TECHNOLOGICAL ANALYSIS OF BLADES AND FLAKES FROM 'AIN GHAZAL

by
Gary O. Rollefson
and
Khaled Abu Ghaneima

Introduction

The analyses of chipped stone assemblages from later prehistoric periods in the Near East have until very recently concentrated primarily on typological grounds, effectively ignoring the vast amount of information contained in the unretouched flakes and blades commonly subsumed under the "waste" rubric. While the focus on the objects of a stone industry (i.e., the tools) is understandable in terms of cultural stability and change (cf. Mortensen, 1970), the means of production of these tools are of equal importance in cultural meaning. In fact, technological features become crucial when dealing with assemblages in which tools are rare (e.g., chipping stations), for there is little other information that can be used to determine cultural-temporal affinity.

The wealth of chipped stone tools from the 1982 excavations at 'Ain Ghazal provides an excellent opportunity to examine features of lithic manufacture which characterize this PPNB assemblage. It will also serve as a foundation for comparing techniques of flint knapping used by social groups at contemporary sites elsewhere in the Near East, and such an analysis can be used to detect similarities and differences in stone tool production in periods preceeding and following the PPNB.

A number of chipped stone artefacts were selected "semi-randomly" from one excavation trench (Sq. 3079) which, it was felt, would be representative of at least one part of the excavated areas at 'Ain Ghazal. The "semi-random" character of the sample should be understood to mean that while the artefacts were not selected in a statistically rigorous manner, the bags of artefacts were selected with no conscious bias or knowledge of what specific artefacts they contained.

In this preliminary analysis, several factors were chosen for monitoring which were deemed important in detecting specific methods and selected options which they may have cultural-temporal bearing. These features include artefact classes, platform types, "directionality" of blade production (see below), presence or absence of natural backing, relative amounts and location of cortex, skew angles, and raw material colour. While several authors have noted some of these features as distinguishing early Neolithic technologies from others (e.g. Mortensen, 1970; Stekelis, 1972; Moore, 1973), there are no published numerical treatments which allow quantitative comparisons among any assemblages. Furthermore, recent analyses of so-called PPNB burin sites (Betts, 1982, and personal communication; Rollefson and Frohlich, 1982) have called into question the reliance of strictly typological determinations of cultural-temporal associations, especially when diagnostic projectile points are not found in a particular site's inventory.

The features selected for this analysis obviously are not exhaustive, but with the limited time available, it was felt that this was the maximum amount of information we could monitor efficiently. Artefact dimensions are of prime importance for future analytical work, particularly measurements of specific flake landmarks such as the width and thickness of striking platforms. Additional features, such as relative platform reduction and platform angles, and finer classification of flake and blade forms are also called for in more detailed analyses.

Artefact Classes

Table 1 presents a breakdown of the general artefact classes in the sq. 3079 sample. The relative frequencies show close correspondence with those for the site as a whole (Rollefson, this volume, Table 1), suggesting that the "semi-randomness" of the sample is adequately representative for the technological features to be discussed below. In Table 1, the "crested elements" refer to core preparation flakes of various aspects (primary and secondary crest blades in Mortensen, 1970: 17-18) which are lumped here for the sake of brevity. The "Other" category includes flakes of rare but specifically recurring (in other samples) shapes or features. In the Sq. 3079 sample, one of these flakes is a primary core tablet (Mortensen, 1970: 17), two are burin spalls, one is a flake of bifacial retouch, another is an angular flake with very steep lateral edges, and the last is a "pseudo-primary crest blade" whose surface is covered with more than 50% cortex. All of the crested elements and "other" flakes are included in the Flake category for the tabulation of artefact classes for the entire site. In subsequent discussions, the debris and indeterminate material (effectively "large debris") will not be included.

Table 1. Absolute and Relative Frequencies of Artefact Classes from the Sq. 3079 Sample from 'Ain Ghazal

Class	*n*	%	%
Core	6	1.1	
Flake	194	35.7	41.8
Blade	309	56.9	58.2
Crested Element	28	5.2	
Other	6	1.1	
Subtotal	543	100.0	100.0
Debris	134	(19.5)	
Indeterminate	11	(1.6)	
Total	688		

Platform Types

The platform types monitored in this analysis are listed in Table 2. The plain platform type has a single facet and may be cortical or non-cortical. Dihedral platforms have two facets, and the multiple facet platform displays three or more facets.

For blades, punch platforms are normally punctiform in shape and usually display a heavy degree of platform reduction on the exterior edge. Occasionally the punch platform may be rather broad (usually with evidence of a single facet), but this is most likely a result of the vagaries of placing the punch on the core and is not a reflection of direct percussion near the edge of a core. For flakes (and some blades), the use of indirect percussion is evidenced solely by extreme platform reduction on the exterior edge of a thin but wide platform. On very thin flakes and blades, punch platforms frequently shatter; such shattered platforms were counted among the punch platform type.

The figures in Table 2 show substantial differences in flake and blade production. Of the flakes, only 36% had punch platforms, and these may relate primarily to the initial preparation of the crest on a blade core. In contrast, punch platforms dominate the blade class, with only 15% of the blades possessing other kinds of platforms. It is possible that plain platforms indicate a special kind of blade production, resulting in thicker pieces for particularly heavy-duty work. This subjective impression requires additional investigation involving correlations of blade measurements, platform dimensions, and specific tool types made on blades.

For the "Other" category in Table 2, crested elements and diverse flake forms were combined because of their small numbers. The angular flake had a plain platform, the core tablet and flake of bifacial retouch revealed multiple facet platforms (to be expected), and both burin spalls had crushed platforms (included in the punch type).

The frequencies of missing platforms reveals the amount of damage that occurred to the various elements either during the detachment from the core or after the pieces were discarded. One other factor involving missing platforms involves intentional removal while forming retouched tools, something that was not monitored for this particular analysis. The difference in missing platforms between flakes and blades may relate to the relative delicacy of the latter, although the high incidence of missing platforms among the normally robust crested elements tends to refute this interpretation.

"Directionality" of Blade Production

It has been noted that bidirectional blade cores are characteristic of the early Neolithic (Moore, 1973: 51), yet single platform cores are by no means unpopular (Rollefson, 1982). Although the typological classification of the cores from 'Ain Ghazal is still in progress, some indication of the popularity of blade core types might be revealed on the blades themselves.

In most cases, the negative scars on the exterior surface of a blade will show whether earlier blades from the same core were removed from a single platform or whether they were detached from opposed platforms. One factor can affect this "second-hand" determination, however, and in this respect the figures in Table 3 may be misleading: if a bidirectional blade core is very long, short blades removed from either platform may not extend far enough along the core to interesect negative scars originating from the other platform. Many of the blades in the Sq. 3079 sample are, in fact, rather short, and many were broken.

Strictly, the determination of directionality using negative blade scars should be limited to pieces, broken or complete, that are at least as long as half the median length of bidirectional blade cores in the assemblage. It has been acknowledged that time constraints affected the present analysis, yet a subjective attempt to abate this source of error was applied: if a complete blade was quite short (*ca.* 4 cm. or less) or if the broken blade was so short that any evidence of bidirectionality was unlikely to have been preserved, the case was deemed "indeterminate". This was the case in 20% of the blades in the sample.

However rigorously the figures in Table 3 are to be viewed, the nearly two-to-one ratio for unidirectional blades still is strong evidence for the popularity of single platform cores in the PPNB period. However, a third of the blades exhibit definite evidence of bipolar blade production, and this may have important consequences for assessing the probable age or socio-cultural affinity of many of the burin sites in the eastern deserts of Jordan, where unidirectional blade production is

Table 2. Absolute and Relative Frequencies of Platform Types on Flakes and Blades in the Sq. 3079 Sample from 'Ain Ghazal

Type	*Flakes*		*Blades*		*Other*	
	n	*%*	*n*	*%*	*n*	*%*
Plain	59	45.7	21	12.5	1	5.9
Dihedral	16	12.4	2	1.2	—	0.0
Multiple facet	7	5.4	2	1.2	2	11.8
Punch	47	36.4	143	85.1	14	82.4
Subtotal	129	99.9	168	100.0	17	100.1
Missing	65	(33.5)	141	(45.6)	17	(50.0)
Total	194		309		34	

Table 3. Absolute and Relative Frequencies of Evidence for "Directionality" Involved in Blade Production in the Sq. 3079 Sample from 'Ain Ghazal.

	Blades		*Flakes*		*Other*	
	n	%	*n*	%	*n*	%
Unidirectional	168	67.5	31	91.2	11	64.7
Bidirectional	81	32.5	3	8.8	6	35.3
Subtotal	249	100.0	34	100.0	17	100.0
Indeterminate	60	(19.4)			8	(32.0)
Total	309				25	

the norm (Rollefson and Frohlich, 1982; Rollefson and Muhaisen, n.d.).

The figures for directionality among the flakes in the sample reflect attempts at blade production that failed. In thirty-four instances, negative scars indicated previous removals of blades from a blade core, but in these cases efforts resulted in pieces with meandering lateral edges. Since all of these pieces are accidental products, the nine-to-one ratio of directionality is not very telling. In the "Other" category (considering only the crested elements), the correspondence with the blades is quite close, suggesting again that unidirectional blade production was popular.

Natural Backing

Attention to the production of naturally-backed elements (flakes and blades which have one steep edge covered with cortex) has not been very intense concerning Neolithic stone tools, but the influence of particular forms of raw material and specific methods of lithic manufacture adopted for tool production have been shown to be of particular importance for earlier prehistoric periods (Rollefson 1981a; 1981b). Analysis of materials from Jebel Uweinid (Rollefson and Frohlich, 1982) and the Kharaneh area (Rollefson and Muhaisen, n.d.) showed a dominating reliance on natural backing during the PPNB, although other contemporary assemblages from southern Jordan suggest a different approach to tool production (MacDonald, Rollefson, and Roller, 1982).

In all cases at 'Ain Ghazal, natural backing constitutes a minor element in the lithic techniques used at the site (Table 4). For finished tools (which have not been adequately sampled in this analysis), natural backing is even less evident.

Table 4. Absolute and Relative Frequencies of Cases of Natural Backing on Flakes and Blades from the Sq. 3079 Sample from 'Ain Ghazal.

	Flakes		*Blades*		*Other*		*Total*	
	n	%	*n*	%	*n*	%	*n*	%
Backed	7	3.6	23	7.4	2	5.9	32	6.0
Not backed	187	96.4	286	92.6	32	94.1	505	94.0
Totals	194	100.0	309	100.0	34	100.0	537	100.0

Cortex

The amount of cortex which occurs on the exterior surface of chipped stone artefacts is one measure of the efficiency of lithic production, although interpretations of this efficiency can become quite complicated due to the complex interrelationships among desired end-products (tools), available resources (tabular or nodular cores, or non-cortical flint/chert outcrops), methods employed in flake and blade production (especially direct vs. indirect percussion), resource abundance, and temporal-cultural development.

Among the flakes in the sample, some 15% are mostly cortical (Table 5), indicating preliminary preparation of cores for subsequent removal of flakes and blades. While nearly half of the flakes have little or no cortex, this contrasts sharply with the blade category, where nearly 88% of the pieces are relatively cortex free. In a Chi-Square comparison, this difference is significant at beyond the .001 level of significance. While some of the flakes produced in the early stages of core reduction at 'Ain Ghazal were intended for use as tools (as cortical scrapers, for example), the presence of even small amounts of cortex on blades made them unsuitable for conversion into tools.

Colour

Moore has noted a prevalence of, if not a preference for, purple-colored flint in the early Neolithic, and honey-colored flint was also a prized resource (Moore, 1973: 47). Certainly this must take into account the local availability and costs of obtaining such resources. While purple flint is relatively abundant in northwestern Jordan, for example, it is quite rare in parts of the eastern deserts of Jordan (cf. Rollefson, 1982).

The artefacts from the Sq. 3079 sample were sorted according to the colours listed in Table 6. This process was not simple, since there is a subtle gradation from one hue to another, and subjective assessments were sometimes necessary to distinguish between the categories. The use of a system similar to the Munsell colour charts would be preferable, yet the colours in the Sq. 3079 sample ranged far beyond the Munsell charts commonly used in Near Eastern archaeology. In other cases, more than one colour was present on an artefact; in these instances, the predominant colour was selected.

The prevalence of purple and pink flint, characteristic of the early Neolithic, is reflected in the figures in Table 6, where these colours account for a majority for all flakes, blades, and other material. A survey of the immediate vicinity of 'Ain

Table 5. Absolute and Relative Frequencies of Cortex Categories Among the Flakes and Blades in the Sq. 3079 Sample from 'Ain Ghazal. ("c.p." stands for cortical platform).

	Flakes		*Blades*		*Other*	
	n	%	*n*	%	*n*	%
No Cortex	87	44.8	243	78.6	27	79.4
None except platform	6	3.1	3	1.0	—	0.0
1-10% Cortex	14	7.2	20	6.5	3	8.8
1-10% with c.p.	8	4.1	2	0.6	—	0.0
10-50%	44	22.7	36	11.6	2	5.9
10-50% with c.p.	5	2.6	1	0.3	1	2.9
50-90%	14	7.2	4	1.3	—	0.0
50-90% with c.p.	2	1.0	—	0.0	1	2.9
100% except platform	9	4.6	—	0.0	—	0.0
100% with c.p.	5	2.6	—	0.0	—	0.0
Total	194	99.9	309	99.9	34	99.9
Cortical platforms	26	(13.4)	6	(1.9)	2	(5.9)

Ghazal is necessary to determine whether this selection reflects locally available resources, or whether special efforts were necessary to obtain this flint from farther afield. (Such a survey is planned for 1983).

The other colours are less meaningful at this stage of the analysis, although the rare occurrence of butterscotch flint is restricted to blades. (A similar situation was noticed at 'Ain el-Assad; cf. Rollefson, 1982). We have the subjective impression that gray flint is generally grainier and less homogeneous than the other materials, and its relative popularity among the flakes may relate to the manufacture of generally cruder tools used in heavy-duty tasks. In some cases, however, gray flint is an excellent material, used in many cases for projectile points.

Skew Angles

Attention to this feature of lithic technology is a relatively recent development (Leach, 1969), and its importance in assessing the selectivity of specific blades and flakes for use as tools has been shown to be critical in earlier prehistoric periods (Jelinek, personal communication, 1977). The skew angle classes used in this analysis measure the divergence of the direction of force applied to the core (the axis of force) and the resulting axis of the flake or blade relative to the platform. Normally, the axis of force is applied 90° (perpendicular) relative to the plane of the platform, but the longest measurement from the point of percussion to the terminal point of the flake or blade is not along that 90° axis in all cases. The angle classes in Table 7 are taken from the Tabun Cave analysis (Jelinek, personal communication, 1977).

The results of the skew angle analysis are presented in two forms in Figure 1. In absolute counts (the numbers of flakes and blades for which this feature could be measured), the orthogonal products (Class 5) are the most frequent for both flakes and blades. The histograms (Fig. 1, bottom) indicate a more random distribution of divergent flakes, with a slight right-handed skew. Blades, on the other hand, show a much more marked kurtosis in the orthogonal class with a narrower range of divergence from the axis of force. The graph showing percentages of flakes and blades in each skew angle class (Fig. 1, top) reflects these differences more markedly.

Figure 1 demonstrates the high degree of skill and careful attention paid to blade and flake production at 'Ain Ghazal. For blades, in particular, the heavy reliance on indirect percussion resulted in predictable shapes, reflecting the efficiency of this

Table 6. Absolute and Relative Frequencies of Colours Among the Artefacts in the Sq. 3079 Sample from 'Ain Ghazal.

	Flakes		*Blades*		*Other*	
	n	*%*	*n*	*%*	*n*	*%*
Brown	33	17.8	60	21.5	2	6.9
Tan	20	10.8	36	12.9	3	10.3
Butterscotch	—	0.0	8	2.9	—	0.0
Pink	11	5.9	7	2.5	4	13.8
Purple	89	48.1	141	50.5	19	65.5
Gray	30	16.2	24	8.6	1	3.4
White	2	1.1	3	1.1	—	0.0
Subtotal	185	99.9	279	100.0	29	99.9
Indeterminate	9	(4.9)	29	(9.4)	5	(14.7)
Total	194		309		34	

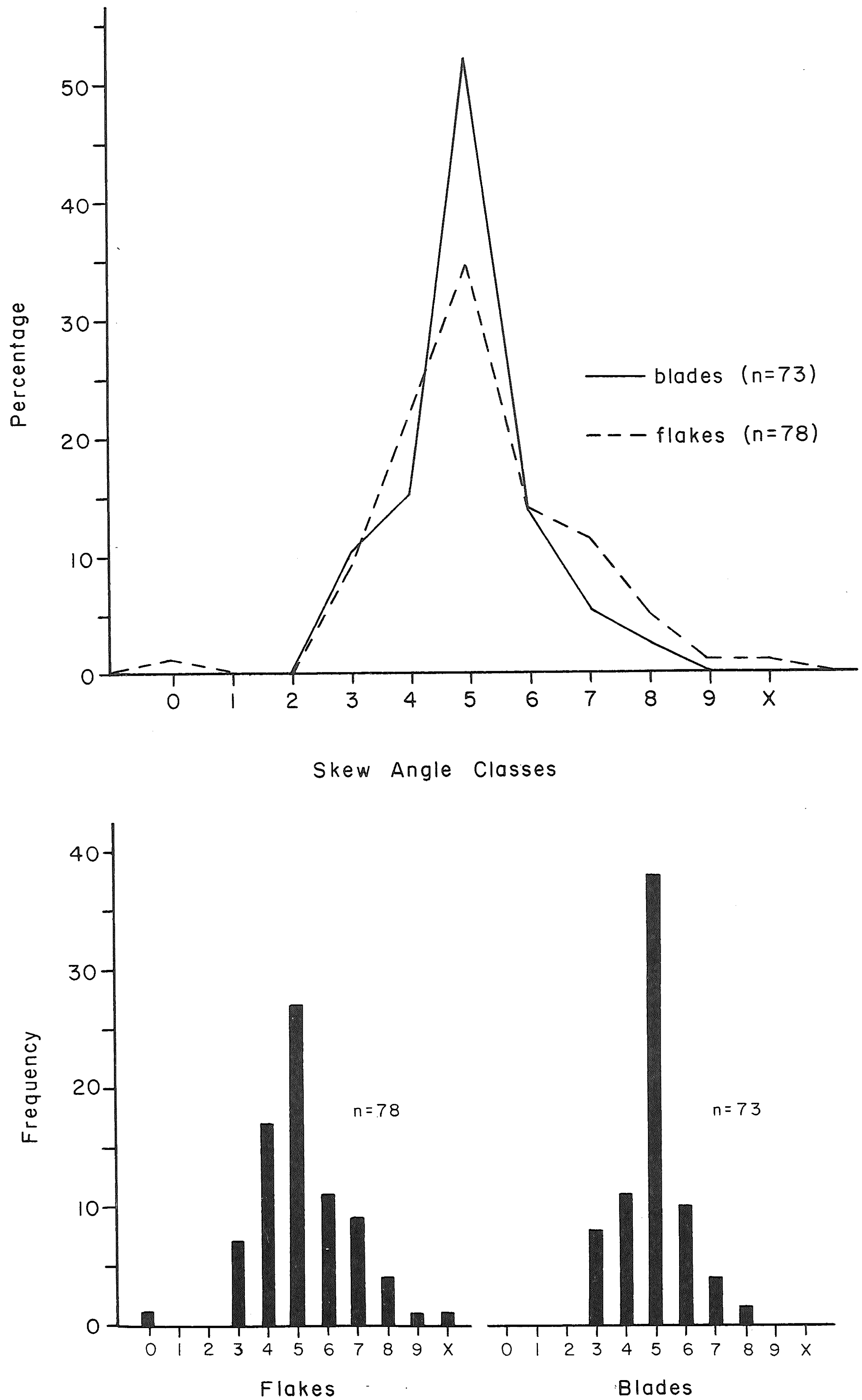

Fig. 1 Relative (top) and absolute frequencies of skew angle classes among blades and flakes in the Sq. 3079 sample from Ain Ghazal.

Table 7. Skew Angle Classes Used in the Analysis of the Sq. 3079 Sample of Flakes and Blades (after Jelinek, 1977).

Class	*Degree Range*	*Class*	*Degree Range*	*Class*	*Degree Range*
0	0-30	4	75-85	8	120-135
1	30-45	5	85-95	9	135-150
2	45-60	6	95-105	X	150-180
3	60-75	7	105-120		

method of blade production. In contrast, the blades and flakes from the Jebel Uweinid and Kharaneh burin sites was more haphazard, probably because direct percussion techniques were used so predominantly. Similar cases of the correlation of punch techniques and orthogonal blades have been noted at other Neolithic and Epipaleolithic sites in Jordan (Rollefson, n.d.).

Summary

The technological analysis of flake and blade production in the Sq. 3079 sample from 'Ain Ghazal provides a first step for developing a systematic foundation of comparing lithic technologies used by early Neolithic flintworkers in the Near East. Although little comparable material is now available from larger villages from this time period, future investigations utilizing this approach could add to our understanding of the degree of sharing of lithic traditions among contemporary peoples.

Whatever may be the traditional relationships among the permanent populations of the area during the PPNB, certainly the occupants of the specialized PPNB camps (burin sites) from the eastern deserts of Jordan used more diverse methods of stone tool manufacture. In some cases the diversity is of a magnitude to call into question whether the PPNB assignation is legitimate: although the desert sites may be of comparable age, the traditions of chipped stone tool manufacture evident in the assemblages from the eastern areas suggest a cultural milieu and resource exploitation quite different from the more established social groups of the western highlands.

Within the 'Ain Ghazal area itself, it is apparent that the flintknappers demonstrate a sophisticated and efficient set of methods for producing stone tools. How closely the traditions at 'Ain Ghazal are related to other major population centres in the area remain to be determined.

Gary O. Rollefson
Yarmouk University
Irbid, Jordan.

Khaled Abu Ghaneima
Department of Antiquities

Bibliography

A. V. G. Betts, Appendix C: Qa'a Mejalla Survey (1979), p. 243-246 in S. W. Helms, *Jawa, Lost City of the Black Desert,* London, 1981.

Prehistoric Sites at Qa'a Mejalla, Eastern Jordan, *Levant,* 14 (1982) p. 1-34.

B. Leach, The Concept of Similarity in Prehistoric Studies, *Studies in Prehistoric Anthropology I,* University of Otago, 1969.

B. MacDonald, G. Rollefson, and D. Roller, The Wadi el-Hasa Survey 1981: A Preliminary Report, *ADAJ,* 26 (1982).

A. T. M. Moore, The Late Neolithic in Palestine, *Levant,* 5 (1973) p. 36-68.

P. Mortensen, Preliminary Study of the Chipped Stone Industry from Beidha, *Acta Archaeologica,* 41 (1970) p. 1-54.

G. O. Rollefson, A Lower Paleolithic Surface Site near Shoback, Wadi el-Bustan, Southern Jordan, *ADAJ,* 25 (1981). p. 153-170; 395-408.

Late Acheulian Artefacts from Ain el-Assad (Lion's Spring), near Azraq, Eastern Jordan, *BASOR,* 240 (1981)

Preliminary Report on the 1980 Excavations at Ain el-Assad, *ADAJ,* 26 (1982).

Quantitative and Qualitative Analysis of the ACOR Lithics Collections, Unpublished manuscript, n.d.

G. O. Rollefson and Bruno Frohlich, A PPNB Burin Site at Jebel 'Uweinid, Eastern Jordan, *ADAJ,* 26 (1982).

G. O. Rollefson, M. Muhaisen, A Specialized PPNB Camp near Kharaneh Castle, Eastern Jordan, Manuscript in preparation, n.d.

M. Stekelis, *The Yarmoukian Culture of the Neolithic Period,* Jerusalem, 1972.