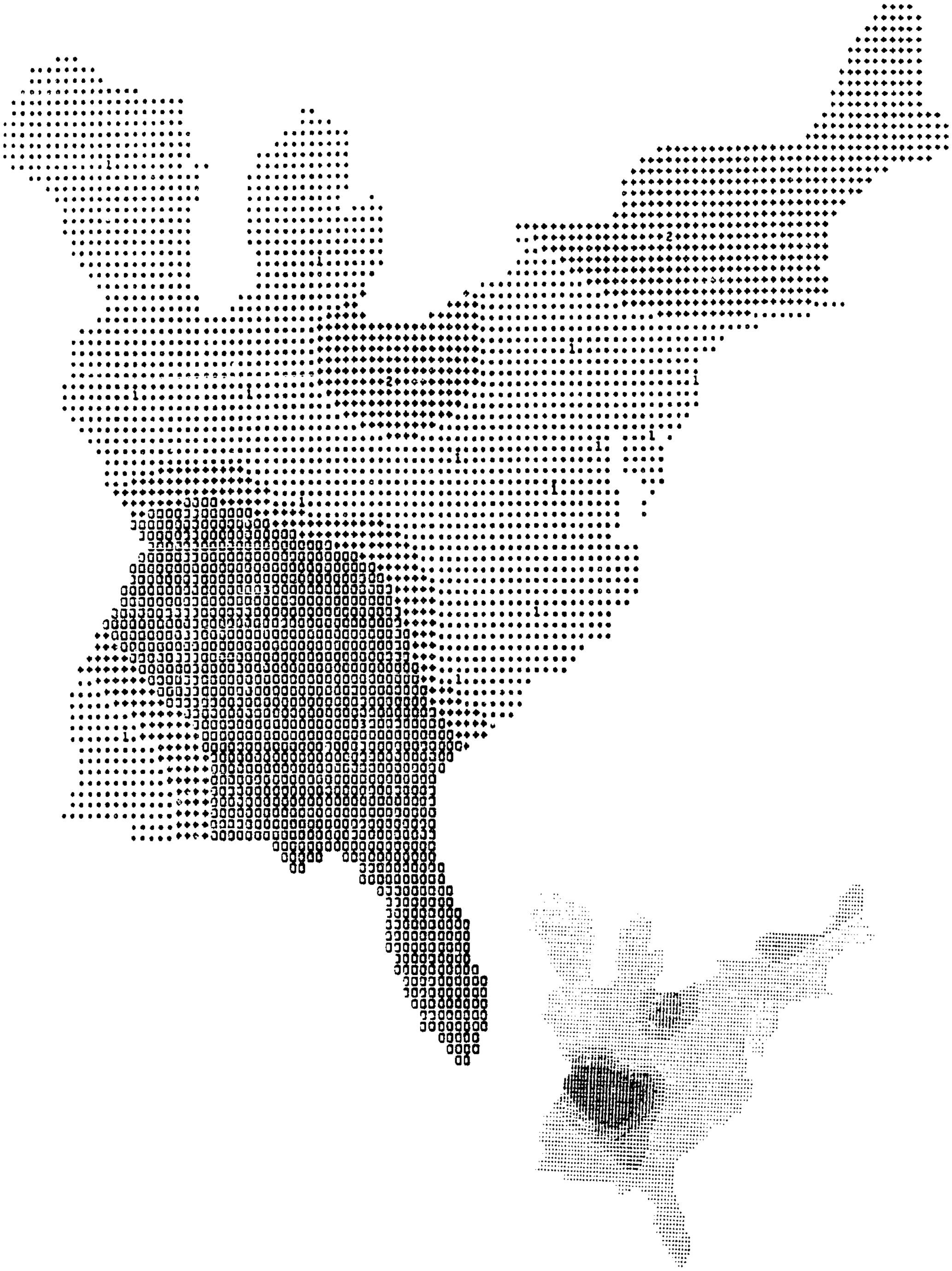

FIGURE 26. Percentage distribution of fluted point class 4123 (absolute frequency distribution in inset)

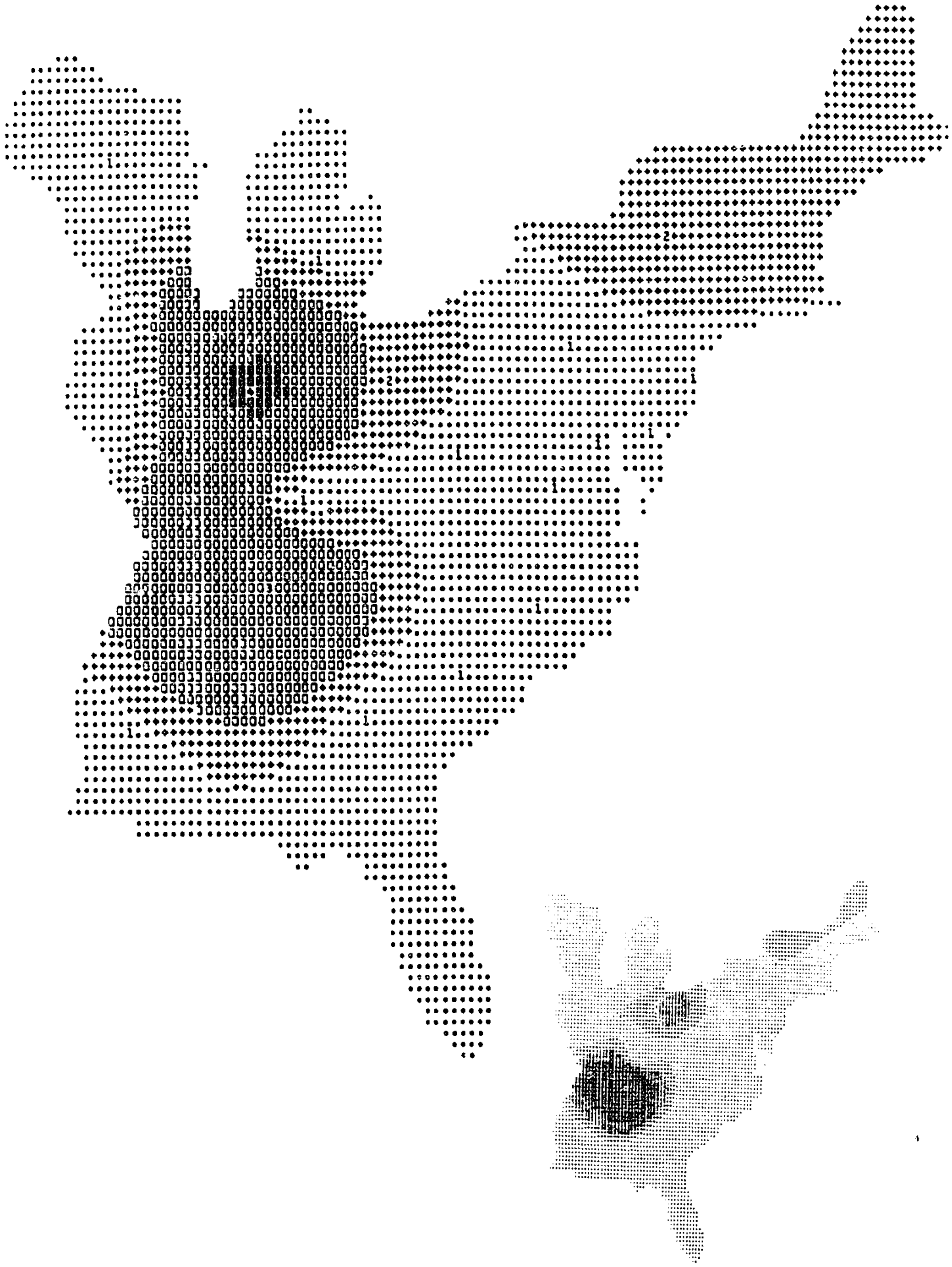

FIGURE 27. Percentage distribution of fluted point class 4133
(absolute frequency distribution in inset)

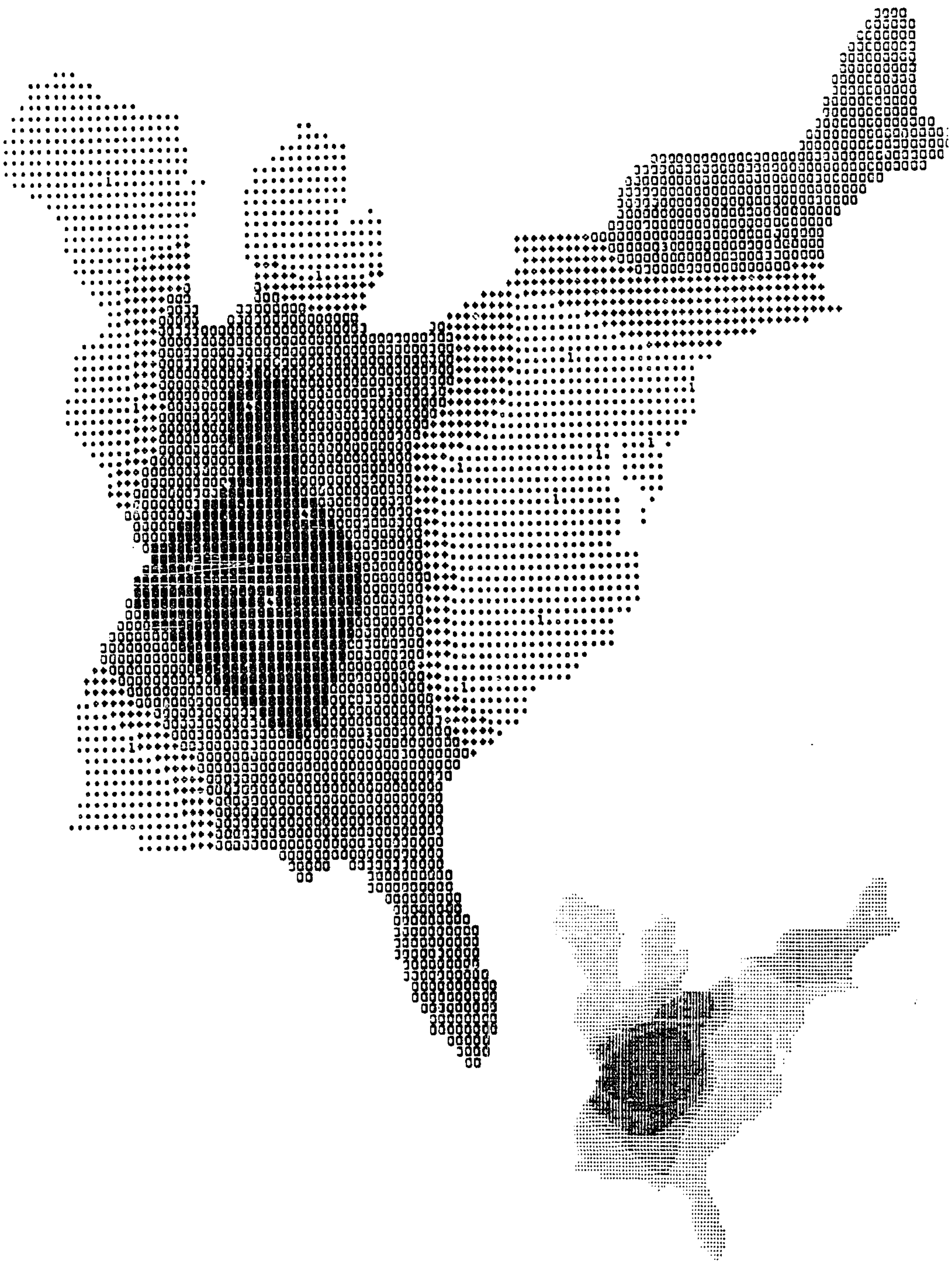

FIGURE 28. Percentage distribution of Cumberland points
(absolute frequency distribution in inset)

although certainly not impossible. In this classification the points from Dutchess Quarry Cave are separated from Cumberland forms as members of class 4132 (Table 31). As such they differ from the classic Cumberland forms in that these points are not "fish-tailed". The ears on the Dutchess Quarry Cave points aim down and not out. In fact, the Dutchess Quarry Cave points bear a strong resemblance to many of the Parkhill points (Roosa 1977b), which makes a great deal more sense, since it indicates an association with a Great Lakes periglacial form and not a southeastern forest form.

Discussion

Figures 13-28 can be interpreted along the lines discussed at the outset of the chapter. Recall that I suggested that if there was no stylistic variation in eastern fluted points, then all would fall into the same class which, when mapped, would cover the entire eastern region.

If the eastern fluted points reflect only spatial (synchronic) variation, I suggested the points would fall into different classes, and a map of their spatial distribution will show each class in a unique area, with no overlap among the classes. The areas should be relatively small and the class boundaries abrupt. Class distribution should not correlate with geochronological features.

If the eastern fluted points reflect only temporal (diachronic) variation, points would fall into different classes and a map of their spatial distribution will show overlap among the classes. Class boundaries will be graded and diffuse. Class distribution will be correlated with geochronological features.

Finally, if eastern fluted points reflect both spatial (synchronic) and temporal (diachronic) variation: points will fall into different classes and a map of their spatial distribution will show well-defined regional classes, as well as time-transgressive class distributions.

Based on earlier discussion and the evidence in Figures 13-28, one can reject the suggestion (Mason 1981) that eastern fluted points are homogeneous. Instead, there are many classes which exhibit marked spatial variation that is neither random nor discontinuous (especially in view of the sample characteristics), and thus must be a consequence of either spatial or temporal patterning or a combination of both. In fact, based on the distributional evidence, I would argue that the last possibility is correct, and that the other two are inadequate to fully explain the spatial patterning evident in the distribution maps.

In support of this argument, let me discuss the evident temporal and spatial variability not only in the classes but in certain attributes of the classes as well. The initial point to be made is that there are three distinctive kinds of class distributions, one of which is clearly a combination of spatial/temporal patterning, one of which is clearly spatial, and one of which is just as clearly temporal. The first kind is comprised of two classes (1221 and 1222, Figures 23 and 24) which are pan-regional, distributed throughout most of eastern North America. The second kind consists of three classes (3232, 4123 and 4133; Figures 25, 26 and 27) distinctly limited in their distribution to particular regions. The third kind is comprised of the remainder of the classes (Figures 13-22) which exhibit a marked, north to south time-transgressive distribution. The edges of these last classes are diffuse and overlap in space, but when one looks at the areas of greatest concentration for each class it is clear that the classes each have an east-west distribution and are stacked on one another in a north to south orientation.

While the latter two kinds of distributions are important, the first has the most significant implications for fluted point studies. I would argue that the pan regional classes - 1221 and 1222, commonly referred to as eastern Clovis - are representative of a "basement" cultural occupation, perhaps the earliest fluted point occupation in the east. My reasons for this are two-fold. First, these classes are concentrated in the unglaciated areas, and thus have the potential for significant antiquity. These are areas that would have been available for occupation for the longest period of time. These points are absent in the areas that only opened for occupation in the very latest Pleistocene.

Second, these classes are also widespread, while the other classes are not. Their morphological and technological homogeneity over broad regions of space could result from one of three process. The patterns could result from the spread of highly mobile populations in a brief period of time; the spread of a small population over a longer period of time; or the diffusion of the fluted point form across extant groups.

One can probably discount the first suggestion since, as argued in Chapter 5, groups in the unglaciated regions do not appear to be highly mobile (this is supported as well by one of the few studies that examines raw material use in isolated fluted points [Perkinson 1971, 1973]; most of the points are from local raw material sources).

The latter two suggestions are more appealing, and if correct, these classes of "Clovis" points mark the spread of a form over the entire region from some homogeneous source. If movements of people were involved, it implies that other groups were not simultaneously occupying that same region (for if there were, then one would not see such widespread distributions). This, in turn, implies that these point classes represent the initial occupation of an empty area by fluted point groups. The source of the group or groups is obscure. It is certainly possible that the groups came from the southern High Plains, where the Clovis form is dated to between 11750 and 11250 B.P. (Haynes 1970). However the tight range of those dates and, conversely, the wide range of potential age for the eastern fluted point materials, suggests an eastern source is more likely.

Alternatively, these forms may represent the rapid diffusion of a new, functionally important tool: the fluted point. In this case, one assumes that the region was fully occupied, and the homogeneity of the point form is a consequence of its rapid diffusion. I am less inclined to accept this interpretation, since it implies the presence of a population for which we have little evidence.

Regardless, both of these possibilities are viable, and either interpretation is supported by the trend in point styles which, when viewed over the long term from Paleo-indian through early Archaic, is clearly one of differentiation, rather than standardization (Caldwell 1958; Ford 1977). A regionally homogeneous point style must be early rather than late.

This widespread and homogeneous occupation appears to break up with the expansion of fluted point groups into the newly opened glaciated regions, and stylistic differentiation within the forested east. Tracking that expansion is the distribution of a series of classes that progressively move further north. I would suggest that classes 1132, 2132 and 3132 are late in the fluted point sequence, and are preceded by class 1232, which in turn is preceded by classes 2221, 2222, and 2232, then classes 1211 and 1242.

Marking the appearance of stylistic differentiation is the development of small, contiguous classes with apparently abrupt spatial boundaries (Classes 3232, 4123, and 4133). The distribution of 4123 (Figure 26), and 4133 (Figure 27) meet the stipulated criteria for a distribution that results solely from a synchronic occupation. These point classes have restricted spatial distributions and lack significant overlap with other classes. They may have abrupt spatial boundaries, but this is difficult to determine since in all cases adjacent samples are too small to judge the abruptness of the boundaries. Certainly neither of these classes are associated with geochronological features.

Certain of the broad chronological patterns evident in the distribution of classes are supported by the spatial patterning in a specific stylistic attribute of fluted points. One attribute long suspected to have chronological significance is blade fluting (Roosa 1965; Roosa and Deller 1982; Storck 1983). In fact, it has been suggested that in the manufacture of eastern fluted points blade fluting postdates flake fluting, just as it does in Plains Paleo-indian material (Roosa 1965).

This is not proven: there is no stratigraphic evidence of a flake to blade fluting transition. On the other hand, areas that could only have been occupied late have only blade fluted points, while areas that could have been occupied early have both blade and flake fluted points.

To see this, note the distribution of Classes 1132, 2132 and 3132 (Figures 13-15) in the northernmost region of the eastern United States. These classes each have blade fluting, and the associated attributes of deep circular bases and downward projecting ears. These points are found as isolates throughout the periglacial region, as well as in sites within that region. Perhaps one can use the data from those sites to roughly date these points. Dated sites with these classes include Vail (Gramly 1982), Debert (MacDonald 1968:72-75) and Whipple (Haynes 1983:25). All three of these sites are reliably dated by the radiocarbon technique to approximately 10600 B.P. (Haynes et. al. 1983). This is late in the fluted point chronology; early Archaic Dalton materials are appearing about this time in the southeast (Goodyear 1982).

No class with flake fluting overlaps these far northern, blade fluted classes. Flake fluting is absent from the points of these late northeastern regions and sites. Instead, flake fluting is largely restricted to southern latitudes (see especially Figures 20, 21, 23 through 25). Where flake fluting occurs in northern areas (Figures 16 through 19), it occurs predominantly in the Great Lakes area. As argued in Chapter 5, the occupation of the Great Lakes region appears to predate the occupation of the far northeastern region.

This spatial evidence does not demonstrate that the two fluting techniques were successive in time. It suggests that blade fluting may outlast flake fluting or that both areas were occupied only during the period blade fluting was in use. The two fluting techniques may have been contemporaneous in part, but by the time the far northern areas were open for colonization and expansion only blade fluted points were being manufactured.

Of course there is also the possibility that the distribution of blade and flake fluting has no temporal significance, and instead reflects functional differences related to the different environments being exploited by these fluted point groups.

Were fluting techniques functionally determined in this manner it is difficult to explain why there is a commonality in fluting techniques between two so markedly different environments: a periglacial tundra and a mixed boreal/deciduous forest. Flake fluting is, in fact, absent in tundra areas, but blade fluting is found in both tundra and forest environments. Point function may vary between these two environments, but this attribute of point manufacture apparently does not.

For example, the projectile points with blade fluting from the tundra region, specifically the points from Vail (Classes 1132, 2132 and 3132), were used as projectile points. They show damage and breakage related to a projectile function, and their spatial distribution at the site - the point tips at the "killing ground", the point bases at the main site area - supports this. Yet the projectile points with blade fluting in the southern forest environments, Classes 4123 and 4133, likely had a different function. These points generally lack impact fractures, and have a size that suggests a more likely use was as a generalized cutting tool (Goodyear et al. 1983). In effect, there are differences between the tundra and forest fluted points, but those differences are in terms of point use, rather than method of point manufacture, thus supporting the view that the differences in blade and flake fluting are temporal.

If blade fluting is late, as it appears to be, then this confirms earlier suspicions (e.g. Mason 1962) that the Cumberland point type (Figure 28) is late in the eastern fluted point sequence. Given the distribution of this type, and assuming that blade fluting is, indeed, late, then the Cumberland material must either predate or be contemporaneous with the subsequent early Archaic materials which appear around 10500 B.P. but which are largely absent from the Ohio Valley.

It would be useful, although beyond the scope of this study, to map the distribution of early Archaic and so-called "late Paleo-indian" Dalton, Quad, Hardaway, Suwanee and Simpson points (the latter three being non-fluted) and compare those distributions with the distribution of Cumberland points and other blade fluted points. My suspicion, and it is only a suspicion, is that the distributions would be contiguous, indicating roughly contemporaneous occupations. For of the points and classes I have mapped, the Cumberland form has the most restricted spatial and temporal distribution, if my suggestions about blade fluting are correct, Cumberland is but another variety of late Paleo/early Archaic point.

This of course is a conclusion that one could not reach based solely on an analysis of Cumberland points in a site context; for there are no Cumberland points in a site context. Cumberland points, like the vast majority of eastern fluted points, are found in a non-site context.

In the final chapter, I examine some of the implications of a cultural occupation being represented in the archaeological record dominantly by thousands of isolated fluted points. Here, let me close by emphasizing the value of the survey and distributional data.

I analyzed a sample of isolated fluted points compiled from unpublished study of point survey materials and from the published literature. It was not a perfect sample. Yet through an analysis of the material I was able to derive reasonable circumstantial evidence for temporal and spatial differences in eastern fluted points. There is, therefore, good reason to continue the tradition of point surveys, but as Funk (1983) and Moeller (1983) point out, these surveys must be enhanced by more detailed information on point provenience. With more information made available - of the sort emphasized earlier and discussed again in the final chapter - we will have "a real basis for enlightenment" (Haynes 1983:25).

CHAPTER 7

SUMMARY AND IMPLICATIONS

I have dealt with three broad questions in this dissertation:

(1) What historical factors account for the creation and subsequent generalization of the archaeological myth of Paleo-indians as specialized big-game hunters?

(2) Is such an adaptation likely given the floral and faunal record for late and postglacial eastern North America; if not, what kinds of adaptive strategies might have taken place within these environments?

(3) What kinds of variation is evident in the current archaeological record of eastern fluted point materials, and does that variation inform on the spatial/temporal distribution and adaptive strategies of eastern fluted point groups?

I argued in Chapter 3 that to understand the origins of our views of Paleo-indian subsistence requires putting Paleo-indian studies in an historical context. There was, in the late 19th and early 20th century, a longstanding debate on human antiquity in North America. One side claimed there was an American Paleolithic, comparable in antiquity to the well documented European Paleolithic era; the other viewed human history on this continent as being geologically and chronologically recent, antedating Columbus by perhaps only a few hundred years.

This apparently straightforward argument on chronology was made extremely complex by the personnel involved. Those arguing the position that North American prehistory began in recent times were scientists of the Bureau of American Ethnology (or BAE) who, under the direction of John Wesley Powell, were busy trying to create an archaeological science in their own image. Supporters of an American Paleolithic - who not surprisingly were all non-government scientists - were attacked as part of the BAE's larger attempt, as Cyrus Thomas put it in 1880, to create a "New Archaeology". For reasons that I discussed, BAE scientists were unwilling theoretically or empirically to accept an American Paleolithic.

Yet these scientists were not being dogmatic. For there was never clearcut evidence either supporting or refuting a human presence in North America during the glacial period. Arguments for the American Paleolithic relied heavily on dubious typological analogues between American and European "paleoliths"; the geological evidence that purported to show human remains in Pleistocene-age strata was simply ambiguous.

The antiquity debate was finally resolved at Folsom, New Mexico in 1927. At Folsom projectile points were found embedded in the ribs of an extinct form of bison. It is important to recognize that in the absence of absolute dating techniques a kill site like Folsom was the only kind of site where the longstanding debate on antiquity could be resolved. Any other site where artifacts and Pleistocene megafauna appeared to be associated would have been - and had been since the 1890s - easily and quickly dismissed as a fortuitous association due to stratigraphic mixing. Unlike other Pleistocene North American occupations, Folsom produced an unequivocal record: projectile points between ribs could not be dismissed.

Yet the importance of Folsom is not limited to the resolution of the chronological issues; it had repercussions throughout archaeological theory and practice. Among other influences, the "culture history" of the pre-Binford era is a direct response to Folsom, as are the views we hold today of Paleoindian adaptations. Regarding the latter, in the years following the Folsom discovery, a whole series of Paleo-indian sites appeared on the western Plains. Not surprisingly, most were kill sites: after all, the remains of animals like mammoth and bison are highly visible archaeologically, and it was the discovery of the bones that led to the artifacts and not the reverse. This repeated association of fluted points and megafauna led to the generalization that this represented the essential Paleoindian adaptive strategy. When fluted points were found over much of eastern North America, the presumed adaptive strategy was extended there as well. But again, there have been no unequivocal kill sites comparable to those in the plains found east of the Mississippi River.

To compensate for the lack of kill sites, a number of bits of indirect evidence have been advanced to support the thesis of continental wide specialized big-game hunting. Among these is the alleged uniformity in fluted points and the Paleo-indian tool kit, thought to reflect the rapid spread of related groups in pursuit of the elusive megafauna. The fact is, however, that fluted points and the Paleo-indian tool kit are quite variable, as demonstrated in Chapters 5 and 6.

A second line of indirect evidence for "specialized" hunting in the east is the so-called Mason-Quimby line (Martin 1967). Fluted points and the remains of extinct megafauna are found in the same areas of Michigan and, while the remains are never physically associated, this coincidence is thought to indicate their prehistoric interaction. This correlation, however, is restricted to a very small area - the lower peninsula of

Michigan - and is not apparent throughout the remainder of the eastern United States and Canada. Vast numbers of proboscidean remains are found in areas lacking fluted points and vice versa. Where abundant remains of each are found in the same area, they are never physically associated. In all likelihood the coincidence of their distribution is best explained by the fact that these remains were deposited and subsequently exposed on surfaces of like age. That they were contemporaries is not equivalent to the interaction assumed in the big-game hunting model.

Finally, whether or not Paul Martin's (1973) specific model of Pleistocene extinction by human overkill is accepted, archaeologists have pointed to this episode as evidence of widespread specialized hunting. The timing of the extinction process, which is said to correlate precisely with the Clovis occupation, is marshalled in support of this argument. Yet a critical analysis of the relevant radiocarbon record (Chapter 2) raises some questions about the apparent synchroneity. The analysis reveals that the Carbon-14 record is strongly biased by a disproportionate number of dated Clovis sites. Whether a site is dated and whether it has associated human remains are not independent variables. So the chronological correlation between extinctions and human hunting may be more apparent than real. Moreover, very little is known of the population dynamics of extinctions. The process could well have started thousands of years before the appearance of the Clovis hunters, making any chronological correlation irrelevant. The connection, if it exists, might also be secondary; that is, both caused by a third variable (e.g. climate).

Having argued that the received view of eastern Paleo-indian subsistence is incorrect, I advanced an alternative model, based on the paleoenvironmental record and models of foraging theory.

There were two major biotic communities in eastern North America during the late Pleistocene, and each posed markedly different adaptive settings (Chapter 4). The first of these was a periglacial tundra, which existed at high altitudes in the Appalachians, and along the ice margin in Ohio and east through New England. The tundra was both a climatic and successional phenomenon, and it steadily broadened then shrank with the northward retreat of the ice. This was a low diversity environment, but included such highly abundant resources as the caribou.

The second, more extensive community was a complex forest south of the ice and tundra some 1000 km wide. Pollen cores indicate this forest was dominated by _Picea_ (spruce), both near the ice sheet and in areas far south of it, where boreal species cannot survive today (areas such as central Georgia and Tennessee). Animal species with boreal affinities occured throughout the eastern states. For example, the modern ranges of the Arctic shrew (_Sorex arcticus_), and yellow-cheeked vole (_Microtus xanthognathus_), are all north of the continental United States in Canada and Alaska. Yet both species occurred in Pleistocene aged deposits in southern Pennsylvania (New Paris No. 4, Bootlegger sink), Virginia (Clark's Cave), and Tennessee (Baker Bluff). As was the case with the pollen, the boreal fauna diminish in frequency in a gradient running north-south.

But as both the pollen and faunal records attest, this community was not entirely boreal in character. High spruce values are accompanied by relatively high values (on the order of 5-25%) of deciduous tree species. This is expected in cores from southern latitudes, since many of these forests were essentially modern in character by 16000 years ago. However these admixtures are not limited to the southern states. Kirchner Marsh (MN), Allenberg Bog (NY) and Moulton Pond (ME), for example, all have relatively high percentages and absolute values for Quercus (Oak), Ulmus (Elm), and Carya (Hickory). Living together in the late Pleistocene at Clark's Cave, Virginia, were species with as diverse a set of habitats as the yellow-cheeked vole, the 13-lined ground squirrel, and the pine vole.

The pollen and faunal evidence indicates that the late Pleistocene "boreal" forest was a mosaic of deciduous tree species, grasses, and sedges within a broader coniferous matrix. This sympatry of species now allopatric made this community significantly different than the modern boreal forest. This has implications for late Pleistocene human adaptation, since this community was highly diverse and thus had relatively lower numbers of individuals per species.

Foraging strategies in all organisms, human beings included, range on a continuum from specialized to generalized (Cleland 1976). Generalists consume a relatively wide range or diversity of food types, have a variety of feeding behaviors, and can extract energy from diverse resources. Specialists have more restricted feeding behavior and extract energy from a few resources. Human groups are, of course, capable of foraging strategies at both ends of the continuum.

As a rule, specialization requires a high degree of resource reliability, availability and relative abundance (a high expectation of locating prey and high effective density). One consequence is that, at least with omnivorous human beings who have high energy requirements, specialization occurs most often in environments of low diversity, since only low diversity environments generally have sufficient numbers of individuals of a single species to provide the requisite biomass and energy to make dietary specialization an efficient option. In equilibrium populations living in diverse environments, generalized foraging strategies are more likely to evolve. This is, of course, dependent on population density, the density of various food items, and food harvesting abilities. While initial colonizers in an environmentally diverse region may be specialists if the appropriate resource is present, as population increases diet breadth either expands or the population will be limited by the resource density. This is what yields the phenomena that Caldwell (1958) labelled "primary forest efficiency" (which is actually a misnomer since as more food types are added, the handling efficiency drops).

The fact that specialized subsistence strategies are rare in the eastern forests prior to the appearance of agriculturalists (who, of course, modify and simplify their environment) is strong supporting evidence that adaptive specialization is generally uncommon among human groups in diverse environments.

The adaptive strategies of fluted point groups in the complex boreal/deciduous forests and tundra or near tundra environments was necessarily quite different. Paleo-indian groups living on the tundra and tundra-forest ecotone were, in all probability, specialists exploiting caribou, the only species in that environment that would yield sufficient economic return to allow humans to survive. There is ample ethnographic evidence from, for example, the Caribou-eater Chipewyan and Caribou Eskimo (Coombs 1980; Heffley 1981; Smith 1978) that specialized caribou hunting is quite viable, although it requires high mobility and fluidity in the social system to reduce search and handling costs. Importantly, it appears that these ethnographic groups ate little else.

Paleo-indian groups in the species-rich eastern forests were, I suspect, generalists, who exploited a variety of subsistence resources, including seeds and nuts, small mammals, and, perhaps, an occasional deer or mastodon.

The few sites that have preserved organic subsistence remains support these inferences. Caribou bones were recovered at three sites (Bull Brook, Dutchess Quarry Cave and Whipple); at a fourth site (Shawnee-Minisink), fruits, nuts and fish remains were recovered. The environmental setting of these sites is obscure, but it is known that Shawnee-Minisink was situated in the midst of the complex eastern forests. The sites with caribou bones are all located in the glaciated northeast, conceivably within or near periglacial tundra.

I have analyzed (Chapter 5) the assemblage data from a dozen of the eastern Paleo-indian sites, which included sites situated in tundra environments and sites located in the complex boreal/deciduous forests. Despite the argument that the Paleo-indian tool kit is essentially uniform throughout North America, there is significant variation in these assemblages and, more importantly, significant differences in tundra versus forest sites.

One of the most striking differences in tundra and forest sites involves tool production and use. Tool kits in the tundra sites are dominated by projectile points, scrapers, bifacial knives and drills. The tools are highly modified; simple <u>ad hoc</u> flake tools are virtually absent. These assemblages are often exhausted; few tools at any of these sites are larger than 50 mm in length, and there is little useable detritus. Projectile points are commonly reused, heavily worn, and often damaged.

So-called pieces esquillees are abundant in these assemblages; it is unclear whether these tools were used as wedges or bipolar cores, the latter representing intensive reduction and recycling of lithic raw material.

By contrast, assemblages in the forest sites are more indulgent. Where lithic reduction at the tundra sites was highly systematic and efficient, in forest sites it was wasteful. Core forms typically are blocky and irregular, producing a great deal of debitage. The tool kits are dominated by simple flake tools, showing little preparation or functional specificity.

There are differences as well in settlement mobility. Tundra sites are uniformly dominated by lithic raw material derived from non-local sources. This is not unexpected given the logistical disparity between a predictable but stationary resource (stone) and a relatively unpredictable and mobile resource (caribou). By contrast, the forest sites and fluted point materials exhibit less long range mobility and a greater reliance on locally occurring raw material.

There are also differences in the site record itself. Sites are not scattered evenly across the area of occupation, but rather are relatively infrequent in the forested east. Surface age and modern agricultural practices may partly account for this pattern. It is interesting to speculate, however, that this might also reflect differences in prehistoric land use. The resources exploited by generalized foragers are extensive and dispersed; more importantly, activities like nut-collecting leave little readily observable food remains to mark their former location or the tools employed. The isolated fluted point may constitute a large fraction of the archaeological record as it was created.

By contrast, specialized hunters who focus on intensive exploitation of point resources such as the caribou, produce a site record more conducive to discovery. The semi-annual migration of this species is sometimes patterned, with the result that certain localities are used and reused on a seasonal basis. Bull Brook, Reagen, Shoop, Vail and Debert all show signs of multiple seasonal occupations. Long-term habitation sites are uncommon in the forests; there the common site is associated with quarrying stone.

It is interesting that the tundra sites - and the three sites with actual caribou remains - are all situated in a similar manner: they are located within a river valley or lake plain where the natural topography would have channeled any animal migration directly toward the site (this is a feature common in ethnographic settings).

These differences between tundra and forest sites reinforce an alternative view of eastern Paleo-indian subsistence systems. The traditional notion that Paleo-indian subsistence was uniform throughout the continent is ecologically improbable, and does not stand up to close empirical scrutiny.

The view that these late Pleistocene human adaptations involved both specialized and generalized subsistence strategies makes more sense theoretically, and helps resolve an old anomaly. Mason observed in 1962 that Dalton tool kits of the early Archaic are remarkably similar to the Paleo-indian tool kits of the eastern forests. As Morse later (1976) put it: "tools associated with the Dalton points [indicate] a close kinship to other early complexes" (Morse 1976:139; Morse 1978). In the traditional interpretation of Paleo-indian and Dalton this "kinship" was anomalous, since the two cultures were thought to have practiced completely different adaptive strategies: one specialized, the other generalized. Any incongruity, of course, disappears when eastern fluted point groups are seen as simply an earlier form of the generalized strategy so evident by Dalton times.

But what is more provocative about this alternative view of Paleo-indian adaptations are its implications for settlement organization among forest groups of the late Pleistocene. The archaeological record of eastern forest fluted point groups lacks the sites that are commonly anticipated and encountered in the archaeological record for contemporaraneous specialized hunters in the tundra and southern Plains. The archaeological record in the southern forests consists almost solely of isolated fluted points and quarry or quarry related sites.

These settlement patterns are in keeping with my arguments about the structure of the environment and the constraints it set on subsistence patterning, for they suggest that the eastern fluted point groups were true ecological foragers, "wandering" over the landscape exploiting a variety of plant and animal species and never participating in the highly structured spatial behavior that produces sites. As Binford (1980) argues

> Under low bulk extraction or low redundancy in localization, the archaeological remains of _locations_ [places where extractive tasks are carried out] may be scattered over the landscape rather than concentrated in recognizable "sites" (Binford 1980:9,emphasis in original).

The most significant - and the most abundant - archaeological manifestation of the eastern forest fluted point foragers is the highly adaptive, multifunctional hafted knife long identified as a fluted "projectile" point. It was the need to produce and manufacture that tool that led to the redundant use of particular stone outcrops, and thus to the creation of quarry and quarry-related sites.

Understanding and recognizing the remains left by foragers requires data-collecting techniques different from those that archaeologists normally employ (Binford 1980:9). The traditional focus in eastern fluted point studies has been on the discovery and excavation of sites. It is an approach long frustrated by an evident lack of sites (MacDonald 1983). Moreover, as Binford argues, it is also the wrong approach, for the archaeology of foraging groups requires "off-site" archaeological strategies (Binford 1980:9).

The archaeology of the forest fluted point groups must begin with the recognition that the archaeological record for eastern fluted point groups is not comprised of abundant sites, as it is in the tundra and on the Plains, but instead is a dispersed occupation manifest by many thousands of isolated fluted points. The focus should be on the recovery and analysis of this class of data.

As noted earlier, detailed data on isolated fluted points is sparse. A great deal could be done were more known about the thousands of isolated fluted points. The precise recording and location of these points in terms of topographic setting, physiographic location, proximity to raw material source, and paleoenvironmental setting - to name a few of the more important variables - would be a valuable first step. Again, one has to assume that the isolated object - the single fluted point - is itself a "site".

In addition, careful functional analysis of each of these isolated fluted points is extremely important. Such analysis should prove that the vast majority of these isolated points had many different uses, and reinforce the claims here that these were multi-purpose tools. Critical to this kind of analysis is the determination that the find location is Paleo-indian and not a later reuse.

The bias toward searching for fluted point sites in the eastern forests neglects an important data source and, if my suggestions are correct, may be a relatively fruitless venture. There simply may not be sites out there of the sort long assumed to exist.

These patterns of fluted point settlement organization in the eastern forests also have implications for the controversial and still unresolved search for pre-Paleo or "Middle" and "Early" (Haynes 1969) Paleo indian remains. The search for such ancient materials has always focused on the discovery of sites dating to the period prior to 12000 B.P. (Haynes 1966, 1969, 1977). Much is made of the relatively abundant and well-documented Clovis sites, and the commensurate lack of abundant sites predating Clovis (Haynes 1966; Klein 1973). This is taken as prima facie evidence of the fact that Clovis is the earliest occupation on the continent, and that earlier materials do not exist.

But if Clovis "kill" sites are not representative of the archaeological remains of fluted point occupations, and instead represent, as I argued at the beginning of this work, a temporally and spatially isolated yet highly visible aspect of that occupation, then expectations derived from the Clovis data are quite irrelevant to gauging whether pre-Clovis materials exist. There may not be any reason to expect that pre-Clovis occupations are represented by sites in the traditional sense.

If there were pre-Clovis occupations in the eastern forests, it is likely that their subsistence and settlement organization was similar to the fluted point groups of the eastern forests. Thus the search for that occupation cannot be in terms of sites but must instead focus on the paleogeographic distribution of individual tool classes that may represent early forms of the fluted point. One such tool class that immediately comes to mind is the Miller Lanceolate point discovered in middle Stratum IIa at Meadowcroft Rockshelter (Adovasio 1983).

Continued searching for "pre-Clovis" sites in eastern North America is unlikely to produce any substantial record, and in truth may be downright misleading. Binford (1981) has observed that over the long sweep of prehistory "archaeological deposits are relatively rare and are commonly a derivative of <u>recent complex cultural systems</u> (Binford 1981:293, emphasis mine). It behooves archaeologists to examine the record accordingly.

Having said a great deal about the eastern forest occupation, let me close with some general comments on the nature of the northeastern tundra adaptive strategy, and its similarity to post-Clovis plains occupations.

The tundra fluted point occupation appears to be both late in the fluted point sequence, and quite distinct from the occupations to the south of it. The subsistence and settlement strategies are relatively uniform throughout the sites in the region, as are aspects of the toolkits and fluted points. There is, for instance, an identity in points between sites as distant as the lower peninsula of Michigan and the Hudson Valley and Atlantic seaboard.

Radiocarbon dates from Debert, Vail and Whipple date part of this tundra occupation to around 10600 B.P. The Paleo-indian occupation on the tundra is evidently both later and more tightly restricted in time than the fluted point occupation in the eastern forests. From this, toolkit evidence, and data from the point distributions, one can reasonably construe that the ancestral populations of the tundra fluted point groups were the generalized foragers of the eastern forests.

This historical divergence is intriguing for two reasons: it indicates that the tundra groups developed a specialized subsistence strategy from a generalized forager base; and it illustrates a fascinating case of evolutionary convergence. The tundra adaptation became highly similar to that practiced on the Plains by Folsom times. This adaptive convergence is understandable insofar as both tundra groups and Folsom hunters adapted to structurally similar biotas (non-wooded environments with large gregarious herd animals).

But unlike the Folsom hunters, whose bison hunting descendants are highly visible on the Plains, the tundra Paleo-indians disappear from archaeological sight by the early Holocene. The reasons are obscure, but one thought comes to mind. Specialized systems evolve by intensification and thus, over the long haul, are quite vulnerable to environmental change (Dunnell 1972; compare Cleland 1976). Generalized strategies, however, evolve through diversification, and are thus more stable. And that, one suspects, is why the prehistory of eastern North America after the Paleo-indians is the history of the descendants of the generalists of the eastern forests.

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APPENDIX
FLUTED POINT DATA

The following Appendix presents the data used in the fluted point analysis in Chapter 6. This includes the data from fluted points I examined in museums and private collections, as well as data I utilized from the published literature.

There are four columns of information. From left to right, Column 1 is a two-digit code representing the number of the state in which the point was found. The numbering system follows the alphabetic ordering of the states, so that 07 is Delaware, 09 is Georgia, and so on. The occasional 1,2 or 9 appended to the front of these two digits is to be ignored.

Column 2 is the classification of the fluted point using the dimensional classification developed in Chapter 6. See that Chapter for the details of the classes and modes.

Column 3 is the sequence number assigned the point in analysis. Sequence numbers 7-370, and 1385-1451 are points that I examined myself. Sequence numbers 371-1098 and 1452-1480 are from the published literature.

Column 4 is a listing of the relevant cataloging information. For those points I examined myself, I have tried in all cases to list the museum or collection where the point is curated, and the point's catalogue or accession number. For those points I utilized from the published literature, I have included a citation of the publication, and descriptive information that will allow the identification of the point in the publication's photographs or tables. All citations to published works are listed in the Bibliography that precedes this Appendix.

07	1012142	07	PEABODY MUSEUM NO. 88-8-10:46726
09	4122332	08	SMITHSONIAN NO. 132179
09	1042244	10	SMITHSONIAN NO. 171684
09	1042234	12	SMITHSONIAN NO. 174064
09	1062211	13	SMITHSONIAN NO. 174064
09	1032132	14	SMITHSONIAN NO. 174064
09	2034134	15	SMITHSONIAN NO. 174064
09	3033244	17	SMITHSONIAN NO. 210120
09	4073344	19	SMITHSONIAN NO. 210120
09	1102132	23	SMITHSONIAN NO. 210120
11	1033232	26	SMITHSONIAN
11	2053222	27	SMITHSONIAN NO. 32524
912	1103123	34	SMITHSONIAN NO. 140748
12	1033232	35	PEABODY MUSEUM NO. 78-5-10:15712
15	2033232	36	SMITHSONIAN NO. 19238
15	1033133	37	PEABODY MUSEUM NO. 82-58-10:28377
15	1044234	38	PEABODY MUSEUM NO. 87-24-10:42473

15	1102132	39	PEABODY MUSEUM NO. 87-24-10
15	1102131	40	PEABODY MUSEUM NO. 87-29-16:42475
15	2015444	41	PEABODY MUSEUM NO. 25-15-10:93905
15	1103232	42	PEABODY MUSEUM NO. 87-24-10:43096
15	1074232	43	PEABODY MUSEUM NO. 78-52-10:15471
15	1031133	44	SMITHSONIAN NO. 214526
15	1143222	46	SMITHSONIAN NO. 287569
15	4033212	47	SMITHSONIAN NO. 287570
18	1031144	49	SMITHSONIAN NO. 382705
18	1044232	50	SMITHSONIAN NO. 461189
31	1033144	66	SMITHSONIAN NO. 272986
30	2013231	67	SMITHSONIAN NO. 397665
233	1042233	68	SMITHSONIAN NO. 224142
233	1103233	69	SMITHSONIAN NO. 224142
233	1143233	70	SMITHSONIAN NO. 224142
233	1113222	71	SMITHSONIAN NO. 224142
933	2034232	73	PEABODY MUSEUM NO. 56-10-10:35336
133	2033232	74	PEABODY MUSEUM NO. 84-68-10:36168
33	3013122	75	PEABODY MUSEUM NO. 89-64:34324
233	2033232	76	PEABODY MUSEUM NO. 45-6-10:27595
233	1062132	77	PEABODY MUSEUM NO. 45-6-10:27596
36	1032232	78	SMITHSONIAN NO. 402467
36	1034232	79	SMITHSONIAN NO. 402471
36	1032234	80	SMITHSONIAN NO. 402472
36	1034234	81	SMITHSONIAN NO. 402473
36	1132132	82	SMITHSONIAN NO. 402474
36	4133134	83	SMITHSONIAN NO. 402475
36	7135442	84	SMITHSONIAN NO. 402476
36	6054232	85	SMITHSONIAN NO. 402477
36	1103232	86	SMITHSONIAN NO. 402479
36	1064134	87	SMITHSONIAN NO. 402480
36	1012134	88	SMITHSONIAN NO. 402481
36	1102232	89	SMITHSONIAN NO. 402483
36	1033234	90	SMITHSONIAN NO. 402485
36	1035442	91	SMITHSONIAN NO. 402486
36	3035242	92	SMITHSONIAN NO. 402487
36	1035442	93	SMITHSONIAN NO. 402488
36	1155442	94	SMITHSONIAN NO. 402489
36	1031133	95	SMITHSONIAN NO. 402490
36	1035442	96	SMITHSONIAN NO. 402491
36	7035443	97	SMITHSONIAN NO. 402492
36	7155442	98	SMITHSONIAN NO. 402493
36	7155443	99	SMITHSONIAN NO. 402494
36	7155443	100	SMITHSONIAN NO. 402495
36	1155442	104	SMITHSONIAN NO. 402499
36	7155444	105	SMITHSONIAN NO. 402500
36	1033232	106	SMITHSONIAN NO. 402501
36	1033232	107	SMITHSONIAN NO. 402502
36	1033232	108	SMITHSONIAN NO. 402503
36	7155444	109	SMITHSONIAN NO. 402504
36	1155444	110	SMITHSONIAN NO. 402505
36	1154132	111	SMITHSONIAN NO. 402506
36	1082132	112	SMITHSONIAN NO. 402507

36	1153132	113	SMITHSONIAN NO. 402508
40	6013233	114	SMITHSONIAN NO. 404550
40	1035232	115	SMITHSONIAN NO. 65806
40	1062132	116	SMITHSONIAN NO. 30175
40	4012312	117	SMITHSONIAN NO. 8241
44	1032142	119	SMITHSONIAN NO. 362902
44	3033232	120	SMITHSONIAN NO. 362902
44	1103222	122	SMITHSONIAN NO. 391884
47	2035442	123	SMITHSONIAN NO. 338997
47	1043233	126	SMITHSONIAN NO. 71562
47	2112132	127	SMITHSONIAN NO. 385651
47	7023233	129	SMITHSONIAN NO. 391822
99	2073232	131	SMITHSONIAN
01	7043233	132	SMITHSONIAN NO. 327923
01	7093333	136	SMITHSONIAN NO. 327923
01	4102332	138	SMITHSONIAN NO. 61338
15	2074232	139	SMITHSONIAN NO. 149943
22	2153222	140	SMITHSONIAN NO. 114593
44	1131132	141	THUNDERBIRD MUSEUM (GARDNER AND VERREY 1979:NO. 4)
44	7151143	142	THUNDERBIRD MUSEUM (GARDNER AND VERREY 1979:NO. 5)
44	6112442	143	THUNDERBIRD MUSEUM (GARDNER AND VERREY 1979:NO. 7)
44	2012132	145	THUNDERBIRD MUSEUM
44	1153232	146	THUNDERBIRD MUSEUM (GARDNER AND VERREY 1979:NO. 21)
44	1033244	147	THUNDERBIRD MUSEUM (GARDNER AND VERREY 1979:NO. 13)
44	4015242	148	THUNDERBIRD MUSEUM (GARDNER AND VERREY 1979:NO. 19)
44	1015442	149	THUNDERBIRD MUSEUM (GARDNER AND VERREY 1979:NO. 1)
44	4042232	150	THUNDERBIRD MUSEUM (GARDNER AND VERREY 1979:NO. 30)
31	1092232	164	UNC NO. R-1
31	1032133	165	UNC NO. R09-359
31	6033232	183	UNC
31	2143232	184	UNC
38	1144232	196	USC NO. 98
38	2104132	197	USC NO. 93
38	2053232	199	USC NO. 94
38	1142144	200	USC NO. 72
38	3033233	201	USC NO. 28
38	1012144	202	USC NO. 92
38	1042244	203	USC NO. 75
38	1135444	204	USC NO. 78
38	1101144	205	USC NO. 70
38	2093242	210	USC NO. 7
38	1033233	211	USC NO. 1121
38	1032243	212	USC NO. 77
38	1153244	213	USC NO. 66
40	1101132	214	UT NO. 2/101
40	4013322	215	UT NO. MG31/256
40	1052142	216	UT NO. LO35/969
40	4052322	217	UT NO. PK3/120
40	1052132	218	UT NO. HA80/120
40	1012132	219	UT NO. HA54/120
40	3022232	220	UT NO. HA80/120
40	1032132	221	UT NO. HA74/120
40	7015442	222	UT NO. H560/109

40	7115442	223	UT NO. H560/112
40	1012233	224	UT NO. H560/114
40	1103232	227	UT NO. H560/2731
40	1012142	228	UT NO. MRG2/125
40	1033232	229	UT NO. MR2
40	4013312	230	UT NO. 2/107
40	4015412	231	UT NO. 1/275
40	4013322	232	UT NO. 24/103
40	1102232	233	UT NO. 11/103
40	1104132	234	UT
911	4132332	236	UT NO. 90/103
912	4013312	237	UT NO. 2/103
912	2042132	238	UT NO. 8/103
912	1132132	239	UT NO. 17/103
15	2123132	240	UT NO. 22/103
15	2013132	241	UT NO. 10/103
22	2033133	242	UT NO. 2/70
22	2013232	243	UT NO. 1/70
40	4013322	247	UT NO. HA43
40	4062312	248	UT NO. 141E A7
40	1133232	249	UT NO. 141E 27
40	7055442	250	UT NO. 141E A26
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40	1152242	252	UT NO. 141E A1
40	4053311	253	UT NO. 140E
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40	4012312	255	UT NO. 37
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40	7014133	258	UT NO. 140E
40	7015442	259	UT
40	1102211	260	UT NO. 140E A3
99	2063222	261	UT NO. 6/103
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99	1132132	263	UT NO. 21/103
99	4031332	264	UT NO. 38/103
15	3012242	265	UKMA NO. HK45/2523
15	2102144	266	UKMA NO. HK45/1581
15	1013242	267	UKMA NO. HK45/1580
15	2153244	268	UKMA NO. HK45/1582
33	2013232	270	OHS NO. 1021
233	2013232	271	OHS NO. 851/11
233	1033232	272	OHS NO. 10/23
933	2083132	273	OHS
233	4032332	274	OHS NO. 203/222
133	4042332	275	OHS NO. 815/27
133	3013232	276	OHS NO. 200
33	3013222	277	OHS NO. ?/106
133	3013222	278	OHS
233	4013322	279	OHS NO. 67/503
133	4993342	280	OHS
133	2045442	281	OHS NO. 200
133	7155444	282	OHS NO. 164/6

15	7015441	283	OHS	NO. 230/5
133	4113332	284	OHS	NO. 1929/159
133	7055441	285	OHS	NO. 967
133	7015442	286	OHS	NO. 11250
133	7115441	287	OHS	NO. 19528
33	1015242	288	OHS	NO. 266
233	1013232	289	OHS	NO. 128/35
33	2053222	290	OHS	NO. 15/9
33	2054232	291	OHS	NO. 15/9
133	2013242	292	OHS	NO. 13/4
33	2032132	293	OHS	NO. 308/99
233	1014232	294	OHS	NO. 11/28
133	2053232	295	OHS	NO. 206/13
233	1153232	296	OHS	NO. 1929/155
933	1103232	297	OHS	NO. 20/103
133	4112311	298	OHS	NO. 3876/6
133	2063232	299	OHS	NO. 251/63
133	2033232	300	OHS	NO. 13/37
133	2123232	301	OHS	NO. 107/14
133	1032232	302	OHS	
33	1032232	303	OHS	NO. 967/2
233	1033232	304	OHS	NO. 21194
933	2032232	305	OHS	NO. 206/13
133	2033232	306	OHS	NO. 1437/19
133	1103232	307	OHS	NO. 13/14
933	2103242	308	OHS	
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133	2013232	310	OHS	NO. 107/14
33	1013232	311	OHS	NO. 12012
133	1015443	312	OHS	NO. 18718
133	7015442	313	OHS	NO. 19200
133	2113232	314	OHS	NO. 164
233	1015242	315	OHS	NO. 841
933	2014233	316	OHS	NO. 203/222
133	2042232	317	OHS	NO. 13/11
33	1032232	318	OHS	NO. 12/58
133	3042232	319	OHS	NO. 244/35
33	1013242	320	OHS	NO. 79
133	6042233	321	OHS	NO. 305/37
233	1054212	322	OHS	NO. 73/35
233	6102133	323	OHS	NO. 223/2
133	2042232	324	OHS	NO. 251/65
233	1155443	325	OHS	NO. 11/30
133	6032233	326	OHS	NO. 13/15
33	4055442	327	OHS	NO. 266/?
33	2045442	328	OHS	NO. 161
33	2052232	329	OHS	NO. 266
33	2122232	330	OHS	NO. 266/11
933	2033232	331	OHS	NO. 815/30
933	2103232	332	OHS	NO. 251
33	2153233	333	OHS	NO. 266
133	2115232	334	OHS	NO. 967/2
133	1102432	335	OHS	NO. 306

133	2012232	336	OHS NO. 164/5
33	1013212	337	OHS NO. 15/9
133	1032132	338	OHS NO. 815/27
933	2033232	339	OHS NO. 147/30
133	1032132	340	OHS NO. 164/6
33	3015442	341	OHS NO. 9111
133	4112332	342	OHS NO. 306/63
33	1115442	343	OHS NO. 266
33	1104232	344	OHS NO. 266
233	1132232	345	OHS NO. 128/35
133	7015442	346	OHS NO. 244/37
33	7115442	347	OHS NO. 266/1
933	2044232	348	OHS NO. 217/2
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33	2012132	350	OHS NO. 266/11
233	2032132	351	OHS NO. 48/134
133	1033232	352	OHS NO. 21231
133	1132132	353	OHS NO. 177
233	1102132	354	OHS NO. 272
233	4112332	358	OHS NO. 85/9
133	4013332	359	OHS NO. 110/11
233	1102132	360	OHS NO. 272
233	1042133	361	OHS NO. 223/1
133	6043132	362	OHS NO. 815/30
133	1103132	363	OHS NO. 251
933	1132133	364	OHS NO. 147/30
233	1042132	365	OHS NO. 2121/364
133	1102132	366	OHS NO. 1951/13
233	1102132	367	OHS NO. 272/2
233	1103132	368	OHS NO. 297/24
233	1012132	369	OHS NO. 2179/1
33	1103233	370	OHS NO. 199/9
33	715544	371	(PRUFER AND WRIGHT 1970:TABLE 1)
33	715544	372	(PRUFER AND WRIGHT 1970:TABLE 1)
33	715544	373	(PRUFER AND WRIGHT 1970:TABLE 1)
33	715544	374	(PRUFER AND WRIGHT 1970:TABLE 1)
33	715544	375	(PRUFER AND WRIGHT 1970:TABLE 1)
33	715544	376	(PRUFER AND WRIGHT 1970:TABLE 1)
33	715544	377	(PRUFER AND WRIGHT 1970:TABLE 1)
33	715544	378	(PRUFER AND WRIGHT 1970:TABLE 1)
33	715544	379	(PRUFER AND WRIGHT 1970:TABLE 1)
33	715544	380	(PRUFER AND WRIGHT 1970:TABLE 1)
30	102323	381	(RITCHIE 1957:PLATE CAPTION 16)
30	103313	382	(RITCHIE 1957:PLATE CAPTION 18)
30	205322	383	(RITCHIE 1957:PLATE CAPTION 28)
30	215324	384	(RITCHIE 1957:PLATE CAPTION 12)
30	201323	385	(RITCHIE 1957:PLATE CAPTION 1)
30	110323	386	(RITCHIE 1957:PLATE CAPTION 2)
30	101221	387	(RITCHIE 1957:PLATE CAPTION 3)
30	103223	388	(RITCHIE 1957:PLATE CAPTION 4)
30	201324	389	(RITCHIE 1957:PLATE CAPTION 15)

30	202323	390	(RITCHIE 1957:PLATE CAPTION 9)
30	202423	391	(RITCHIE 1957:PLATE CAPTION 13)
30	304324	392	(RITCHIE 1957:PLATE CAPTION 17)
30	201322	393	(RITCHIE 1957:PLATE CAPTION 20)
30	303323	394	(RITCHIE 1957:PLATE CAPTION 5)
30	401232	395	(RITCHIE 1957:PLATE CAPTION 32)
30	115214	396	(RITCHIE 1957:PLATE CAPTION 36)
30	215214	397	(RITCHIE 1957:PLATE CAPTION 37)
30	215114	398	(RITCHIE 1957:PLATE CAPTION 34)
30	301324	399	(RITCHIE 1957:PLATE CAPTION 39)
30	301323	400	(RITCHIE 1957:PLATE CAPTION 41)
30	101323	401	(RITCHIE 1957:PLATE CAPTION 40)
30	103323	402	(RITCHIE 1957:PLATE CAPTION 31)
30	603344	403	(RITCHIE 1957:PLATE CAPTION 29)
30	215214	404	(RITCHIE 1957:PLATE CAPTION 35)
30	304323	405	(RITCHIE 1957:PLATE CAPTION 14)
30	101223	406	(RITCHIE 1957:PLATE CAPTION 33)
30	301311	407	(RITCHIE 1957:PLATE CAPTION 43)
30	401323	408	(RITCHIE 1957:PLATE CAPTION 44)
30	104324	409	(RITCHIE 1957:PLATE CAPTION 45)
30	202313	410	(RITCHIE 1957:PLATE CAPTION 47)
30	104413	411	(RITCHIE 1957:PLATE CAPTION 10)
30	201321	412	(RITCHIE 1957:PLATE CAPTION 7)
30	401323	413	(RITCHIE 1957:PLATE CAPTION 26)
30	405223	414	(RITCHIE 1957:PLATE CAPTION 23)
30	410233	415	(RITCHIE 1957:PLATE CAPTION 22)
30	103323	416	(RITCHIE 1957:PLATE CAPTION 25)
30	201323	417	(RITCHIE 1957:PLATE CAPTION 6)
30	203213	418	(RITCHIE 1957:PLATE CAPTION 8)
30	201323	419	(RITCHIE 1957:PLATE CAPTION 19)
30	101323	420	(RITCHIE 1957:PLATE CAPTION 11)
30	405333	421	(RITCHIE 1957:PLATE CAPTION 21)
30	415234	422	(RITCHIE 1957:PLATE CAPTION 52)
30	204324	423	(RITCHIE 1957:PLATE CAPTION 51)
30	211324	424	(RITCHIE 1957:MAYER-OAKES 1955:PLATE 1A)
30	210214	425	(RITCHIE 1957:MAYER-OAKES 1955:PLATE 1C)
30	211213	426	(RITCHIE 1957:PLATE CAPTION 50)
30	201323	427	(RITCHIE 1957:PLATE CAPTION 49)
30	104313	428	(RITCHIE 1957:PLATE CAPTION 48)
30	201213	429	(SAXON 1973:FIGURE 1A)
30	203323	430	(SAXON 1973:FIGURE 1B)
30	105423	431	(SAXON 1973:FIGURE 1D)
30	210223	432	(SAXON 1973:FIGURE 1E)
30	103224	433	(SAXON 1973:FIGURE 1F)
30	403223	434	(SAXON 1973:FIGURE 2B)
30	104213	435	(SAXON 1973:FIGURE 2C)
30	115213	436	(SAXON 1973:FIGURE 2D)
20	204223	437	(MASON 1958:TABLE II)
20	301323	438	(MASON 1958:TABLE II)
20	201223	439	(MASON 1958:TABLE II)
20	201323	440	(MASON 1958:TABLE II)
20	201323	441	(MASON 1958:TABLE II)
20	410423	442	(MASON 1958:TABLE II)

20	103213	443	(MASON 1958:TABLE II)
20	403323	444	(MASON 1958:TABLE II)
20	201323	445	(MASON 1958:TABLE II)
20	205213	446	(MASON 1958:TABLE II)
20	310223	447	(MASON 1958:TABLE II)
20	214323	448	(MASON 1958:TABLE II)
20	315213	449	(MASON 1958:TABLE II)
20	513334	450	(MASON 1958:TABLE II)
20	203213	451	(MASON 1958:TABLE II)
20	605323	452	(MASON 1958:TABLE II)
20	103323	453	(MASON 1958:TABLE II)
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20	112323	455	(MASON 1958:TABLE II)
20	110213	456	(MASON 1958:TABLE II)
20	103233	457	(MASON 1958:TABLE II)
20	111324	458	(MASON 1958:TABLE II)
20	715544	459	(MASON 1958:TABLE III)
20	715544	460	(MASON 1958:TABLE III)
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20	715544	480	(MASON 1958:TABLE IV)
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20	715544	482	(MASON 1958:TABLE IV)
20	715544	483	(MASON 1958:TABLE IV)
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20	715544	487	(MASON 1958:TABLE IV)
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20	715544	489	(MASON 1958:TABLE V)
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20	715544	502	(MASON 1958:TABLE V)
20	715544	503	(MASON 1958:TABLE V)
20	715544	504	(MASON 1958:TABLE V)
20	715544	505	(MASON 1958:TABLE V)
20	715544	506	(MASON 1958:TABLE V)
07	715544	507	(MASON 1959:TABLE 1)
07	715544	508	(MASON 1959:TABLE 1)
07	715544	509	(MASON 1959:TABLE 1)
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07	715544	514	(MASON 1959:TABLE 1)
07	715544	515	(MASON 1959:TABLE 1)
128	601314	516	(MASON 1959:TABLE 1)
28	715544	517	(MASON 1959:TABLE 1)
28	715544	518	(MASON 1959:TABLE 1)
28	303314	519	(MASON 1959:TABLE 1)
28	715544	520	(MASON 1959:TABLE 1)
28	715544	521	(MASON 1959:TABLE 1)
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28	715544	523	(MASON 1959:TABLE 1)
28	103324	524	(MASON 1959:TABLE 1)
28	201224	525	(MASON 1959:TABLE 1)
28	715544	526	(MASON 1959:TABLE 1)
28	715544	527	(MASON 1959:TABLE 1)
28	715544	528	(MASON 1959:TABLE 1)
28	715544	529	(MASON 1959:TABLE 1)
28	715544	530	(MASON 1959:TABLE 1)
28	715544	531	(MASON 1959:TABLE 1)
28	715544	532	(MASON 1959:TABLE 1)
28	115344	533	(MASON 1959:TABLE 1)
28	203414	534	(MASON 1959:TABLE 1)
28	601324	535	(MASON 1959:TABLE 1)
128	715544	536	(MASON 1959:TABLE 1)
128	715544	537	(MASON 1959:TABLE 1)
128	715544	538	(MASON 1959:TABLE 1)
128	715544	539	(MASON 1959:TABLE 1)
28	715544	540	(MASON 1959:TABLE 1)
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28	715544	542	(MASON 1959:TABLE 1)
28	715544	543	(MASON 1959:TABLE 1)
228	715544	544	(MASON 1959:TABLE 1)
128	715544	545	(MASON 1959:TABLE 1)
228	715544	546	(MASON 1959:TABLE 1)
228	715544	547	(MASON 1959:TABLE 1)
228	715544	548	(MASON 1959:TABLE 1)

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228 715544    550 (MASON 1959:TABLE 1)
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 36 715544    555 (MASON 1959:TABLE 1)
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236 715544    558 (MASON 1959:TABLE 1)
 99 715544    559 (MASON 1959:TABLE 1)
 99 715544    560 (MASON 1959:TABLE 1)
 47 115224    561 (STOLTMAN AND WORKMAN 1969: 1)
 47 115214    562 (STOLTMAN AND WORKMAN 1969: 2)
 47 215324    563 (STOLTMAN AND WORKMAN 1969: 3)
 47 115214    564 (STOLTMAN AND WORKMAN 1969: 4)
 47 215324    565 (STOLTMAN AND WORKMAN 1969: 5)
 47 215324    566 (STOLTMAN AND WORKMAN 1969: 6)
 47 215544    567 (STOLTMAN AND WORKMAN 1969: 7)
 47 115214    568 (STOLTMAN AND WORKMAN 1969: 8)
 47 115414    569 (STOLTMAN AND WORKMAN 1969: 9)
 47 115324    570 (STOLTMAN AND WORKMAN 1969:10)
 47 215324    571 (STOLTMAN AND WORKMAN 1969:11)
 47 215324    572 (STOLTMAN AND WORKMAN 1969:12)
 47 215314    573 (STOLTMAN AND WORKMAN 1969:13)
 47 215344    574 (STOLTMAN AND WORKMAN 1969:14)
 47 115324    575 (STOLTMAN AND WORKMAN 1969:15)
 47 115324    576 (STOLTMAN AND WORKMAN 1969:16)
 47 115214    577 (STOLTMAN AND WORKMAN 1969:17)
 47 115214    578 (STOLTMAN AND WORKMAN 1969:18)
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 47 115224    580 (STOLTMAN AND WORKMAN 1969:20)
 47 215324    581 (STOLTMAN AND WORKMAN 1969:21)
 47 215314    582 (STOLTMAN AND WORKMAN 1969:22)
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 47 115224    584 (STOLTMAN AND WORKMAN 1969:24)
 47 415234    585 (STOLTMAN AND WORKMAN 1969:25)
 47 115214    586 (STOLTMAN AND WORKMAN 1969:26)
 47 115114    587 (STOLTMAN AND WORKMAN 1969:27)
 47 315324    588 (STOLTMAN AND WORKMAN 1969:28)
 47 215224    589 (STOLTMAN AND WORKMAN 1969:29)
 47 115324    590 (STOLTMAN AND WORKMAN 1969:30)
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 47 115324    594 (STOLTMAN AND WORKMAN 1969:34)
 47 415334    595 (STOLTMAN AND WORKMAN 1969:35)
 47 115114    596 (STOLTMAN AND WORKMAN 1969:36)
 47 115224    597 (STOLTMAN AND WORKMAN 1969:37)
 47 115224    598 (STOLTMAN AND WORKMAN 1969:38)
 47 115114    599 (STOLTMAN AND WORKMAN 1969:39)
 47 115114    600 (STOLTMAN AND WORKMAN 1969:40)
 47 115214    601 (STOLTMAN AND WORKMAN 1969:41)
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47	115324	602	(STOLTMAN AND WORKMAN 1969:42)
47	115324	603	(STOLTMAN AND WORKMAN 1969:43)
47	115214	604	(STOLTMAN AND WORKMAN 1969:44)
47	115324	605	(STOLTMAN AND WORKMAN 1969:45)
47	215324	606	(STOLTMAN AND WORKMAN 1969:46)
47	215114	607	(STOLTMAN AND WORKMAN 1969:47)
47	215324	608	(STOLTMAN AND WORKMAN 1969:48)
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47	115314	611	(STOLTMAN AND WORKMAN 1969:51)
47	115324	612	(STOLTMAN AND WORKMAN 1969:52)
47	315224	613	(STOLTMAN AND WORKMAN 1969:53)
47	215214	614	(STOLTMAN AND WORKMAN 1969:54)
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47	215324	616	(STOLTMAN AND WORKMAN 1969:56)
47	115224	617	(STOLTMAN AND WORKMAN 1969:57)
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47	115224	619	(STOLTMAN AND WORKMAN 1969:59)
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47	115244	623	(STOLTMAN AND WORKMAN 1969:64)
47	115214	624	(STOLTMAN AND WORKMAN 1969:65)
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31	104213	627	(PERKINSON 1971: 3)
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31	403214	629	(PERKINSON 1971: 5)
31		630	(PERKINSON 1971: 6)
31	204323	631	(PERKINSON 1971: 7)
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31	103334	633	(PERKINSON 1971: 9)
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31	210223	636	(PERKINSON 1971:12)
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31	104321	640	(PERKINSON 1971:16)
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31	415434	643	(PERKINSON 1971:19)
31	404323	644	(PERKINSON 1971:20)
31	404321	645	(PERKINSON 1971:21)
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31	104323	649	(PERKINSON 1971:25)
31	204224	650	(PERKINSON 1971:26)
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31	414213	652	(PERKINSON 1971:28)
31	104313	653	(PERKINSON 1971:29)

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31	201323	655	(PERKINSON 1973:31)
31	210413	656	(PERKINSON 1973:32)
31	113433	657	(PERKINSON 1973:33)
31	301323	658	(PERKINSON 1973:34)
31	410223	659	(PERKINSON 1973:35)
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31	204524	661	(PERKINSON 1973:37)
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31	103112	681	(PERKINSON 1973:57)
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31	301321	683	(PERKINSON 1973:59)
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31	104223	687	(PERKINSON 1973:63)
31	404223	688	(PERKINSON 1973:64)
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31	305322	691	(PERKINSON 1973:67)
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44 715544	709	(MC CARY 1947A: 2)
44 415324	710	(MC CARY 1947A: 3)
44 115544	711	(MC CARY 1947A: 4)
44 415344	712	(MC CARY 1947A: 5)
44 115224	713	(MC CARY 1947A: 6)
44 115324	714	(MC CARY 1947A: 7)
44 115314	715	(MC CARY 1947A: 8)
44 415324	716	(MC CARY 1947A: 9)
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44 415224	718	(MC CARY 1947A: 11)
44 115324	719	(MC CARY 1947A: 12)
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44 115324	721	(MC CARY 1947A: 14)
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44 115214	723	(MC CARY 1947A: 16)
44 115324	724	(MC CARY 1947A: 17)
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44 415234	727	(MC CARY 1947A: 20)
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44 115324	730	(MC CARY 1947A: 23)
44 115214	731	(MC CARY 1947A: 24)
44 415234	732	(MC CARY 1947A: 25)
44 215224	733	(MC CARY 1947A: 26)
44 215324	734	(MC CARY 1947A: 27)
44 415334	735	(MC CARY 1947A: 28)
44 115324	736	(MC CARY 1947A: 29)
44 115214	737	(MC CARY 1947A: 30)
44 115214	738	(MC CARY 1947A: 31)
44 415234	739	(MC CARY 1947A: 32)
44 215214	740	(MC CARY 1947A: 33)
44 215324	741	(MC CARY 1947A: 34)
44 215324	742	(MC CARY 1947A: 35)
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44 115214	744	(MC CARY 1947A: 37)
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44 315334	746	(MC CARY 1947A: 39)
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44 415334	748	(MC CARY 1947A: 41)
44 115324	749	(MC CARY 1947A: 42)
44 115224	750	(MC CARY 1947A: 43)
44 115214	751	(MC CARY 1947A: 44)
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44 115324	754	(MC CARY 1947A: 47)
44 115124	755	(MC CARY 1947A: 48)
44 215324	756	(MC CARY 1947A: 49)
44 315324	757	(MC CARY 1947A: 50)
44 315324	758	(MC CARY 1947A: 51)
44 215324	759	(MC CARY 1947A: 52)

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44	115224	762	(MC CARY 1947A: 55)
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44	115114	764	(MC CARY 1947A: 57)
44	115414	765	(MC CARY 1947A: 58)
44	115324	766	(MC CARY 1947A: 59)
44	115324	767	(MC CARY 1947A: 60)
44	315224	768	(MC CARY 1947A: 61)
44	315214	769	(MC CARY 1947A: 62)
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44	115224	771	(MC CARY 1947A: 64)
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44	115224	774	(MC CARY 1947A: 67)
44	115114	775	(MC CARY 1947A: 68)
44	315214	776	(MC CARY 1947A: 69)
44	415224	777	(MC CARY 1947A: 70)
44	415214	778	(MC CARY 1947A: 71)
44	315214	779	(MC CARY 1947A: 72)
44	115214	780	(MC CARY 1947A: 73)
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44	215214	782	(MC CARY 1947A: 75)
44	115214	783	(MC CARY 1947A: 76)
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44	315324	785	(MC CARY 1947A: 78)
44	215214	786	(MC CARY 1947A: 79)
44	115324	787	(MC CARY 1947A: 80)
44	115224	788	(MC CARY 1947A: 81)
44	115224	789	(MC CARY 1947A: 82)
44	315224	790	(MC CARY 1947A: 83)
44	115214	791	(MC CARY 1947A: 84)
44	215214	792	(MC CARY 1947A: 85)
44	215224	793	(MC CARY 1947A: 86)
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44	215324	795	(MC CARY 1947A: 88)
44	115214	796	(MC CARY 1947A: 89)
44	215214	797	(MC CARY 1947A: 90)
44	715544	798	(MC CARY 1947A: 91)
44	115424	799	(MC CARY 1947A: 92)
44	615114	800	(MC CARY 1947A: 93)
44	215324	801	(MC CARY 1947A: 94)
44	215324	802	(MC CARY 1947A: 95)
44	115214	803	(MC CARY 1947A: 96)
44	115214	804	(MC CARY 1947A: 97)
44	215214	805	(MC CARY 1947A: 98)
44	115214	806	(MC CARY 1947A: 99)
44	415224	807	(MC CARY 1947A:100)
44	115324	808	(MC CARY 1947A:101)
44	115324	809	(MC CARY 1947A:102)
44	115224	810	(MC CARY 1947A:103)
44	215214	811	(MC CARY 1947A:104)
44	215424	812	(MC CARY 1947A:105)

44	115224	813	(MC CARY 1947A:106)
44	115224	814	(MC CARY 1947A:107)
44	115324	815	(MC CARY 1947A:108)
44	215324	816	(MC CARY 1947A:109)
44	215214	817	(MC CARY 1947A:110)
44	215214	818	(MC CARY 1947A:111)
44	215224	819	(MC CARY 1947A:112)
44	115144	820	(MC CARY 1947A:113)
44	115224	821	(MC CARY 1947A:114)
44	215214	822	(MC CARY 1947A:115)
44	215324	823	(MC CARY 1947A:116)
44	215324	824	(MC CARY 1947A:117)
44	215224	825	(MC CARY 1947A:118)
44	115224	826	(MC CARY 1947A:119)
44	615324	827	(MC CARY 1947A:120)
44	215324	828	(MC CARY 1947A:121)
44	415214	829	(MC CARY 1947A:122)
44	215324	830	(MC CARY 1947A:123)
44	115214	831	(MC CARY 1947A:124)
44	115214	832	(MC CARY 1947A:125)
44	215324	833	(MC CARY 1947A:126)
44	715324	834	(MC CARY 1947B:127)
44	715544	835	(MC CARY 1947B:128)
44		836	(MC CARY 1947B:129)
44	215314	837	(MC CARY 1947B:130)
44	115324	838	(MC CARY 1947B:131)
44	215224	839	(MC CARY 1947B:132)
44	315214	840	(MC CARY 1947B:133)
44	115224	841	(MC CARY 1947B:134)
44	115224	842	(MC CARY 1947B:135)
44	215224	843	(MC CARY 1947B:136)
44	203214	844	(MC CARY 1948:137)
44	210224	845	(MC CARY 1948:138)
44	115214	846	(MC CARY 1948:139)
44	115114	847	(MC CARY 1948:140)
44	115214	848	(MC CARY 1948:141)
44	215214	849	(MC CARY 1949:142)
44	415114	850	(MC CARY 1949:143)
44	115224	851	(MC CARY 1949:144)
44	215324	852	(MC CARY 1949:145)
44	115114	853	(MC CARY 1949:146)
44	215224	854	(MC CARY 1949:147)
44	115214	855	(MC CARY 1949:148)
44	215324	856	(MC CARY 1949:149)
44	215324	857	(MC CARY 1949:150)
44	715544	858	(MC CARY 1949:151)
44	115324	859	(MC CARY 1949:152)
44	215224	860	(MC CARY 1949:153)
44	115224	861	(MC CARY 1949:154)
44	215214	862	(MC CARY 1949:155)
44	215324	863	(MC CARY 1949:156)
44	215324	864	(MC CARY 1949:157)
44	315324	865	(MC CARY 1949:158)

44 115324	866	(MC CARY 1949:159)
44 115224	867	(MC CARY 1949:160)
44 115324	868	(MC CARY 1949:161)
44 215314	869	(MC CARY 1951:162)
44 215214	870	(MC CARY 1951:163)
44 215214	871	(MC CARY 1951:164)
44 115214	872	(MC CARY 1951:165)
44 115324	873	(MC CARY 1951:166)
44 215324	874	(MC CARY 1951:167)
44 115214	875	(MC CARY 1951:168)
44 115214	876	(MC CARY 1951:169)
44 115224	877	(MC CARY 1951:170)
44 215214	878	(MC CARY 1951:171)
44 115214	879	(MC CARY 1951:172)
44 115224	880	(MC CARY 1952:173)
44 315224	881	(MC CARY 1952:174)
44 215214	882	(MC CARY 1952:175)
44 415214	883	(MC CARY 1952:176)
44 115324	884	(MC CARY 1952:177)
44 315324	885	(MC CARY 1952:178)
44 715544	886	(MC CARY 1952:179)
44 115224	887	(MC CARY 1952:180)
44 215224	888	(MC CARY 1952:181)
44 215114	889	(MC CARY 1952:182)
44 215214	890	(MC CARY 1952:183)
44 415214	891	(MC CARY 1952:184)
44 115114	892	(MC CARY 1952:185)
44 215214	893	(MC CARY 1952:186)
44 115214	894	(MC CARY 1952:187)
44 215214	895	(MC CARY 1952:188)
44 215224	896	(MC CARY 1952:189)
44 415224	897	(MC CARY 1952:190)
44 115424	898	(MC CARY 1952:191)
44 115324	899	(MC CARY 1952:192)
44 715544	900	(MC CARY 1952:193)
44 115324	901	(MC CARY 1952:194)
44 115324	902	(MC CARY 1952:195)
44 115214	903	(MC CARY 1952:196)
44 115224	904	(MC CARY 1952:197)
44 215214	905	(MC CARY 1952:198)
44 215224	906	(MC CARY 1952:199)
44 115224	907	(MC CARY 1952:200)
44 115324	908	(MC CARY 1952:201)
44 115114	909	(MC CARY 1952:202)
44 115224	910	(MC CARY 1952:203)
44 115214	911	(MC CARY 1952:204)
44 115214	912	(MC CARY 1952:205)
44 215224	913	(MC CARY 1952:206)
44 115214	914	(MC CARY 1952:207)
44 115114	915	(MC CARY 1952:208)
44 115214	916	(MC CARY 1952:209)
44 215214	917	(MC CARY 1952:210)
44 115324	918	(MC CARY 1952:211)

44 115214	919	(MC CARY 1952:212)
44 215214	920	(MC CARY 1952:213)
44 415224	921	(MC CARY 1952:214)
44 115214	922	(MC CARY 1952:215)
44 215214	923	(MC CARY 1952:216)
44 215114	924	(MC CARY 1952:217)
44 215314	925	(MC CARY 1952:218)
44 215324	926	(MC CARY 1952:219)
44 103214	927	(MC CARY 1953:220)
44 203224	928	(MC CARY 1953:221)
44 203324	929	(MC CARY 1953:222)
44 103224	930	(MC CARY 1953:223)
44 104114	931	(MC CARY 1953:224)
44 710324	932	(MC CARY 1953:225)
44 105224	933	(MC CARY 1954:226)
44 110214	934	(MC CARY 1954:227)
44 215324	935	(MC CARY 1954:228)
44 204324	936	(MC CARY 1954:229)
44 104214	937	(MC CARY 1954:230)
44 203424	938	(MC CARY 1954:231)
44 115114	939	(MC CARY 1956A:232)
44 103224	940	(MC CARY 1956A:233)
44 115224	941	(MC CARY 1956A:234)
44 115214	942	(MC CARY 1956A:235)
44 415224	943	(MC CARY 1956A:236)
44 215214	944	(MC CARY 1956A:237)
44 215114	945	(MC CARY 1956A:238)
44 415224	946	(MC CARY 1956A:239)
44 215214	947	(MC CARY 1956A:240)
44 115114	948	(MC CARY 1956A:241)
44 715224	949	(MC CARY 1956A:242)
44 415324	950	(MC CARY 1956A:243)
44 115214	951	(MC CARY 1956A:244)
44 215324	952	(MC CARY 1956A:245)
44 215214	953	(MC CARY 1956A:246)
44 215224	954	(MC CARY 1956A:247)
44 215214	955	(MC CARY 1956A:248)
44 303324	956	(MC CARY 1956A:249)
44 215224	957	(MC CARY 1956A:250)
44 115214	958	(MC CARY 1956A:251)
44 715544	959	(MC CARY 1956A:252)
44 415224	960	(MC CARY 1956A:253)
44 315324	961	(MC CARY 1956A:254)
44 115114	962	(MC CARY 1956A:255)
44 115324	963	(MC CARY 1956A:256)
44 115214	964	(MC CARY 1956A:257)
44 715544	965	(MC CARY 1956A:258)
44 215224	966	(MC CARY 1956A:259)
44 310324	967	(MC CARY 1956A:260)
44 215324	968	(MC CARY 1956A:261)
44 104414	969	(MC CARY 1956A:262)
44 115544	970	(MC CARY 1956A:263)
44 403214	971	(MC CARY 1956B:264)

44	315324	972	(MC CARY 1958:265)
44	215214	973	(MC CARY 1958:266)
44	415224	974	(MC CARY 1958:267)
44	215324	975	(MC CARY 1958:268)
44	415224	976	(MC CARY 1958:269)
44	115224	977	(MC CARY 1958:270)
44	115214	978	(MC CARY 1958:271)
44	415234	979	(MC CARY 1958:272)
44	115424	980	(MC CARY 1958:273)
44	715524	981	(MC CARY 1958:274)
44	315324	982	(MC CARY 1958:275)
44	215214	983	(MC CARY 1958:276)
44	115224	984	(MC CARY 1958:277)
44	415224	985	(MC CARY 1958:278)
44	415214	986	(MC CARY 1958:279)
44	715214	987	(MC CARY 1958:280)
44	415224	988	(MC CARY 1958:281)
44	104214	989	(MC CARY 1961:282)
44	210414	990	(MC CARY 1961:283)
44	404334	991	(MC CARY 1961:284)
44	403324	992	(MC CARY 1961:285)
44	103214	993	(MC CARY 1961:286)
44	103324	994	(MC CARY 1961:287)
44	215544	995	(MC CARY 1961:288)
44	104324	996	(MC CARY 1961:289)
44	104214	997	(MC CARY 1961:290)
44	115324	998	(MC CARY 1961:291)
44	104324	999	(MC CARY 1961:292)
44	203324	1000	(MC CARY 1961:293)
44	715544	1001	(MC CARY 1963:294)
44	715324	1002	(MC CARY 1963:295)
44	210414	1003	(MC CARY 1963:296)
44	110324	1004	(MC CARY 1963:297)
44	404324	1005	(MC CARY 1963:298)
44	204214	1006	(MC CARY 1963:299)
44	104324	1007	(MC CARY 1963:300)
44	215544	1008	(MC CARY 1963:301)
44	115324	1009	(MC CARY 1963:302)
44	110224	1010	(MC CARY 1963:303)
44	204324	1011	(MC CARY 1963:304)
44	103424	1012	(MC CARY 1963:305)
44	115244	1013	(MC CARY 1963:306)
44	115224	1014	(MC CARY 1963:307)
44	715544	1015	(MC CARY 1963:308)
44	204224	1016	(MC CARY 1963:309)
44	203224	1017	(MC CARY 1963:310)
44	215324	1018	(MC CARY 1963:311)
44	415224	1019	(MC CARY 1963:312)
44	115324	1020	(MC CARY 1963:313)
44	715544	1021	(MC CARY 1963:314)
44	103214	1022	(MC CARY 1965:315)
44	203224	1023	(MC CARY 1965:316)
44	204224	1024	(MC CARY 1965:317)

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44 715544  1025 (MC CARY 1965:318)
44 403324  1026 (MC CARY 1965:319)
44 210214  1027 (MC CARY 1965:320)
44 103224  1028 (MC CARY 1965:321)
44 104214  1029 (MC CARY 1965:322)
44 715544  1030 (MC CARY 1965:323)
44 403224  1031 (MC CARY 1965:324)
44 110214  1032 (MC CARY 1965:325)
44 115324  1033 (MC CARY 1965:326)
44 204224  1034 (MC CARY 1965:327)
44 101324  1035 (MC CARY 1965:328)
44 715544  1036 (MC CARY 1965:329)
44 115214  1037 (MC CARY 1965:330)
44 204214  1038 (MC CARY 1965:331)
44 303224  1039 (MC CARY 1965:332)
44 110114  1040 (MC CARY 1965:333)
44 310224  1041 (MC CARY 1965:334)
44 103424  1042 (MC CARY 1965:335)
44 103324  1043 (MC CARY 1965:336)
44 203214  1044 (MC CARY 1965:337)
44 215224  1045 (MC CARY 1965:338)
44 115214  1046 (MC CARY 1965:339)
44 403224  1047 (MC CARY 1965:340)
44 310324  1048 (MC CARY 1965:341)
44 110424  1049 (MC CARY 1965:342)
44 115424  1050 (MC CARY 1965:343)
44 715544  1051 (MC CARY 1965:344)
44 715544  1052 (MC CARY 1965:345)
44 103224  1053 (MC CARY 1965:346)
44 115114  1054 (MC CARY 1965:347)
44 315214  1055 (MC CARY 1968:348)
44 715544  1056 (MC CARY 1968:349)
44 615544  1057 (MC CARY 1968:350)
44 115324  1058 (MC CARY 1968:351)
44 215214  1059 (MC CARY 1968:352)
44 115214  1060 (MC CARY 1968:353)
44 115214  1061 (MC CARY 1968:354)
44 215324  1062 (MC CARY 1968:355)
44 715544  1063 (MC CARY 1968:356)
44 215544  1064 (MC CARY 1968:357)
44 103224  1065 (MC CARY 1968:358)
44 415334  1066 (MC CARY 1968:359)
44 415214  1067 (MC CARY 1968:360)
44 415324  1068 (MC CARY 1968:361)
44 103224  1069 (MC CARY 1968:362)
44 404224  1070 (MC CARY 1968:363)
44 310224  1071 (MC CARY 1968:364)
44 204224  1072 (MC CARY 1968:365)
44 104214  1073 (MC CARY 1968:366)
44 115214  1074 (MC CARY 1968:367)
44 403224  1075 (MC CARY 1968:368)
44 303344  1076 (MC CARY 1968:369)
44 115544  1077 (MC CARY 1968:370)
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44	715324	1078	(MC CARY 1968:371)
44	104214	1079	(MC CARY 1968:372)
44	215214	1080	(MC CARY 1968:373)
44	115214	1081	(MC CARY 1968:374)
44	415224	1082	(MC CARY 1968:375)
44	315324	1083	(MC CARY 1968:376)
44	715544	1084	(MC CARY 1968:377)
44	115224	1085	(MC CARY 1968:378)
44	215224	1086	(MC CARY 1968:379)
46	110424	1087	(HYDE 1960:PLATE 1)
46	204214	1088	(HYDE 1960:PLATE 2)
46	415214	1089	(HYDE 1960:PLATE 3)
46	215314	1090	(HYDE 1960:PLATE 4)
46	115214	1091	(HYDE 1960:PLATE 5)
46	215324	1092	(HYDE 1960:PLATE 6)
46	515314	1093	(HYDE 1960:PLATE 7)
46	215444	1094	(HYDE 1960:PLATE 8)
46	415114	1095	(HYDE 1960:FIGURE 12)
46	401323	1096	(HYDE 1960:PLATE 9&10R)
46	101214	1097	(HYDE 1960:PLATE 14)
46	201324	1098	(HYDE 1960:PLATE 16)

31	4043132	1385	(P. PERKINSON PRIVATE COLLECTION)
31	1013244	1386	(P. PERKINSON PRIVATE COLLECTION)
31	3013242	1387	(P. PERKINSON PRIVATE COLLECTION)
31	1103242	1388	(P. PERKINSON PRIVATE COLLECTION)
31	1042244	1389	(P. PERKINSON PRIVATE COLLECTION)
31	1033312	1390	(P. PERKINSON PRIVATE COLLECTION)
31	1035444	1391	(P. PERKINSON PRIVATE COLLECTION)
31	2043232	1392	(P. PERKINSON PRIVATE COLLECTION)
31	2033232	1393	(P. PERKINSON PRIVATE COLLECTION)
40	4012431	1394	(B. BURBAGE PRIVATE COLLECTION NO. 598)
40	4113321	1395	(B. BURBAGE PRIVATE COLLECTION NO. 2507)
40	4013212	1396	(B. BURBAGE PRIVATE COLLECTION NO. 2361)
40	2042132	1397	(B. BURBAGE PRIVATE COLLECTION NO. 1049)
40	2013232	1398	(B. BURBAGE PRIVATE COLLECTION NO. 1948)
40	2073232	1399	(B. BURBAGE PRIVATE COLLECTION NO. 309)
40	2022132	1400	(B. BURBAGE PRIVATE COLLECTION NO. 2350)
40	4144332	1401	(B. BURBAGE PRIVATE COLLECTION NO. 1274)
40	1043232	1402	(B. BURBAGE PRIVATE COLLECTION NO. 2246)
40	2082132	1403	(B. BURBAGE PRIVATE COLLECTION NO. 1042)
40	1082232	1404	(B. BURBAGE PRIVATE COLLECTION NO. 660)
40	4052322	1405	(B. BURBAGE PRIVATE COLLECTION NO. 1474)
40	1012142	1406	(B. BURBAGE PRIVATE COLLECTION NO. 2354)
40	5042142	1407	(B. BURBAGE PRIVATE COLLECTION NO. 320)
40	4042142	1408	(B. BURBAGE PRIVATE COLLECTION NO. 1393)
40	1044132	1409	(B. BURBAGE PRIVATE COLLECTION NO. 484)
40	1013212	1410	(B. BURBAGE PRIVATE COLLECTION NO. 1685)
40	1032122	1411	(B. BURBAGE PRIVATE COLLECTION NO. 2245)
40	4112332	1412	(B. BURBAGE PRIVATE COLLECTION NO. 1476)
40	4053311	1413	(B. BURBAGE PRIVATE COLLECTION NO. 1440)
40	4033312	1414	(B. BURBAGE PRIVATE COLLECTION NO. 1641)

40	4012311	1415	(B. BURBAGE PRIVATE COLLECTION NO. 2351)
40	1133242	1416	(B. BURBAGE PRIVATE COLLECTION NO. 2379)
40	1102142	1417	(B. BURBAGE PRIVATE COLLECTION NO. 1849)
40	4143342	1418	(B. BURBAGE PRIVATE COLLECTION NO. 1478)
40	3013222	1419	(B. BURBAGE PRIVATE COLLECTION NO. 1087)
40	3013222	1420	(B. BURBAGE PRIVATE COLLECTION NO. 898)
40	3042132	1421	(B. BURBAGE PRIVATE COLLECTION NO. 486)
40	3023232	1422	(B. BURBAGE PRIVATE COLLECTION NO. 671)
40	2042132	1423	(B. BURBAGE PRIVATE COLLECTION NO. 2027)
40	2152132	1424	(B. BURBAGE PRIVATE COLLECTION NO. 1702)
40	6013232	1425	(B. BURBAGE PRIVATE COLLECTION NO. 2330)
40	1013232	1426	(B. BURBAGE PRIVATE COLLECTION NO. 625)
40	1132132	1427	(B. BURBAGE PRIVATE COLLECTION NO. 897)
40	5063232	1428	(B. BURBAGE PRIVATE COLLECTION NO. 307)
40	1042132	1429	(B. BURBAGE PRIVATE COLLECTION NO. 643)
40	4113311	1430	(B. BURBAGE PRIVATE COLLECTION NO. 6199)
40	4013331	1431	(B. BURBAGE PRIVATE COLLECTION NO. 1294)
40	4012321	1432	(B. BURBAGE PRIVATE COLLECTION NO. 266)
40	2023132	1433	(B. BURBAGE PRIVATE COLLECTION)
40	2023132	1434	(B. BURBAGE PRIVATE COLLECTION NO. 1357)
40	2113132	1435	(B. BURBAGE PRIVATE COLLECTION NO. 1356)
40	1044233	1436	(B. BURBAGE PRIVATE COLLECTION NO. 1503)
40	3123132	1437	(B. BURBAGE PRIVATE COLLECTION NO. 2247)
40	4143233	1438	(B. BURBAGE PRIVATE COLLECTION NO. 1238)
40	4143333	1439	(B. BURBAGE PRIVATE COLLECTION NO. 2399)
40	6054232	1440	(B. BURBAGE PRIVATE COLLECTION NO. 1623)
40	4103332	1441	(B. BURBAGE PRIVATE COLLECTION NO. 2357)
40	7014334	1442	(B. BURBAGE PRIVATE COLLECTION NO. 650)
40	1032134	1443	(B. BURBAGE PRIVATE COLLECTION NO. 2109)
40	1043212	1444	(B. BURBAGE PRIVATE COLLECTION NO. 3000)
40	3062232	1445	(B. BURBAGE PRIVATE COLLECTION NO. 1703)
40	2032132	1446	(B. BURBAGE PRIVATE COLLECTION NO. 1701)
40	1112332	1447	(B. BURBAGE PRIVATE COLLECTION NO. 1622)
40	4012232	1448	(B. BURBAGE PRIVATE COLLECTION NO. 1437)
40	4012332	1449	(B. BURBAGE PRIVATE COLLECTION NO. 2394)
40	4041332	1450	(B. BURBAGE PRIVATE COLLECTION NO. 2015)
40	3052232	1451	(B. BURBAGE PRIVATE COLLECTION NO. 1132)

17	201324	1452	(GRAMLY 1982:TABLE 2: 1)
17	101324	1453	(GRAMLY 1982:TABLE 2: 2)
17	101324	1454	(GRAMLY 1982:TABLE 2: 3)
17	101324	1455	(GRAMLY 1982:TABLE 2: 4)
17	201324	1456	(GRAMLY 1982:TABLE 2: 5)
17	101324	1457	(GRAMLY 1982:TABLE 2: 6)
17	101324	1458	(GRAMLY 1982:TABLE 2: 7)
17	101324	1459	(GRAMLY 1982:TABLE 2: 8)
17	201324	1460	(GRAMLY 1982:TABLE 2: 9)
17	101324	1461	(GRAMLY 1982:TABLE 2:10)
17	101324	1462	(GRAMLY 1982:TABLE 2:11)
17	101324	1463	(GRAMLY 1982:TABLE 2:12)
17	101324	1464	(GRAMLY 1982:TABLE 2:13)
17	101324	1465	(GRAMLY 1982:TABLE 2:14)

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17 201324  1466 (GRAMLY 1982:TABLE 2:15)
17 201324  1467 (GRAMLY 1982:TABLE 2:16)
17 101324  1468 (GRAMLY 1982:TABLE 2:17)
17 201324  1469 (GRAMLY 1982:TABLE 2:18)
17 101324  1470 (GRAMLY 1982:TABLE 2:19)
17 301324  1471 (GRAMLY 1982:TABLE 2:20)
17 101324  1472 (GRAMLY 1982:TABLE 2:21)
17 101324  1473 (GRAMLY 1982:TABLE 2:22)
17 101324  1474 (GRAMLY 1982:TABLE 2:23)
17 701324  1475 (GRAMLY 1982:TABLE 2:24)
17 101324  1476 (GRAMLY 1982:TABLE 2:25)
17 201324  1477 (GRAMLY 1982:TABLE 2:26)
17 301324  1478 (GRAMLY 1982:TABLE 2:27)
17 101324  1479 (GRAMLY 1982:TABLE 2:28)
17 101324  1480 (GRAMLY 1982:TABLE 2:29)
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