APPENDIX II

METHODS OF ATTRIBUTE ANALYSIS OF DEBITAGE

The purpose of this appendix is to outline and describe the methods used to analyze the debitage from six archaeological sites (7NC-J-134, 7K-C-359, 7K-C-363, 7K-C-364, 7K-C-367, and 7K-D-22) along the State Route 1 Relief Route. Sites 7K-C-360, 7K-C-365A, and the Middle Leipsic River Valley site complex (7K-C-203, 7K-C-204, 7K-C-194, 7K-C-195, and 7K-C-194A) were excluded from the present analysis in order that more extensive research can be undertaken at these sites and presented in the final reports detailing their excavations. The main goal of the analysis is to determine the source of the debitage, particularly to see if it was derived from bifaces or from cores. This appendix will first outline the theoretical basis for studying the question of the bifacial or unifacial core origin of flakes. Next, it will describe the flake attributes used to study the debitage with respect to its origin. Finally, a series of base line studies of flakes of known bifacial or unifacial origin will be presented to show the validity of the research methods.

THEORETICAL BACKGROUND

It is important to know whether debitage was derived from bifaces or from unifacial prepared, or amorphous, cores for a number of reasons. At the most basic level, organization of lithic technologies and patterns of lithic resource use are closely linked to settlement patterns and adaptations in various ways. Gardner's (1974, 1977, 1989, 1990) analyses of Paleo-Indian lithic technologies and lithic resource use are some of the first of these studies to be undertaken in the Middle Atlantic and recent studies have more closely analyzed the general trends noted by Gardner (eg. - Custer, Cavallo, and Stewart 1983; Stewart 1990). Other more generalized studies (eg. Kuhn 1989; Bamforth 1986; Binford 1977; Bleed 1986; Goodyear 1979; Kelly 1988; Parry and Kelly 1987; Shott 1989; Torrence 1987; White and Modjeska 1978; Wiant and Hassen 1985; and Magne 1985) have addressed similar issues.

Most of these studies have shown that factors such as settlement mobility, lithic resource availability, and the situational contingency of lithic tool use all play a role in determining how lithic technologies are organized, particularly the use of curated biface and prepared cores versus the expedient use of cores. For example, highly mobile groups who frequent areas where lithic resources are scarce have been seen to use carefully curated stone tool kits consisting of bifaces and prepared cores. On the other hand, less mobile groups in areas of readily available lithic raw materials will tend to make expedient use of quickly prepared amorphous cores. And, in some cases, a single group will alter its resource use based strictly on the availability of raw materials. For example, Paleo-Indian groups in the Shenandoah Valley of Virginia made and used carefully prepared tool kits based on bifaces and prepared cores when they were traveling away from the major quarry sources of jasper near the western margin of the Blue Ridge mountains (Gardner 1989; Verrey 1986). However, at hunting and processing sites close to the quarry sites, they expediently used a variety of amorphous cores (Carr 1986). In sum, it can be very useful to know whether an assemblage of debitage was derived from bifaces or cores in order to determine if the prehistoric groups who inhabited a site were focusing their lithic technologies on bifaces or cores.

When considering the lithic technologies of prehistoric groups of the Delmarva Peninsula, it should be noted that numerous studies of lithic technologies have shown that there is a large amount of variability in the use of bifaces or unifacial cores, as portable tool kits. For example, a close analysis of late Paleo-Indian/Early Archaic tool kits from central Eastern Shore of Maryland (Lowery and Custer 1990) has shown that these early groups made extensive use of bifaces as the central element of their transported tool kit during part of their journeys across the landscapes of the Delmarva Peninsula, where lithic resources were at a premium. This use of bifaces has been seen as one reason for a focused use of cryptocrystalline materials (Goodyear 1979; Custer 1989:119). However, when their transported, or curated (Binford 1979) tool kits were depleted, they seem to have focused more on unifacial cores (Lowery 1989) procured and produced on an expedient, or as-needed basis. In contrast, numerous studies of lithic technologies of later groups (eg. - Custer and Bachman 1986c; Custer 1987; Custer, Watson, Hoseth, and Coleman 1988) indicate that there was a greater emphasis on cores, rather than bifaces, as sources of flakes in transported and curated tool kits during the Woodland I Period when levels of residential mobility were somewhat lower than at earlier times.

Studies of lithic technologies of northern Delaware, have shown other sources of variability in the composition of stone tool kits and patterns of lithic resource use. Cobble beds are quite numerous along the Fall Line and the adjacent areas of the High Coastal Plain and these locales are important sources of secondary raw materials which are suitable for the manufacture of stone tools (Custer and Galasso 1980). At the same time, high quality primary cryptocrystalline lithic resources are available from the Delaware Chalcedony Complex (Custer, Ward and Watson 1986) which is located just south of the Fall Line in western New Castle County, Delaware, and eastern Cecil County, Maryland. All of these sources of lithic raw materials were used by the prehistoric inhabitants of northern Delaware and the varieties of uses seem to be greatest during the Woodland I Period. Some groups seem to be making use of secondary cobble resources for both bifaces and cores, although cobble resources seem to be more commonly used for cores (eg. - Custer 1987; Custer and Bachman 1986c; Custer, Sprinkle, Flora, and Stiner 1981). On the other hand, some groups seem to have transported large cores of cryptocrystalline jasper and used them as a source for flake tools (eg. - Custer, Watson, Hoseth, and Coleman 1988).

Because the tools and debitage deposited at a site by its prehistoric inhabitants reflect the lithic materials which they had with them, or could obtain locally at the site, and because curated lithic materials reflect immediately prior visits to quarry sites or other lithic source locations, we can understand prehistoric groups movement patterns by comparing the range of lithic resources used at a site with the locally available materials. Furthermore, if we can determine whether the flakes were derived from bifaces, prepared cores, or amorphous expediently-manufactured cores, we can understand how prehistoric groups were transporting and using lithic resources.

Prior research (Watson and Custer 1990) has shown that there are important regional differences in lithic transport and use in the central Middle Atlantic region that can reveal much about their movement patterns, settlement mobility, and patterns of organization of lithic technologies. In the central and southern New Jersey Coastal Plain and the central Delaware region, particularly the St. Jones and Murderkill drainages, lithic resource use during early Woodland I times seems to be focused on the use of argillite and rhyolite for bifaces and cryptocrystalline cobble cores for flake tools. In contrast, contemporary groups of the Fall Line Zone and High Coastal Plain of Delaware have a very different and highly variable technological organization based on a use of primary jasper and cherts for both large cores and bifaces, cobble resources for both cores and bifaces, and some ironstone, argillite, and rhyolite for bifaces. These lithic resource patterns are so very different that they might be indicators of varied ethnic groups using different territories, or they might be indicative of the incredible variability of lithic resource use patterns within a single social group. Application of the research methods described in this appendix will help us to better understand how these prehistoric groups were using these different lithic resources at different locations across the landscape.

FLAKE ATTRIBUTES

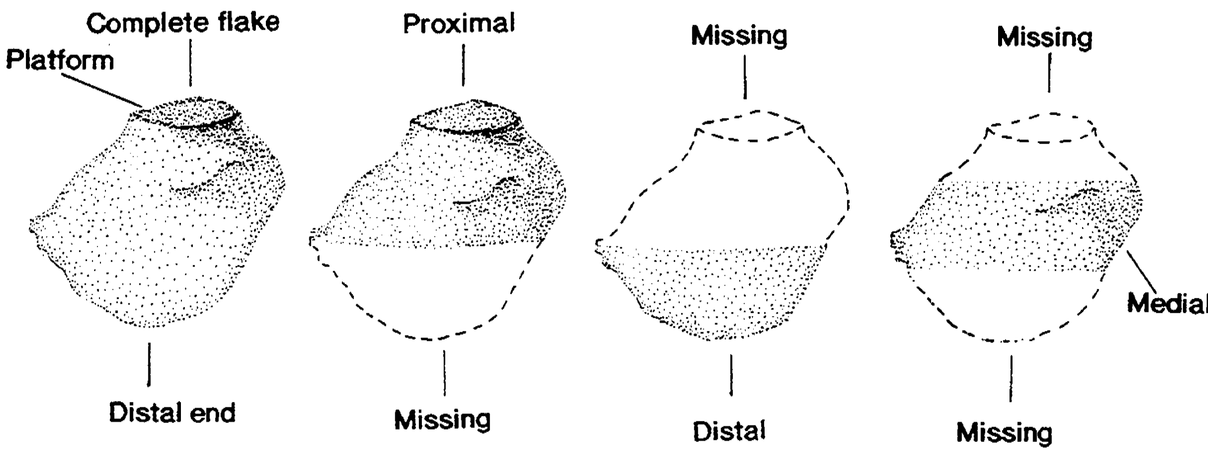
The attributes used in this analysis were selected from a variety of debitage attributes described in the work of Verrey (1986), Magne (1981, 1985), and Gunn and Mahula (1977), and are listed below:

1) Flake Type (complete, proximal, medial, or distal) (Figure 144). This variable measures the degree of breakage of the flake assemblage and is useful because biface reduction tends to produce more broken flakes than does production of flakes from cores. Biface reduction produces more broken flakes because during biface reduction the emphasis is on effectively reducing the thickness of the biface (Callahan 1979) and the production of flakes takes on a more secondary role. In contrast, core reduction emphasizes the flake and fewer broken flakes result.

2) Presence or Absence of Cortex. This attribute helps to determine if the flake was derived from a primary or secondary raw material source.

FIGURE 144

Flake Type



3) Flake Size (<2cm, >2cm-<5cm, >5cm)
(<10mm, >10mm-<15mm, >15mm-<20mm, >20mm-<25mm, >25mm-<30mm, >30mm-<35mm, >35mm-<40mm, >40mm-<45mm, >45mm)

4) Number of Flake Scars on the Flake's Distal Surface. This variable was recorded because flakes produced from biface reduction tend to have more remnant flake scars on their dorsal surface than do flakes derived from cores due to earlier episodes of bifacial reduction.

5) Number of Directions from which the Flake Scars Were Struck. This variable is also related to the identification of flakes produced from bifacial reduction, as opposed to cores, because flakes from bifacial reduction will show a greater number of flake directions on their dorsal surfaces due to earlier episodes of biface reduction.

6) Shape of the Flake Platform (flat, round, triangular) (Figure 145). Gunn and Mahula (1977) note that flat platforms are typical of flakes struck from cores, triangular platforms are typical of biface thinning flakes, and round platforms are typical of early stage biface reduction flakes and decortication flakes.

7) Presence or Absence of Remnant Biface Edges. This attribute is the best sign that a flake was derived from a biface rather than a core.

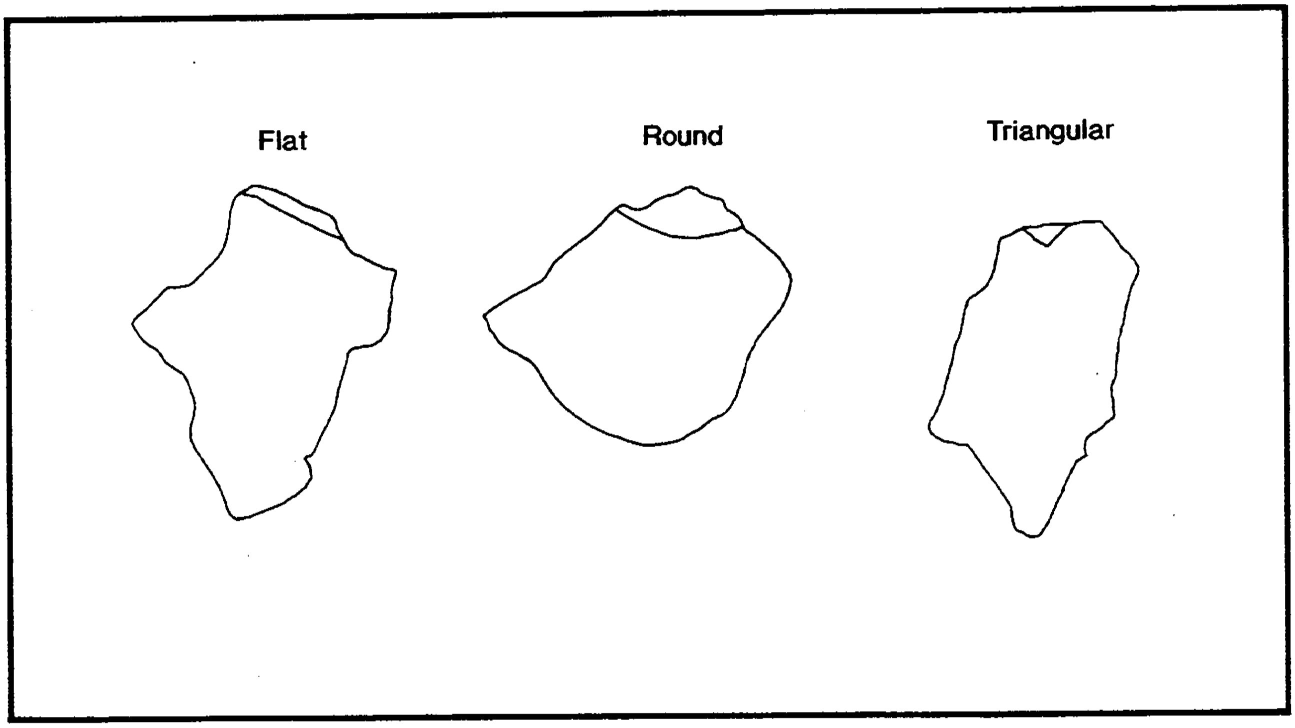
8) Presence or Absence of Retouch. This variable simply records whether or not the flake was retouched to have a particular edge shape.

CONTROL ANALYSES

The attributes listed above have been shown to be sensitive to the discrimination of flakes derived from bifaces from flakes removed from cores in the studies noted above especially Gunn and Mahula (1977) and Magne

FIGURE 145

Platform Shapes



(1981, 1985). Nonetheless, in order to test their validity as discriminating attributes, a series of control studies was undertaken using debitage from experimental reproductions of bifacial tools and debitage from archaeological contexts where refitting analyses confirmed the origin of flakes from either cores or bifaces. The first set of control debitage is a random sample of 100 flakes from the Fifty Site, a stratified Paleo-Indian/Early Archaic site from the Shenandoah Valley of Virginia. Refitting of the debitage (Carr 1986) from the site has shown that the flakes are primarily derived from the reduction of amorphous and blocky cores of jasper. The remaining control samples of debitage were derived from the manufacture of three bifaces by Errett Callahan. The three bifaces are depicted in Figure 146. One is an early stage biface and the other two are middle to late stage bifaces (see Callahan 1979 for a description of the stages). All of the debitage from the bifaces was saved by stage so that the samples could be divided into early and late stage debitage.

Table 44 shows the distribution of the flake attributes for each of the bifaces, the late stage biface samples combined all bifaces combined, and the core debitage from the Fifty Site. Table 45 shows the values of the test statistics for a series of comparisons of the debitage samples using difference-of-proportion and difference-of-mean tests (Parsons 1974). The first set of test statistics shows a comparison of the debitage samples from the two late stage bifaces. Some differences are noted with one of the debitage assemblages showing significantly more complete flakes, more examples of platform preparation, and more complex patterns of flake scars on the flakes' distal surfaces. However, the second two comparisons noted in Table 45 show that both late stage biface debitage assemblages are significantly different from the early stage biface. In general, there are significantly more complete flakes in the early stage assemblages, more small flakes in the later stage assemblages, more flake scars in more complex patterns among the late stage assemblages, and more triangular shaped platforms among the late stage assemblages. Because the late stage biface debitage assemblages were more like each other than they were like the early stage assemblage, these two samples were combined for analysis. A comparison of the early stage assemblage and the combined late stage sample is also noted in Table 45 and the results of comparison show the same pattern of significant differences above.

FIGURE 146
Biface Production Stages

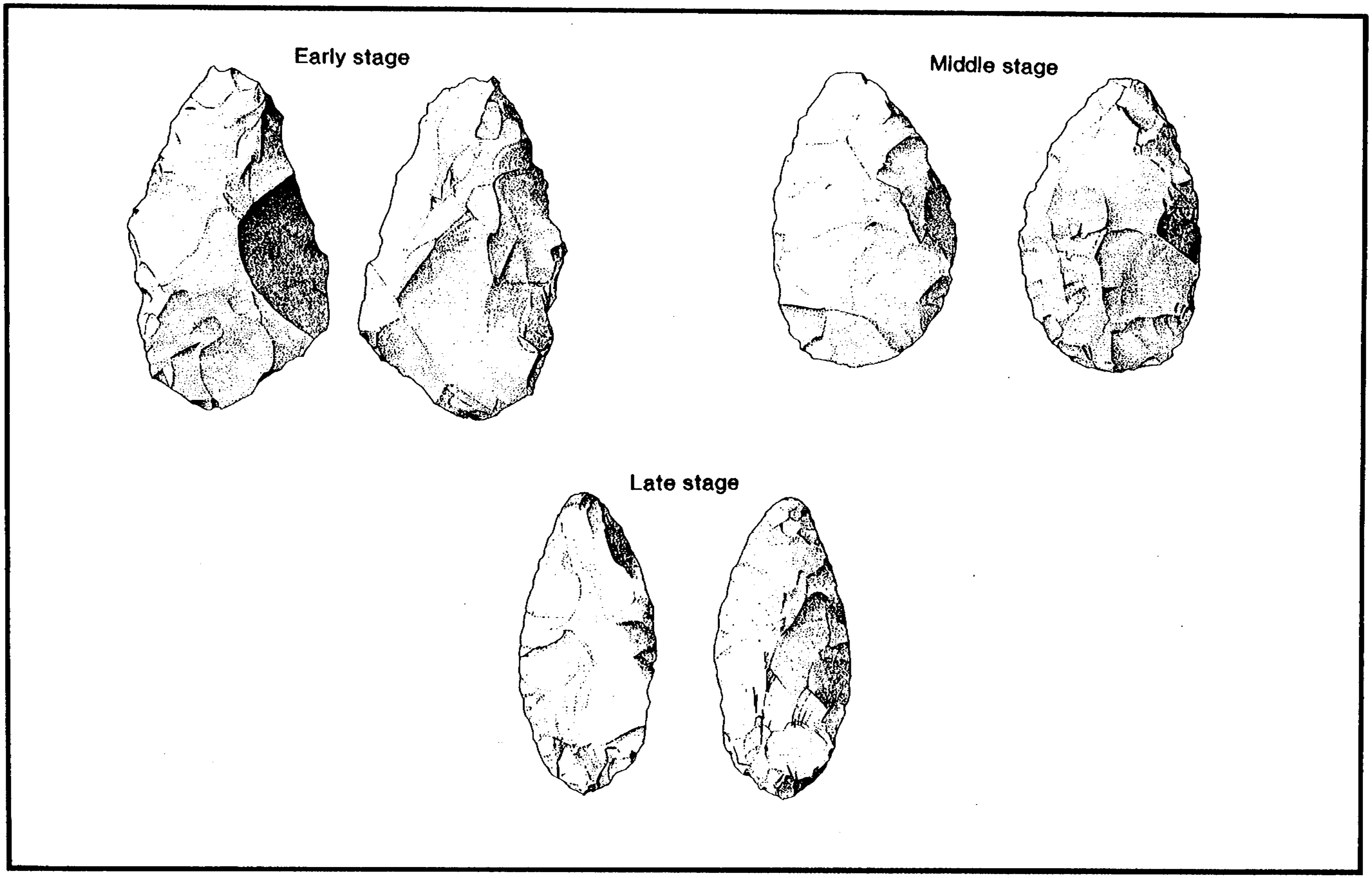


TABLE 44

DISTRIBUTION OF FLAKE ATTRIBUTES

Distribution	Callahan Early Stage Biface No. %	Callahan Late Stage Biface 1 No. %	Callahan Late Stage Biface 2 No. %	All Late Stage Bifaces No. %	All Bifaces No. %	44WR50 Core No. %
Flake Type						
Complete	30 (11)	6 (4)	21 (18)	27 (11)	60 (12)	63 (63)
Proximal	51 (19)	52 (38)	44 (38)	96 (38)	147 (28)	19 (19)
Medial	76 (29)	37 (27)	20 (17)	57 (22)	133 (26)	4 (4)
Distal	106 (40)	43 (31)	32 (27)	75 (29)	181 (35)	14 (14)
Cortex						
Yes	162 (61)	4 (3)	0 (0)	4 (2)	166 (32)	0 (0)
No	104 (39)	134 (97)	117 (100)	251 (98)	355 (68)	100 (100)
Size						
Large	11 (4)	1 (1)	1 (1)	2 (1)	13 (2)	5 (5)
Medium	66 (25)	25 (18)	16 (14)	41 (16)	107 (20)	46 (46)
Small	189 (71)	112 (81)	100 (85)	212 (83)	401 (78)	49 (49)
Scar Count						
Mean	1.81	2.25	2.13	2.19	2.00	1.33
Standard Deviation	1.01	.82	.86	.84	.95	1.22
Directions						
Mean	1.52	2.06	1.80	1.94	1.73	.73
Standard Deviation	.81	.66	.25	.69	.78	.60
Platform Shape						
Triangular	58 (67)	50 (91)	60 (91)	110 (91)	168 (81)	10 (10)
Round	8 (9)	5 (9)	3 (5)	8 (6)	16 (7)	37 (37)
Flat	20 (23)	0 (0)	3 (5)	3 (3)	23 (12)	35 (35)
Biface Edge						
Yes	12 (13)	17 (31)	11 (17)	28 (23)	40 (19)	3 (3)
No	77 (87)	38 (69)	55 (83)	93 (77)	170 (81)	97 (97)
Platform Preparation						
Yes	74 (90)	55 (98)	54 (82)	109 (77)	183 (88)	10 (10)
No	12 (10)	1 (2)	12 (18)	13 (23)	25 (12)	72 (72)
Number	268	141	119	260	528	100

TABLE 45

TEST STATISTICS FOR COMPARISONS

	LS1/ LS2	E/ LS1	E/ LS2	E/ LATE	44WR50/E	44WR50/L
Flake Type						
Complete	3.52*	2.34*	1.73	.29	10.06*	10.21*
Proximal	.01	3.98*	3.79*	4.61*	.08	3.37*
Medial	1.86	.44	2.44*	1.70	5.11*	4.12*
Distal	.67	1.80	2.42*	2.59*	4.76*	3.01*
Size						
Large	.11	1.91	1.69	2.45*	.34	2.56*
Medium	.96	1.52	2.45*	2.46*	3.85*	5.89*
Small	.92	2.21*	3.02*	3.27*	3.94*	6.55*
Scar Count						
Mean	1.14	4.75*	3.19*	4.69*	3.511*	6.49*
Standard Deviation	--	--	--	--	--	--
Directions						
Mean	4.32*	7.26*	5.13*	6.41*	10.16*	16.42*
Standard Deviation	--	--	--	--	--	--
Platform Shape						
Triangular	0.00	3.21*	3.44*	4.25*	8.11*	12.01*
Round	1.00	.04	1.12	.71*	4.14*	5.31*
Flat	1.60	3.86*	3.19*	4.69*	2.02*	6.63*
Biface Edge						
Yes	1.85	2.53*	.55	1.76	2.66*	2.57*
No	1.85	2.53*	.55	1.76	2.66*	2.57*
Platform Preparation						
Yes	2.92*	2.45*	.71	.72	10.39*	11.79*
No	2.92*	2.45*	.71	.72	10.39*	11.79*

* - Statistically Significant Difference

FIGURE 147

Comparison of Flake Attributes

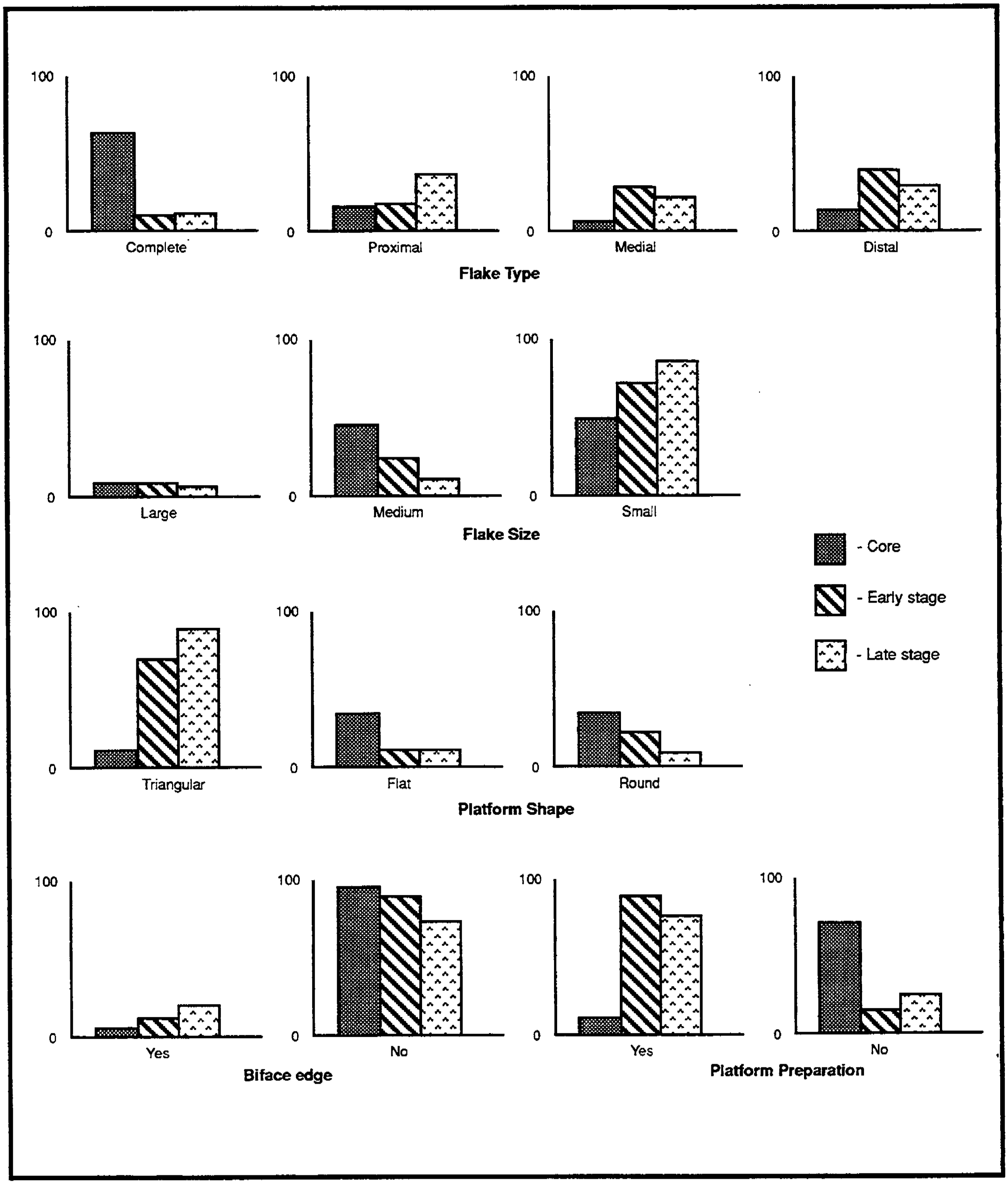


Figure 147 shows a comparison of the debitage assemblages from the core, the early stage biface, and the late stage bifaces. Test statistics from these comparisons are also noted in Table 45. With respect to flake types, the main difference between the biface and core debitage assemblages is the presence of significantly more complete flakes in the core assemblage. Significant differences are also noted in flake size with more smaller flakes present in the biface assemblages. Likewise, triangular-shaped platforms are significantly more common among the biface assemblages. Remnant biface edges are significantly more common among biface assemblages, as expected, and platform preparation is significantly more common among the biface assemblages as well.

In general, the comparison of the control assemblages confirms the results of prior studies (Magne 1981, 1985; Gunn and Mahula 1977). For the most part, a debitage assemblage from biface reduction is characterized by low proportions of complete flakes, large proportions of small flakes, large proportions flakes with triangular platforms, large proportions of remnant biface edges, and many instances of platform preparation. In contrast, core reduction debitage assemblages have large proportions of complete flakes, and few instances of triangular platforms, remnant biface edges, and platform preparation. These attributes will be applied to the debitage assemblages from Sites 7NC-J-134, 7K-C-359, 7K-C-363, 7K-C-364, 7K-C-367, and 7K-D-22 discussed in this report.